# List of New Course(s) Introduced

**Department : *Chemistry***

**Programme Name : *B.Sc.***

***Academic Year : 2019-20***

## *List of New Course(s) Introduced*

| Sr. No. | Course Code | Name of the Course |
|---|---|---|
| 01. | CBT-5 | Inorganic Chemistry II |
| 02. | CBL-5 | Inorganic Chemistry II Practical |
| 03. | CBT-6 | Organic Chemistry II |
| 04. | CBL-6 | Organic Chemistry II Practical |
| 05. | CBT-7 | Physical Chemistry III |
| 06. | CBL-7 | Physical Chemistry III Practical |
| 07. | GE-3 | Generic Elective – 3 |
| 08. | GE-3 LAB | Generic Elective Practical – 3 |
| 09. | SEC-1 | Skill Enhancement Course |
| 10. | CBT-8 | Inorganic Chemistry III |
| 11. | CBL-8 | Inorganic Chemistry III Practical |
| 12. | CBT-9 | Organic Chemistry III |
| 13. | CBL-9 | Organic Chemistry III Practical |
| 14. | CBT-10 | Physical Chemistry IV |
| 15. | CBL-10 | Physical Chemistry IV Practical |
| 16. | GE-4 | Generic Elective – 4 |
| 17. | GE-4 LAB | Generic Elective Practical – 4 |
| 18. | SEC-2 | Skill Enhancement Course |

# Minutes of Meetings (MoM) of Board of Studies (BoS)

**Academic Year : 2019-20**

**School : *School of Studies of Physical Science***

**Department : *Chemistry***

**Date and Time : *Nov. 03, 2017 – 11:30 AM***

**Venue : *Meeting room***

The scheduled meeting of member of Board of Studies (BoS) of Department of Chemistry, School of Studies of Physical Science, Guru Ghasidas Vishwavidyalaya, Bilaspur was held to design and discuss the structure and scheme of examination of Integrated UG/PG, M. Sc. Chemistry syllabi.

The following members were present in the meeting:

1. Prof. Bali Ram (External Expert Member BoS, Dept. of Chemistry, BHU, Varanasi)
2. Prof. G. K. Patra (Member BoS, Dept. of Chemistry)
3. Dr. Charu Arora (HOD, Associate Prof., Dept. of Chemistry-cum Chairman, BOS)
4. Dr. Arti Srivastava (Member BoS, Assistant Professor, Dept. of Chemistry)

Following points were discussed during the meeting

1. Draft prepared to revise course structure and scheme of examination in the light of UGC directives (as per CBCS Scheme) to be implemented from 2018-19.
2. Elective paper Advanced Quantum and Computational Chemistry (CMT-405) has been incorporated in M.Sc. IV sem.
3. The core paper Organic Chemistry-IV (CBT-503) of B.Sc.-Vth sem has been interchanged with core paper Physical Chemistry-IV (CBT-601) to justify semester wise teaching load.

The following new courses were introduced in the B. Sc. and M. Sc.:

- B. Sc. CBCS scheme
- Advanced Quantum and Computational Chemistry (CMT-405)

Signature & Seal of HoD

अध्यक्ष/Head
रसायन शास्त्र विभाग
Deptt. of Chemistry
गुरु घासीदास विश्वविद्यालय,
Guru Ghasidas Vishwavidyalaya,
बिलासपुर 495009 (छ.ग.)
Bilaspur 495009 (C.G.)

# Scheme and Syllabus

| | | | | | |
|---|---|---|---|---|---|
| **SUMMER Internship: 15 days** | | | **Swayam Swachhta / NSS / Industrial/ others** | **2** | **100** |
| III | Core-5 | CBT-5 | Inorganic Chemistry II | 4 | 4 |
| | Core -5 Practical | CBL-5 | Inorganic Chemistry II: Practical | 2 | 4 |
| | Core -6 | CBT-6 | Organic Chemistry-II | 4 | 4 |
| | Core -6 Practical | CBL-6 | Organic Chemistry-II : Practical | 2 | 4 |
| | Core - 7 | CBT-7 | Physical Chemistry-III | 4 | 4 |
| | Core – 7 Practical | CBL-7 | Physical Chemistry-III: Practical | 2 | 4 |
| | Generic Elective -3 | | 3A<br>3B<br>3C<br>3D | 4 | 4 |
| | Generic Elective - Practical | | | 2 | 4 |
| | Skill Enhancement Course (SEC - 1) | | Select one from the Pool of SEC courses offered by different departments | 4 | 2 (4) |
| | | | Total | 28 | 34 |
| IV | Core-8 | CBT-8 | Inorganic Chemistry III: | 4 | 4 |
| | Core -8 Practical | CBL-8 | Inorganic Chemistry III: Practical | 2 | 4 |
| | Core -9 | CBT-9 | Organic Chemistry III | 4 | 4 |
| | Core -9 Practical | CBL-9 | Organic Chemistry III: Practical | 2 | 4 |
| | Core - 10 | CBT-10 | Physical Chemistry-IV | 4 | 4 |
| | Core -10 Practical | CBL-10 | Physical Chemistry-IV: Practical | 2 | 4 |
| | Generic Elective - 4 | | 4A<br>4B<br>4C<br>4D | 4 | 4 |
| | Generic Elective - Practical | | | 4 | 4 |
| | Skill Enhancement Course (SEC -2) | | Select one from the Pool of SEC courses offered by different departments | 4* | 2 (4) |
| | | | TOTAL | 28 | 34 |
| **SUMMER Internship: 15 days** | | | **Swayam Swachhta / NSS / Industrial/ others** | **2** | **100** |
| V | Core-11 | CBT-11 | Organic Chemistry IV | 4 | 4 |
| | Core -11 Practical | CBL-11 | Organic Chemistry IV: Practical | 2 | 4 |

## Semester III

## CHEMISTRY-C V: INORGANIC CHEMISTRY-II (CBT-5)

**(Credits: Theory-04, Practicals-02)**
**Theory: 60 Lectures**

### General Principles of Metallurgy

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

### Acids and Bases

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

### Chemistry of *s* and *p* Block Elements:

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

Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

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

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

### Noble Gases:

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

### Inorganic Polymers:

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

**Reference Books:**


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


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## CHEMISTRY LAB-C V INORGANIC CHEMSITRY LAB (CBT-5)

**60 Lectures**

**(A) Iodo / Iodimetric Titrations**

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
(iii) Estimation of available chlorine in bleaching powder iodometrically.

**(B) Inorganic preparations**

(i) Cuprous Chloride, $Cu_2Cl_2$

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

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

**Reference Books:**


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


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## CHEMISTRY-C VI: ORGANIC CHEMISTRY-II (CBT-6)

**(Credits: Theory-04, Practicals-02)**
**Theory: 60 Lectures**

**Alkyl halides:** Preparation and general reactions of alkyl halides; Grignard reagents: preparation and synthetic applications; Reformatsky reaction; Wurtz reactions.

**Substitution and Elimination Reactions:** Nucleophilic substitution – SN1 and SN2 mechanisms; Elimination reaction: E1 and E2 mechanisms, Elimination Vs Substitution reactions; energy profile diagrams – transition states, intermediates (general considerations).

**Alcohols and ethers:** General properties of alcohols. Synthesis of alcohols from alkenes *via* hydroboration-oxidation, oxymercuration-demercuration. Reactions of alcohols: Dehydration, oxidation and distinction of primary, secondary and tertiary alcohols. Acetal and ketal formation, Pinacole-pinacolone rearrangement. Preparation and general reactions of ethers; nucleophilic ring-opening of epoxides.

**Aldehydes and Ketones:** Preparation of carbonyl compounds. Oxidation and reduction reaction, Condensation reactions, Nucleophilic addition reactions: aldol condensation, Perkin reaction, Wittig Reaction, Cannizzaro reaction, benzoin condensation, Haloform reaction, Keto-enol tautomerism.

**Carboxylic acids & its Derivatives:** General method for the preparation of carboxylic acids, amides, esters, anhydrides, acid halides, and acid azides; Relative reactivity of carboxylic acids and their chemical reactions.

**Stereochemistry:** Optical activity and plane-polarized light. Plane and centre of Symmetry, Chirality, enantiomers, diasteroisomers, mesomers, atropisomers and recemic mixtures. Fischer, Newman and Sawhorse Projection Formula. E/Z, D/L and R/S nomenclature. Walden inversion.

**Books Recommended**

1. '*Organic Chemistry*", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
2. "*Organic Chemistry*", S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.
3. "*Organic Chemistry – Structure and Reactivity*", Seyhan N. Ege, 3rd Edition (1998), ITBS Publishers and Distributtors, Delhi.
4. *"Organic Chemistry"*, I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in1996], ELBS and Longman Ltd., New Delhi.
5. *"A Guide Book to Mechanism in Organic Chemistry"*, P. Sykes, 6th Edition (1997), Orient Longman Ltd., New Delhi.
6. *"Organic Chemistry"*, J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).
7. "*Stereochemistry of Organic Compounds*", D. Nasipuri, New Age International.
8. "*Stereochemistry of Organic Compounds*", P.S. Kalsi, New Age International.
9. "*Organic Chemistry*", G. Solomon, Willey Inida, Paper Back, 9th Edition.
10. "*Modern Organic Chemistry*", M. K. Jain and S. C. Sharma, Vishal Publishing CO. Jalandhar, India, 4th Edition (2012).

## CHEMISTRY LAB- C VI ORGANIC CHEMSITRY – II LAB (CBL-6)

**60 Lectures**

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Preparation of Derivatives of functional groups:

**Reference Books**


- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)


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## CHEMISTRY-C VII: PHYSICAL CHEMISTRY-III (CBT-7)

**(Credits: Theory-04, Practicals-02)**
**Theory: 60 Lectures**

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

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.

Three component systems, water-chloroform-acetic acid system, triangular plots.

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

Nernst distribution law: its derivation and applications.

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

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

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

**Surface chemistry:**
Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

**Reference Books:**


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


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## CHEMISTRY PRACTICAL-C VII PHYSICAL CHEMISTRY-III LAB (CBL-7)

**60 Lectures**

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

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
   a. simple eutectic and
   b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)^{2+}$

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

the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.
   b. Saponification of ethyl acetate.

3. Compare the strengths of HCl and $H_2SO_4$ by studying kinetics of hydrolysis of methyl acetate.

**VI. Adsorption**

I. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

**Reference Books:**


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


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## Semester IV

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## CHEMISTRY-VIII: INORGANIC CHEMISTRY-III (CBT-8)

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

**Theory: 60 Lectures**

**Coordination Chemistry:**

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq ( o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq ( o, t). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

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

**Transition Elements:**

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

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

**Lanthanoids and Actinoids:**

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

**Bioinorganic Chemistry:**

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

**Reference Books:**


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


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## CHEMISTRY-C VIII: INORGANIC CHEMISTRY-III LAB (CBL-8)

**60 Lectures**

**Gravimetric Analysis:**

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as $Fe_2O_3$ by precipitating iron as $Fe(OH)_3$.
iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

**Inorganic Preparations:**

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)

**Chromatography of metal ions**

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

**Reference Book:**


- 1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.


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## CHEMISTRY-C IX: ORGANIC CHEMISTRY-III (CBT-9)

**(Credits: Theory-04, Practicals-02)**
**Theory: 60 Lectures**

**Aromatic Compounds:** Introduction, nomenclature of benzene derivatives, the Kekule structure of benzene, Valance bond & molecular orbital theories of the structure of benzene, Huckel's rule: (4n+2) π electron rule, Anti-aromatic compounds, non-aromatic, homoaromatic.

**Electrophilic Substitution Reactions of Aromatic Compounds:** Electrophilic substitution reactions ($S_EAr$), A general mechanism for electrophilic aromatic substitution – Arenium ions, Halogenation, Nitration and sulphonation of benzene, Friedel–Crafts alkylation and its limitations, Friedel–Crafts acylation; Effect of substituent's on reactivity and orientation.

**Nucleophilic Substitution Reactions of Aromatic Compounds:** Halobenzenes, and nucleophilic aromatic substitutions ($S_NAr$), bimolecular mechanism ($A_ND_N$), benzyne mechanism ($D_NA_N$). Preparation and uses of DDT and BHC.

**Phenols:** General methods of preparation and reactions of phenol. Relative acidity of phenol, alcohol and carboxylic acid. Reimer-Tiemann and Kolbe reactions; Claisen and Fries rearrangements.

**Nitrogen Containing Compounds:** Nitrobenzene and reduction products. Amines and amides. Comparative basicity of aliphatic and aromatic amines, Diazonium salts: preparation (Diazo reaction) and synthetic applications (Sandmeyer reactions).

**Polynuclear Aromatic Hydrocarbons:** Synthesis and reactions of naphthalene, anthracene, phenantherene.

**Books Recommended**:

1. *"Organic Chemistry"*, R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
2. *"Organic Chemistry"*, S. M. Mukherji , S. P. Singh, and R. P. Kapoor, 1st Edition (1985), 5th Reprint (1999), New Age International (P) Ltd.Publishers, New Delhi.
3. *"Organic Chemistry – Structure and Reactivity"*, Seyhan N. Ege, AITBS publishers, Delhi (1998).
4. *"Organic Chemistry"*, Paula Y. Bruice, 2nd Edition , Prentice-Hall Internattional Inc, New Jersey, International Edition (1998).

5. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).
6. *"Organic Chemistry"*, G. Solomon, Willey India, Paper Back, 9th Edition.

## CHEMISTRY PRACTICAL-C IX ORGANIC CHEMISTRY-III LAB (CBL-9)

**60 Lectures**

**Organic preparations:**

1. Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β -naphthol, vanillin, salicylic acid) by any one method:
2. Benzolyation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (β -naphthol, resorcinol, p- cresol)
3. Hydrolysis of amides and esters.
4. Aldol condensation reactions.

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

*Reference Books:*

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

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## CHEMISTRY-C X: PHYSICAL CHEMISTRY-IV (CBT-10)

**(Credits: Theory-04, Practicals-02)**
**Theory: 60 Lectures**

### Conductance

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

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

### Electrochemistry

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

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining
(i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and $SbO/Sb_2O_3$ electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

**Electrical & Magnetic Properties of Atoms and Molecules**
Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

**Reference Books:**


- Atkins, P.W & Paula, J.D. *Physical Chemistry*, 9th Ed., Oxford University Press (2011).
- Castellan, G. W. *Physical Chemistry 4th Ed.*, Narosa (2004).
- Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP (2009).
- Barrow, G. M., *Physical Chemistry 5th Ed.*, Tata McGraw Hill: New Delhi (2006).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
- Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
- Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry 4th Ed.*, John Wiley & Sons, Inc. (2005).


## CHEMISTRY PRACTICAL-C X PHYSICAL CHEMISTRY-IV LAB (CBL-10)

**60 Lectures**

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**Conductometry**

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation Constant of a weak acid.
III. Perform the following conductometric titrations:
   i. Strong acid vs. strong base
   ii. Weak acid vs. strong base
   iii. Mixture of strong acid and weak acid vs. strong base
   iv. Strong acid vs. weak base

**Potentiometry**

I Perform the following potentiometric titrations:
   i. Strong acid vs. strong base
   ii. Weak acid vs. strong base
   iii. Dibasic acid vs. strong base
   iv. Potassium dichromate vs. Mohr's salt

## SKILL ENHANCEMENT COURSE (ANY FOUR) (CREDIT: 02 EACH)
## SEC1 TO SEC4

### SEC-1: BASIC ANALYTICAL CHEMISTRY (Credits: 02)
**30 Lectures**

**Introduction:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

**Analysis of soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of pH of soil samples.
b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.

**Analysis of food products:** Nutritional value of foods, idea about food processing and food preservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

**Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion ($Fe^{3+}$ and $Al^{3+}$).
b. To compare paint samples by TLC method.

**Ion-exchange:** Column, ion-exchange chromatography etc.
Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

**Analysis of cosmetics:** Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

**Suggested Applications (Any one):**

a. To study the use of phenolphthalein in trap cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.

**Suggested Instrumental demonstrations:**

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

**Reference Books:**

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

## SEC-2: INTELLECTUAL PROPERTY RIGHTS (IPR)

**(Credits: 02)**
**Theory: 30 Lectures**

*In this era of liberalization and globalization, the perception about science and its practices has undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels – statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue.*

**Introduction to Intellectual Property:**
Historical Perspective, Different Types of IP, Importance of protecting IP.

**Copyrights**
Introduction, How to obtain, Differences from Patents.

**Trade Marks**
Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

**Patents**
Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

**Geographical Indications**
Definition, rules for registration, prevention of illegal exploitation, importance to India.

**Industrial Designs**
Definition, How to obtain, features, International design registration.

**Layout design of integrated circuits**
Circuit Boards, Integrated Chips, Importance for electronic industry.

**Trade Secrets**
Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

**Different International agreements**
**(a) Word Trade Organization (WTO):**
(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty

**(b) Paris Convention**
**WIPO** and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity
**IP Infringement issue and enforcement** – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

**Reference Books:**

- N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
- Manjula Guru & *M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
- P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001).
- Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000).
- Jayashree Watal, *Intellectual property rights in the WTO and developing countries*, Oxford University Press, Oxford.