Department of Chemical Sciences

Course Structure and Syllabus of Integrated B.Sc.-B.Ed. in Chemistry
(Four Year Course/VIII-SEMESTER)

Minimum credit requirement :170

COURSE STRUCTURE

Semester I

Course Code	**Course Name**	**L-T-P**	**CH**	**CR**	**Remark**
PD 101	Physics-I	2-0-1	4	3	
CD 101	Chemistry-I	2-0-2	6	4	
BI 101	Biology-I	2-0-1	4	3	
MD 101	Mathematics-I	2-1-0	3	3	
ED 101	Education: An Evolutionary Perspective	2-0-1	4	3	Education
ED 104	Communicative English (Language Proficiency)	2-1-0	3	3	Education
ED 105	Basics in Computer Applications	2-0-1	4	3	Education
Total credits				**22**	

Semester II

Course Code	**Course Name**	**L-T-P**	**CH**	**CR**	**Remark**
PD 102	Physics-II	2-0-1	4	3	
CD 102	Chemistry-II	2-0-2	6	4	
BI 102	Biology-II	2-0-1	4	3	
MD 102	Mathematics-II	2-1-0	3	3	
ED 102	Education and Development	2-0-1	4	3	Education
NS 102	National Service Scheme (N.S.S/NCC)	0-0-2	4	2	
	CBCT Elective			3	CBCT
Total credits				**21**	

Semester III

Course Code	Course Name	L-T-P	CH	Credit	Remark
CD 201	Physical Chemistry-I	2-1-0	3	3	
CD 203	Organic Chemistry-I	2-1-0	3	3	
CD 205	Inorganic Chemistry-I	2-1-0	3	3	
CD 207	Chemistry Laboratory-I	1-0-0	2	1	**Not approved by AC**
MD 211	Numerical Methods and integrals	2-1-0	3	3	Common paper
PD 211	Quantum Physics	2-1-0	3	3	
ED 201	Environmental Education	2-0-1	4	3	Education
ED 202	Learner and Learning	2-0-1	4	3	Education
	CBCT Elective			3	CBCT
Total credits				**25**	

Semester IV

Course Code	Course Name	L-T-P	CH	Credit	Remark
CD 202	Physical Chemistry-II	2-1-0	3	3	
CD 204	Organic Chemistry-II	2-1-0	3	3	
CD 206	Inorganic Chemistry-II	2-1-0	3	3	
CD 208	Chemistry Laboratory-II	0-0-3	6	3	**Not approved by AC**
MD 212	Introductory Statistics	2-1-0	3	3	Common paper
PD 216/ BI 224	Thermodynamics and Optics /Ecology and Environmental Biology	2-1-0/ 2-1-0	3/ 3	3/ 3	
ED 203	Contemporary Issues in Education	2-0-1	4	3	Education
ED 204	Assessment and Evaluation	2-0-1	4	3	Education
Total credits				**24**	

Semester V

Course Code	Course Name	L-T-P	CH	Credit	Remark
CD 301	Physical Chemistry – III	3-0-0	3	3	
CD 303	Organic Chemistry-III	3-0-0	3	3	
CD 305	Inorganic Chemistry-III	3-0-0	3	3	
CD 307	Chemistry Laboratory-III	0-0-3	6	3	
ED 301	Teaching Approaches and Strategies	2-0-1	4	3	Education
ED 302	Classroom Organization and Management	2-0-1	4	3	Education
	CBCT Elective			3	CBCT
Total credits				**21**	

Semester VI

Course Code	Course Name	L-T-P	CH	Credit	Remark
CD 302	Physical Chemistry-IV	3-0-0	3	3	
CD 304	Organic Chemistry-IV	3-0-0	3	3	
CD 306	Principles and Applications of Spectroscopy	3-0-0	3	3	
ED 308	Pedagogy A: Physical Science I	2-0-1	4	3	Education
ED 307 or ED 309	Pedagogy B: Mathematics I Or Pedagogy B: Bio Science I	2-0-1 or 2-0-1	4 or 4	3 or 3	Education

ED 303	School Education in North East India	2-0-0	2	2	Education
	CBCT Elective			3	CBCT
Total credits				**20**	

Semester VII

Course Code	**Course Name**	**L-T-P**	**CH**	**Credit**	**Remark**
CD-401	Quantum Chemistry and Chemical Bonding	3-0-0	3	3	
CD-403	Inorganic Chemistry-IV	3-0-0	3	3	
CD-405	Chemistry Laboratory IV (Organic Chemistry)	3-0-0	6	3	
ED 408	Pedagogy A:Physical Science II	2-0-1	4	3	Education
ED 407 or ED 409	Pedagogy B: Mathematics II or Pedagogy B Biological Science II	2-0-1 or 2-0-1	4 or 4	3 or 3	Education
ED 404	Initial School Experience/ school Internship-I	0-0-3	6	3	Education
	CBCT Elective			3	CBCT
Total credits				**21**	

Semester VIII

Course Code	**Course Name**	**L-T-P**	**CH**	**Credit**	**Remark**
CD-402	Chemistry Laboratory- V	3-0-0	6	3	

	(Computational Chemistry)				
CD-404	Chemistry Laboratory- VI (Inorganic Chemistry)	2-0-0	4	2	
ED 405	School Internship	0-0-12	24	12	Education
	CBCT Elective			3	CBCT
Total credits				**20**	

L: Lectures T: Tutorials P: Practical CH: Contact Hours (all per week) CR: Credit
MD: Courses offer by the Department of Mathematical Sciences
PD: Courses offer by the Department of Physics
CD: Courses offer by the Department of Chemical Sciences
BI: Courses offer by the Department of Molecular Biology and Biotechnology

Total Credit : (22+21+24+21+21+20+21+20) = **170**
Total Credit in Lab & Project : (6+7+2+2+2+2+5+12) = **38**
Total Credit excluding Lab & Project : = **132**
Total Credit in CBCT : (0+3+3+0+3+3+3+3) = **18**
(Choice Based Credit Transfer)

Note: 1. CBCT Elective-I to CBCT Elective-VI are to be chosen from the list of CBCT courses given below.

Course Code	Course Name	L-T-P	CH	Credit	Remark
CS 535	Introduction to Scientific Computing	2-0-1	4	3	
EG 101	Communicative English	2-1-0	3	3	
ES 102	Elementary Environmental Science	2-1-0	3	3	
EG 102	Communicative English-II	2-1-0	3	3	Proposed to be introduced
SC 102	Basic Sociology	2-1-0	3	3	
ES 542	Laboratory Guidance and Safety	2-1-0	3	3	Proposed to be introduced
BM 101	Elementary Economics	2-1-0	3	3	
CL 121	Basic Chinese-I	2-1-0	3	3	Proposed to be introduced
FL 101	Basic French-I	2-1-0	3	3	Proposed to be introduced
GL 101	Basic German-I	2-1-0	3	3	Proposed to be introduced
DM 301	Disaster Management	2-1-0	3	3	Proposed to be introduced
CL 122	Basic Chinese- II	2-1-0	3	3	Proposed to be introduced

FL 102	Basic French-II	2-1-0	3	3	Proposed to be introduced
GL 102	Basic German-II	2-1-0	3	3	Proposed to be introduced

Detailed Syllabi

FIRST SEMESTER

CD 101 Chemistry I **L2-T0-P2-CH6-CR4**

Unit I

Structure of atom, Hund's rule, Aufbau principle, Pauli's exclusion principle.

Periodic Properties:

Periodicity of the elements, shielding, effective nuclear charge, Slater's rule, the size of the atoms, atomic, covalent and van der Waals radii, ionization energy, electron affinity, electronegativity.

Unit II

Reactivity effects:

Hybridization (sp, sp^2, sp^3) of organic molecules, Inductive effects, Hyperconjugation, Electromeric effect, Mesomeric effect, Resonance theory, Tautomerism, Steric effect, Strain theory, Conformation of substituted and unsubstituted cyclohexane

Nomenclature:

IUPAC nomenclature of organic compounds including bicyclic compounds

Alkanes:

Preparation, properties and reactions

Alkenes:

Preparation, properties and reactions, Cis-trans isomerism, Markownikoff's and anti-Markownikoff's addition rules, Saytzeff rule

Unit-III

First Law of Thermodynamics:

Thermodynamics terms, state and path functions, concept of heat and work, internal energy, enthalpy, first law of thermodynamics; w, q, ΔU and ΔH for expansion and compression of ideal gases, heat capacities, physical change, standard enthalpies of physical and chemical changes, Hess's law, Kirchhoff's law.

Second Law of Thermodynamics:

Spontaneous processes, Carnot cycle, entropy, criteria of spontaneity, statements of the second law of thermodynamics, entropy changes, Clausius inequality, Gibbs energy, Helmholtz energy. Third law of thermodynamics.

Solutions:

Ideal and non-ideal solutions.

Colligative properties.

Practical:

1. Preparation of buffer solution and measurement of pH.
2. Viscosity measurement of solution.
3. Conductometric acid-base titration.
4. Measurement surface tension of liquid by stalagmometer.
5. Verification of Beer-Lamberts law.
6. Titration of a mixture of AcOH, HCl and $CuSO_4$ by conductometric method.

Textbooks

1. Lee, J. D. *Concise Inorganic Chemistry,5thEdn.* (Chapman & Hall, 2002).
2. Viswanathan, B., Raghavan, P. S. *Practical Physical Chemistry* (Viva Books Private Limited, 2005).
3. Carey, F. A., Sundberg, R. J. *Advanced Organic Chemistry, 4th ed.,* (Plenum Publishers, 2001).

Reference Books

1. Atkins, P., Paula, J. de. *Elements of Physical Chemistry, 4th Edn*. (Oxford University Press, 2005).
2. Puri, B. R., Sharma, L. R., Pathania, M. S. *Principles of Physical Chemistry, 2nd Edn.* (Shoban Lal Nagin Chand and Co. 1980).
3. Clayden, J., Greeves, N., Warren, S., Wothers, P. *Organic Chemistry* (Oxford University Press, 2008).

SECOND SEMESTER

CD 102 : Chemistry-II **L2-T0-P2-CH6-CR4**

Unit I

Structure and Bonding:

Valence Bond and LCAO-MO theory, bonding in homonuclear diatomic molecules, covalent and ionic bonding, resonance, formal charge, hybridization, VSEPR model. Polarizability of cations and anions, Fazan's rules.

Unit II

Fundamental reactions of organic molecules:

Chemical reactions and mechanism, nucleophile and electrophile, substitution and elimination reactions, addition reactions, condensation reactions, rearrangement reactions.

Stereochemistry:

Optical isomerism, Chirality, racemic mixture, relative and absolute configuration determination, Fisher, Newman and Sawhorse representation, D-L notation, R/S and E/Z nomenclature

Reactive intermediates:

Carbocation, carbanion, carbene, nitrene, benzyne-Generation, stability and reactions

Unit III

Properties of gases and liquids:

Equations of state, kinetic model of gases, collision theory, real gases, Maxwell distribution of molecular speeds, qualitative description of the structure of liquids, surface tension and viscosity

Electrochemistry:

Conduction in electrolyte solutions, ionic mobility, Kohlrausch law, Ostwald's dilution law, transport number, Debye-Huckel Limiting Law, electrochemical cells, EMF, Nernst equation

Rate of reactions:

Rate equations of zero, first, second, pseudo 1st order reactions, determination of order of a reaction, activation energy, activated complex theory, collision theory.

Practical:

Unit I

Preliminary investigations and qualitative analysis of solid organic compounds with functional groups detection.

Unit II: Qualitative Analysis of Inorganic Mixtures (excluding interfering radicals).

Textbooks*

1. Atkins, P., Paula, J. de. *Elements of Physical Chemistry, 4th Edn*. (Oxford University Press, 2005).
2. Shriver, D. F., Atkins, P. W. *Inorganic Chemistry 3rd Edn*, (Oxford University Press, 1999).
3. Furniss, B. S., Ford, A. J. H., Smith, P. W. H., Tatchell, A., R. *Vogel's Textbook of Practical Organic Chemistry, 5th Edn*. (John Wiley, 1989).
4. Svehla, G., *Vogel's Qualitative Inorganic Analysis, 7th Edn.* (Prentice Hall, 1996).
5. Smith, M. B., March, J. *March's Advanced Organic Chemistry, Reaction Mechanism and Structure* (John Wiley, 2001).

** We could not reduce the number of textbook as this paper involves both theory (inorganic, organic and physical) and practicals (inorganic, and organic).*

Reference books

1. Viswanathan, B., Raghavan, P. S. *Practical Physical Chemistry* (Viva Books Private Limited, 2008).
2. Clayden, J., Greeves, N., Warren, S., Wothers, P. *Organic Chemistry* (Oxford University Press, 2008).
3. Vishnoi, *Advanced Practical Organic Chemistry,2nd Revised Edn*. (Vikas Publisher, 2007).

THIRD SEMESTER

CD 201 : Physical chemistry-I **L2-T1-P0-CH3-CR3**

Second law of thermodynamics:

Maxwel relations, entropy, variation of entropy with temperature and pressure.

Third law of thermodynamics:

Residual entropy, spectroscopic entropy, Tautons law

Free energy functions:

Gibbs and Helmholtz free energy, variation of free energy with temperature and pressure criteria of spontaneity, Gibbs-Helmholtz equation.

System of variable compositions:

Partial Molar quantity, chemical potential, Gibbs-Duhem equation, thermodynamic functions of mixing, excess thermodynamic functions.

Phase equilibria:

Thermodynamic derivation of the phase rule, application of phase diagram to one component system (H_2O, S), Clausius-Clapeyron equation.

Gaseous state:

Kinetic theory and its limitations, kinetic gas equation, Distribution of molecular speed, most probable, root mean square and average velocity. Real gases and ideal gases, Boyle temperature, critical temperature, equation of state for real gases, compression factor, the law of corresponding state, Second virial coefficient. Fugacity, fugacity and equilibrium constant for real gases.

Textbooks

1. Atkins, P. W. *Physical Chemistry, 7th Edn.* (Oxford University Press, 2006).
2. Levine, I. *Physical Chemistry, 5th Edn.* (Tata McGraw Hill, 2007).

Reference books

1. Berry, R. S., Rice, S. A., Ross, J. *Physical Chemistry, 2nd Edn.* (Oxford University Press, 2000).
2. Moore, W. J. *Physical chemistry, 5th Edn.*(Orient Longmann, 1990).

CD 203 : Organic Chemistry – I **L3-T0-P0-CH3-CR3**

Some important concepts:

Strength of organic acids and bases, Basicity and nucleophilicity of organic compounds, Aromaticity and Huckel Rule, Orientation of substituents, Directive influence of substituents, o/p ratio, kinetically controlled reaction , thermodynamically controlled reaction, Diffusion controlled reaction.

Aromatic hydrocarbons:

Preparation, properties and reactions of monocyclic and polynuclear hydrocarbons

Alcohols:

1^0, 2^0, 3^0 classification of alcohols and their characteristic reactions, Preparation, properties and reactions, Polyhydric alcohols

Phenols:

Preparation, properties and reactions, Acidity

Textbooks

1. Smith, M. B., March, J. *March's Advanced Organic Chemistry, Reaction Mechanism and Structure* (John Wiley, 2001).
2. Ghosh, S. K., *Advanced General Organic Chemistry, 3rd Edn.* (New Central Book Agency (P) Ltd., 2008).

Reference Books

1. House, H. O. *Modern Synthetic Reaction*, (W. A. Benjamin Inc. 1972).
2. Norman, R. O. C., Coxon, J. M. *Principles in Organic Synthesis, 3rd Edn.* (Blackie Academic & Professional, 1993).

CD 205 : Inorganic Chemistry-I **L2-T1-P0-CH3-CR3**

Hydrogen bonding, Metallic bonding, band theory

Classification of hard and soft acids and bases, HSAB principle and its applications.

Oxidation and Reduction: Oxidation numbers, redox potential, half-cell reaction, Nernst equation, Electrochemical series, Latimer and Frost diagrams.

Statistical methods of analysis: Types of errors, accuracy, precision, significant figures, standard and mean deviations, f-test and t-test.

Nuclear chemistry: Nuclear stability, isotopes, isobars and isotones, laws of radioactivity, artificial radioactivity, nuclear fission and fusion, radiocarbon dating.

Textbooks

1. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K. *Inorganic Chemistry: Principles of Structure and Reactivity*, *4th Edn*. (Pearson Education, 2006).
2. Mendham, J., Denney, R. C., Barnes, J. D., Thomas, M. J. K. *Vogel's Quantitative Chemical Analysis*, *6th Edn*. (Pearson Education, 1999).
3. Arnikar, H. J. *Essentials of Nuclear Chemistry*, *4th Edn*. (New Age International, 2008).

Reference Books

1. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F. *Inorganic Chemistry*, (Oxford University Press, 2006).
2. Wulfsberg, G. *Inorganic Chemistry*, *2nd Edn.* (Viva Books Private Limited, 2010).

FOURTH SEMESTER

CD 202 Physical Chemistry-II L2-T1-P0-CH3-CR3

Electrochemistry:

Types of electrodes, types of cells, EMF, electrochemical series, application of EMF measurement (calculation of ΔG, ΔH and ΔS), Nernst equation, potentiometric titration, batteries, fuel cell, corrosion and its prevention. Electrical double layer, polarization and overvoltage.

Chemical kinetics:

Steady state approximation, kinetics of complex reactions (opposing 1st order, consecutive, parallel, chain, and photochemical reactions). Lindemann theory of unimolecular reaction, fast reactions and oscillatory reactions.

Catalysis:

Classification, characteristic of catalytic reaction, homogeneous and heterogeneous catalysis, acid base catalysis, autocatalysis, inhibitor, enzyme catalysis, Michaelis-Menten equation, lineweaver -burk plot.

Adsorption:

Difference between absorption and adsorption, physical and chemical adsorption, factors influencing adsorption, adsorption isotherms (Langmuir, Freundlich and BET), application of adsorption isotherms for surface area measurement, application of adsorption.

Macromolecules:

Classification of polymers, number average and weight average molar masses of polymers, techniques for determination of molar masses of polymers, electrically conducting polymers and their applications.

Colloids:

Definition of colloids and crystalloids, classification of colloids, preparation and purification techniques of colloidal dispersion, Tyndal effect, Brownian movement, electrophoresis, electro-osmosis, protective colloids, gold number, zeta potential, lyophilic, lyophobic, ampiphilic colloids, gels, emulsifiers, stabilization by emulsification, micelles, critical micelles concentration(CMC).

Textbooks

1. Atkins, P. W. *Physical Chemistry*, *7th Edn.* (Oxford University Press, 2006).
2. Moore, W. J. *Physical Chemistry*, *5th Edn.* (Orient Longmann, 1990).

Reference Books

1. Adamson, A. W., Gast, A. P. *Physical Chemistry of Surfaces* (John Wiley and Sons, 1997).
2. Laidler, K. J., *Chemical Kinetics, 3rd Edn.* (Harper and Row, 1987).

CD 204 Organic Chemistry-II (L2-T1-P0-CH4-CR3

Ethers:

Preparation, properties and reactions

Amines:

1^0, 2^0, 3^0 classification of amines, Preparation, properties and reactions, Basicity, Diazonium ions and their synthetic utility.

Carbonyl compounds:

Preparation, properties and reactions, Comparisons of reactivity of aldehydes and ketones

Carboxylic acids and its derivatives:

Preparation, properties and reactions, Acidity of substituted benzoic acid, Acid chlorides, Esters, active methylene compounds and synthetic uses of ethyl acetoacetate and diethyl malonate

Carbohydrates:

Monosaccharide, Disaccharide and polysaccharides-their reactions, Configuration and conformation of anomers of glucose, open chain and ring structure of glucose and fructose, mutarotation, epimers

Textbooks

1. Smith, M. B., March, J. *March's Advanced Organic Chemistry, Reaction Mechanism and Structure* (John Wiley, 2001).
2. Ghosh, S. K., *Advanced General Organic Chemistry, 3rd Edn,* (New Central Book Agency (P) Ltd., 2008).

Reference books

1. House, H. O. *Modern Synthetic Reaction*, (W. A. Benjamin Inc. 1972).
2. Norman, R. O. C., Coxon, J. M. *Principles in Organic Synthesis, 3rd Edn.* (Blackie Academic & Professional, 1993).
3. Clayden, J., Greeves, N., Warren, S., Wothers, P. *Organic Chemistry* (Oxford University Press, 2008).

CD 206 Inorganic Chemistry-II L2-T1-P0-CH3-CR3

*Chemistry of Group 13 Elements***:**

The elements and their properties; Chemistry of Boron; Borides; Boron hydrides(Preparation, structure, bonding, reactions and properties); Wade's rule, Boron halides, Boron-Nitrogen chemistry; Boron-Oxygen chemistry.

Chemistry of Group 14 Elements:

The elements and their properties; Allotropy of Carbon: Diamond, Graphite, and Fullerenes; Intercalation); Carbides; Carbon halides and oxides; Compounds with C-N and C-S bonds; Silane reagents, Synthesis, properties and modifications on polysilanes. Condensation vs catenation, Silicides, Silicone Polymers; Oxygen compounds of silicon.

Chemistry of Group 15 Elements:

The elements and their properties; Nitrides; Hydrides of Nitrogen; Oxides of Nitrogen; Oxo acids and anions of Nitrogen; Activation of Nitrogen; Reaction of coordinated NO; Phosphides; Phosphorous halides and oxides; Oxoacids of phosphorous and their salts.

Textbooks

1. Greenwood, N. N., Earnshaw, A. *Chemistry of the Elements* (Pergamon Press, 1984).

2. Cotton, F. A., Wilkinson, G. *Advanced Inorganic Chemistry, 5th Edn.* (John Wiley, 1988).

Reference Books

1. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F. *Inorganic Chemistry*, (Oxford University Press, 2006).
2. Wulfsberg, G. *Inorganic Chemistry, 2nd Edn.* (Viva Books Private Limited, 2010).

FIFTH SEMESTER

CD 301 Physical Chemistry-III (L3-T0-P0-CH3-CR3

Chemical equilibrium:

Reversible reaction, law of mass action, equilibrium constant K, thermodynamic treatment of the law of mass action, relationship among Kp, Kc and Kx. Temperature and pressure dependence of chemical equilibrium, vant Hoffs equation, Le Chatelier principle.

Ionic equilibrium:

Arrhenius theory of electrolytic dissociation, Ostwald dilution law, Dissociation constant of week acids and bases, Ionization of water, pK_w and pH. Salt effect, pH expressions for various neutralization reaction, Henderson- Hasselblak equation, solubility product, common ion effect, Buffer solutions, theory of acid base indicators, acid base titration curves(pH variation).

Solutions:

Ideal and non –ideal solutions, colligative properties, Gibbs-Duhem-Marcules equation, Vapour pressure- composition and boiling point composition curves for completely miscible binary solutions, Partially miscible liquids, azeotropic mixtures, lever rule, lower and upper critical solution temperature, Immiscible liquids, fractional distillation and steam distillation.

Phase equilibria:

Phase diagram for two component systems with eutectic (Pb-Ag, KI-H_2O), congruent system (phenol-aniline, $FeCl_6$-H_2O) and incongruent (NaCl-H_2O) system. Peritectic reactions. Three component system, tie line, Nernst distribution law and its application.

Textbooks

1. Atkins, P. W. *Physical chemistry, 7th Edn*. (Oxford University Press, 2006).
2. Castellan, G. W. *Physical Chemistry, 4th Edn*. (McGraw Hill, 1999).

Reference books

1. Berry, R. S., Rice, S. A., J. Ross, *Physical Chemistry, 2nd Edn*. (Oxford University Press, 2000).
2. Mcquarrie, D. A., Simon, J. D. *Physical Chemistry, 1st Edn*. (Viva Books Private Limited, 2008).
3. Moore, W. J. *Physical Chemistry, 5th Edn*, (Orient Longmann, 1990).

CD 303 Organic Chemistry – III **L3-T0-P0-CH3-CR3**

Stereochemistry:

Conformation of acyclic systems, Free and restricted rotation, Rotamers, their stability and nomenclature, Racemisation and resolution of racemic mixtures, Concept of topocity and prostereoisomerism, Diasteromerism, Conformation of cyclic systems, angle strain, torsional strain

Optical isomerism in disubstituted cyclohexane.

Fats and Oils:

Structure, physical properties and analysis of fats and oils

Proteins:

Amino acids-properties, reactions; peptides, Importance of proteins, Primary, secondary and tertiary structure of proteins, denaturation, isoelectric point

*Heterocyclic compounds***:**

IUPAC nomenclature, synthesis, structure and bonding, properties (basicity, aromaticity)

*Organic photochemistry***:**

Theory of photochemistry, Jablonski diagram, Frank-Condon principle, Photosensitisers, Einstein's law of photochemical equivalence, typical photoreactions such as photoreaction of benzophenone, photolytic reactions of ketones.

Textbooks

1. Finar, I. L. *Organic Chemistry, Vol 1, 6th Edn*. (ELBS, 1997).

2. Finar, I. L. *Organic Chemistry, Vol 2, 6th Edn*. (ELBS, 1997).

Reference Books

1. Rohatgi-Mukherjee, K. K. *Fundamentals of Photochemistry, 2nd Revised Edn,* (New Age international Publishers, 2006).
2. Clayden, J., Greeves, N., Warren, S., Wothers, P. *Organic Chemistry* (Oxford University Press, 2008).
3. Kalsi, P. S. *Stereochemistry, Conformation and Mechanism* (New Age international Publishers, 2009).

CD 305 Inorganic Chemistry III ***L3-T0-P0-CH3-CR3***

The chemistry of the halogens and the noble gases:

Halogen family: Electronic structure and valences, preparation, interhalogen compounds, polyhalides, pseudohalogens, charge transfer complexes of halogens, oxides and oxoacids of halogens.

Noble gas family: Atomic and physical properties of the elements, compounds of xenon, bonding in noble gas compounds, compounds of other noble gases.

Coordination chemistry:

Werner's theory, classification of ligands, coordination number, nomenclature of coordination compounds, isomerism.

Aspects of d- block elements:

Elements of first transition series and their comparison with the second and third series, general periodic trends, chemistry of various oxidation states of first row transition metals and their comparison based on electronic configuration. The splitting of d-orbitals in octahedral, tetrahedral and square planar fields.

Magnetic properties of transition metal complexes:

Dia, para, ferro and antiferromagnetic behaviour of compounds, Curie-Weiss law, Curie temperature, Neel temperature.

Textbooks

1. Huheey, J. E., Keiter, E. A., Keiter, R. L, Medhi, O. K. *Principles of Structure and Reactivity, 1st Ed.*, (Pearson Education, 2006).
2. Dutta, R. L., Syamal, A. *Elements of Magnetochemistry, 2nd Edn.* (East-West Press, New Delhi, 1993).

3. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F. *Inorganic Chemistry*, (Oxford University Press, 2006).

Reference Books

1. Greenwood, N. N., Earnshaw, A. *Chemistry of the Elements* (Pergamon Press, 1984).
2. Cotton, F. A., Wilkinson, G. *Advanced Inorganic Chemistry, 5th Edn.* (John Wiley, 1988).

CD 307: Chemistry laboratory-III **L0-T0-P3-CH6-CR3**

Inorganic:

Inorganic preparations, Gravimetric estimation of copper and Nickel. Paper chromatographic separation of Ag(I),Hg(II) and Pb(II) ions,

Organic:

Qualitative Analysis of solid and liquid organic compounds containing one or more functional groups.

Two step organic preparation using common reagents such as Benzil-Benzillic acid rearrangement, Beckman rearrangement etc.

Physical:

Rate constant at elevated temperatures, energy of activation

Polarimetry, Partition function, Critical solution temperature etc.

Textbooks

1. Mendham, J., Danney, R. C., Barnes, J. D., Thomas, M. *Vogel's Textbook of Quantitative Chemical Analysis* (Peterson Education, 2004).
2. Viswanathan, B., Raghavan, P. S. *Practical Physical Chemistry* (Viva Books Pvt. Ltd. 2005).
3. Pasto, D., Johnson, C., Miller, M. *Experiments and Techniques in Organic Chemistry* (Prentice Hall, 1992).

Reference Books

1. Furniss, B. S., Ford, A. J. H., Smith, P. W. H., Tatchell, A., R. *Vogel's Textbook of Practical Organic Chemistry, 5th Ed*. (John Wiley, 1989).
2. Gurdeep, R. *Advanced Practical Inorganic Chemistry, 1st Ed.* (Goel Publishing, 1983).

SIXTH SEMESTER

CD 302 Physical Chemistry-IV **L3-T0-P0-CH3-CR3**

Symmetry and group theory:

Symmetry elements and operators, point groups, determination of point groups of simple molecules, interpretation of character tables, reducible and irreducible representations.

Solid state:

Crystallographic axes, lattice points, lattice constants, crystal classes, Bravais lattice, direction vector, crystal planes, miller indices, planar, atomic and volume density, radius ratio, radius ratio and coordination number. Defects in crystals, point defect, line defects and planar defects.

Diffraction techniques:

Bragg's law, diffraction condition for crystal lattice, X-ray analysis of crystal structure, structure factor, Neutron and electron diffraction.

Electrical properties of solids:

Conductor, semiconductor and insulators, band theory for metallic and non-metallic conductor. Semiconductors, p-n and p-n-p junction, diodes and transistors, variation of conductivity of semiconductors with temperature, superconductivity.

Textbooks

1. Atkins, P. W. *Physical chemistry, 7th Edn*. (Oxford University Press, 2006).
2. Cotton, F. A. *Chemical application of group theory, 3rd Edn.* (Wiley, 2002).

Reference Books

1. Mcquarrie, D. A., Simon, J. D. *Physical Chemistry, 1st Edn*. (Viva Books Private Limited, 2008)
2. Moore, W. J. *Physical Chemistry, 5th Edn.* (Orient Longmann, 1990).

CD 304 Organic Chemistry IV **L3-T0-P0-CH3-CR3**

Oxidation and Reduction:

Some common oxidizing agents-Chromium oxide, selenium dioxide, lead tetracetate, periodic acid, potassium permanganate, osmium tetroxide etc. Oppenauer oxidation, Some common reducing agents-Reduction by metals, Complex metal hydrides etc.

Wolf Kishner reduction, Meerwein - Pondrof - Verley reduction, Rosenmund reduction

*Addition***:**

Peroxide effect, Addition of halogens and halogen acids to olefinic double bonds, hydrogenation of alkenes and alkynes, Addition of HCN and Grignard reagent to carbonyl compound.

Elimination Reactions:

E1 and E2 mechanism, Hoffmann rule.

Substitution reactions:

Free radical substitution reaction (e.g. halogenations of alkanes), Nucleophilic substitution reaction – S_N1, S_N2, S_Ni, electrophilic substitution reaction, e.g. nitration, sulphonation, halogenations, Friedel Craft's alkylation and acylation reactions.

*Rearrangement reactions***:**

Wagner-Meerwein, Wolf, Hoffmann, Lossen, Curtius, Schmidt, Beckmann, Benzil-Benzilic acid, Baeyer-Villiger

Other name reactions:

Aldol condensation, Michael condensation, Knovenagel reaction, Reformatsky reaction, Perkin condensation, Willgerodt reaction, Leuckert reaction, Wittig reaction

Textbooks

1. Smith, M. B., March, J. *March's Advanced Organic Chemistry, Reaction Mechanism and Structure*, (John Wiley, 2001).
2. Clayden, J., Greeves, N., Warren, S., Wothers, P. *Organic Chemistry* (Oxford University Press, 2008).

Reference Books

1. House, H. O. *Modern Synthetic Reaction* (W. A. Benjamin Inc. 1972).
2. Norman, R. O. C., Coxon, J. M. *Principles in Organic Synthesis, 3rd Ed.* (Blackie Academic & Professional, 1993).
3. Sykes, P. *Guide Book to Mechanism in Organic Chemistry, 6th Ed.* (Prentice Hill, Longman, 1996).

CD 306: Principles and Applications of Spectroscopy L3-T0-P0-CH3-CR3

Basic principle of spectroscopy:

Interaction of matter and electromagnetic radiation, Factors affecting widths and intensity of spectral lines.

IR spectroscopy:

Principle, Instrumentation, and applications of IR spectroscopy.

Electronic spectroscopy:

Basic principle, Lambert-Beer law, types of electronic transitions in organic molecules, applications in functional group detection.

NMR spectroscopy:

Theory, origin of chemical shifts, spin-spin coupling, relaxation processes.

Textbooks

1. Banwell, C. N., McCash, E. M. *Fundamentals of Molecular Spectroscopy* (Tata McGraw Hill, 1994).
2. Kemp, W. *Organic Spectroscopy, 3rd Ed.* (McMillan Press, 1991).

Reference Books

1. Silverstein, *Spectrometric Identification of Organic Compounds, 7th Edn***.** (2005)
2. Chandra, S. *Molecular Spectroscopy* (Narosa, 2009).

SEVENTH SEMESTER

CD 401: Quantum Chemistry and Chemical Bonding **L3-T0-P0-CH3-CR3**

Unit 1

Mathematical Review: Basic vector algebra, matrix, determinant, Eigen value equations, quantum mechanical operators, orthogonal functions, Schmidt's orthogonalization technique.

Unit 2

Planck's quantum theory, wave-particle duality, uncertainty principle, postulates of quantum mechanics, Schrödinger equation, free particle, particle in a box, degeneracy, harmonic oscillator, rigid rotator, the hydrogen atom, angular momentum, electron spin, spin-orbit coupling.

Unit 3

Approximate methods in quantum mechanics: The variation theorem, linear variation principle and perturbation theory (first order and non-degenerate), application of variation method and perturbation theory to the Helium atom, antisymmetry, Slater determinant, term symbols and spectroscopic states.

Unit 4

Born-Oppenheimer approximation, Hartree-Fock method, Brillouin theorem, Koopman's theorem, Roothan's equations, models of chemical bonding- Molecular orbital (MO) and Valence bond (VB) theories, application to diatomic molecules such as, H_2, H_2^+, N_2, O_2, and CO. Hybridisation and MOs of H_2O, NH_3 and CH_4, Introduction to the SCF method.

Unit 5

Quantitative MO theory - Huckel π-electron theory and its application to ethylene, butadiene and benzene, energy levels of di- and tri- atomic molecules, Walsh diagrams and molecular geometry, extended Huckel MO theory and calculation on some simple molecules.

Text Book(s)

1. Atkins, P. W., Friedman, R. S., *Molecular Quantum Mechanics*, (Oxford University Press, 1997).
2. McQuarrie, D. A. *Quantum Chemistry* (Viva Books Private Limited, 2003).

Reference Book (s)

a. Levine, I. N *Quantum Chemistry*, (Pearson Education, Inc. 2004).
b. Prasad, R. K. *Quantum Chemistry,* (Wiley Eastern Limited, 2006).

CD 403 Inorganic Chemistry-IV (L 3-T 0-P 0-CH 3- Credit 3)

Unit 1

π- Acid complexes: Preparation, properties, structures and bonding of metal complexes with CO, N_2, NO, PR_3, AsR_3 as ligands, metal carbonyl hydrides and metal carbonyl clusters. LNCC and HNCC, Compounds with metal-metal multiple bonds

Unit 2

Organometallics: Structure, bonding, synthesis and reactions of metal complexes with alkyls, aryls, alkenes, alkynes and allyls, double and multidecker sandwich complexes.

Unit 3

Homogeneous and heterogeneous catalysis: Oxidative addition and reductive elimination reactions, insertion and extrusion reactions, reactions involving co-ordinated ligands, cyclometallation reactions. Catalytic reactions of alkenes – isomerisation, hydrogenation, carbonylation, hydroformylation and polymerization, Fischer-Tropsch process

Unit 4

Introduction to Supramolecular Chemistry, supramolecular synthesis of organic, metal-organic and inorganic compounds, host-guest chemistry

Unit 5

Inorganic Photochemistry: Excited states, ligand field states, Adamson's rules ,charge-transfer states and Thexi states; Phosphoresence and fluorescence; Photochemical reactions: substitution and redox reactions of Cr (III), Ru(II) and Ru(III) complexes

Text Book(s)

1. Elschenbroich, C., Salzer, A. *Organometallics – A Concise Introduction, 2nd edn.*, (VCH Publication 1992).
2. Ramamurthy, V., Schanze, K. S. *Multimetallic and Macromolecular Inorganic Photochemistry molecular and Supramolecular Photochemistry, 4th edn.*, (Marcel Dekker, 1999).

Reference Book(s)

1. Crabtree, R. H. *The Organometallic Chemistry of the Transition Metals, 4th edn.*, (John Wiley, 2005).
2. Hammer, F. *Inorganic Photochemistry*, (Sarup Book Publishers, 2009).

CD 405 : Chemistry Laboratory- IV (Organic Chemistry) L0-T0-P3-CH6-CR3

Unit 1

Separation techniques of organic compounds and their spectroscopic identification
Experiments involving the separation and purification of organic compounds from a mixture, using chromatographic techniques, steam distillation, fractional crystallization and sublimation

Unit 2

Synthesis of organic compounds using common reagents: At least eight preparation (involving two or more than two steps) involving the following representative reactions: (a) Oxidation of alcohol (b) Reduction of carbonyl group (c) Nucleophilic substitution; (d) Cycloaddition reaction; (e) Condensation reaction; (f) Aromatic electrophilic substitution; (g) Preparation of dyes, (h) Heterocyclic synthesis, (i) Solid phase synthesis etc.

Text Book(s)

1. Pasto, D., Johnson, Miller, M. *Experiments and Techniques in Organic Chemistry*, (Prentice Hall, 1992).
2. Williamson, K. L. *Macroscale and Microscale Organic Experiments*, (D. C. Heath & Company, 1999).

Reference Book (s)

1. Furniss, B. S., Ford, A. J. H., Smith, P. W. H., Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry, 5th edn.*, (Wiley, 1989).

EIGHT SEMESTER

CD 402 Chemistry Laboratory- V (L 0-T 0-P 3-CH 6-Credit 3)

Computational practicals

1. DOS, WINDOWS and UNIX operating systems
2. Programming with FORTRAN77
3. Numerical methods in chemistry (using MS EXCEL)
4. Generation of an EXCEL chart to display the variation of the H_{1s} radial function with radial distance from the nucleus.
5. Generation of an EXCEL chart to display the variation of the H_{2s} radial function with radial distance from the nucleus.
6. Generation of an EXCEL chart to display the variation of the H_{2p} radial function with radial distance from the nucleus.
7. EXCEL charts for the hydrogenic radial distribution functions.
8. Generation of the numerical radial wave function for the helium atom "1s' atomic orbital.
9. Generation of the numerical radial wave functions Li_{1s} and Li_{2s} orbitals. Etc
10. Quantum Chemical Calculations with GAUSSIAN and GAMESS

Textbooks

1. Balagurusamy, E. *Numerical Methods*, (Tata McGraw-Hill Publishing Company Limited, 2002)
2. Billo, E. J. *Excel for Chemists: A Comprehensive Guide*, (Willy-VCH, 2001).

Reference Book

2. Quinn, C. M. *Computational Quantum Chemistry: An Interactive Guide to Basis Set Theory*, (Academic Press, 2002).

CD 404 Chemistry Laboratory-VI (L 0-T 0-P 2-CH 4- Credit 2)

Unit 1

Synthesis and characterization of inorganic compounds, including those involving green synthetic methodology: Characterization includes elemental analysis, studies by IR, electronic spectra, magnetic susceptibility, conductance measurements, cyclic voltammetry. TG, DSC.

Text Book(s)

1. Marr, G., Rockett, B. W. *Practical Inorganic Chemistry*, (Van Nostrand, 1972).
2. Jolly, W. L. *Synthesis and Characterization of Inorganic Compounds*, (Prentice Hall, 1970).

Reference Book(s):

1. Wollins, J. D. *Inorganic Experiments*, (VCH, 1994).
2. Parshall, G. W. (Ed. in Chief). *Inorganic Synthesis*, *Vol. 15*, (McGraw Hill, 1974).