

**DAV UNIVERSITY JALANDHAR**



**Course Scheme & Syllabus**  
**For**  
**M.Sc (Hons.)-CHEMISTRY**  
**(Program ID-39)**

**1<sup>st</sup> TO 4<sup>th</sup> SEMESTER**

**2020-2021**

**Total minimum credits required for M.Sc. (Hons.) Chemistry are 96**

**Scheme of Courses M.Sc.**

**M.Sc. (Hons.) Chemistry**

**Semester 1**

| S.No         | Paper Code                 | Course Type | Course Title              | L | T | P | Cr        |
|--------------|----------------------------|-------------|---------------------------|---|---|---|-----------|
| 1            | CHE501B                    | Core        | Organic Chemistry-I       | 4 | 0 | 0 | 4         |
| 2            | CHE502B                    | Core        | Inorganic Chemistry-I     | 4 | 0 | 0 | 4         |
| 3            | CHE503B                    | Core        | Physical Chemistry        | 4 | 0 | 0 | 4         |
| 4            | CHE504B                    | Core        | Analytical Chemistry      | 4 | 0 | 0 | 4         |
| 5            | CHE505B                    | Core        | Organic Chemistry Lab-I   | 0 | 0 | 4 | 2         |
| 6            | CHE506B                    | Core        | Inorganic Chemistry Lab-I | 0 | 0 | 4 | 2         |
| 7            | Interdisciplinary Course-I |             |                           |   |   |   | 4         |
| <b>Total</b> |                            |             |                           |   |   |   | <b>24</b> |

**Semester 2**

| S.No         | Paper Code                  | Course Type | Course Title             | L | T | P | Cr        |
|--------------|-----------------------------|-------------|--------------------------|---|---|---|-----------|
| 1            | CHE507B                     | Core        | Organic Chemistry-II     | 4 | 0 | 0 | 4         |
| 2            | CHE508B                     | Core        | Inorganic Chemistry-II   | 4 | 0 | 0 | 4         |
| 3            | CHE509B                     | Core        | Physical Chemistry-II    | 4 | 0 | 0 | 4         |
| 4            | CHE510B                     | Core        | Spectroscopy-I           | 4 | 0 | 0 | 4         |
| 5            | CHE511B                     | Core        | Organic Chemistry Lab-II | 0 | 0 | 4 | 2         |
| 6            | CHE512B                     | Core        | Physical Chemistry Lab-I | 0 | 0 | 4 | 2         |
| 7            | Interdisciplinary Course-II |             |                          |   |   |   | 4         |
| <b>Total</b> |                             |             |                          |   |   |   | <b>24</b> |

## Semester 3

| S.No                  | Paper Code | Course Type | Course Title                   | L | T | P | Cr     |
|-----------------------|------------|-------------|--------------------------------|---|---|---|--------|
| 1                     | CHE601B    | Core        | Organic Chemistry-III          | 4 | 0 | 0 | 4      |
| 2                     | CHE602B    | Core        | Inorganic Chemistry-III        | 4 | 0 | 0 | 4      |
| 3                     | CHE603B    | Core        | Physical Chemistry-III         | 4 | 0 | 0 | 4      |
| 4                     | CHE604B    | Core        | Spectroscopy-II                | 4 | 0 | 0 | 4      |
| 5                     | CHE606B    | Core        | Inorganic Chemistry Lab-II     | 0 | 0 | 4 | 2      |
| 6                     | CHE607B    | Core        | Physical Chemistry Lab-II      | 0 | 0 | 4 | 2      |
| 7                     | CHE608B*   | Core        | Seminar and Literature Survey  | 0 | 0 | 0 | 2*     |
| 8                     | CHE620B*   | Core        | Advance Chemistry Lab-I        | 0 | 0 | 8 | 4*     |
| Department Elective-I |            |             |                                |   |   |   | 4      |
| Total                 |            |             |                                |   |   |   | 26/28* |
| Department Elective-I |            |             |                                |   |   |   |        |
| 1                     | CHE605B    | Elective    | Advanced Electrochemistry      | 4 | 0 | 0 | 4      |
| 2                     | CHE617B    | Elective    | Synthetic Organic Chemistry    | 4 | 0 | 0 | 4      |
| 3                     | CHE614B    | Elective    | Molecules of Life              | 4 | 0 | 0 | 4      |
| 4                     | PHY670     | Elective    | Nanoscience and Nanotechnology | 4 | 0 | 0 | 4      |
| 5                     | CHE622     | Elective    | Industrial Chemistry           | 4 | 0 | 0 | 4      |
| 6                     | CHE623     | Elective    | Physical Organic Chemistry     | 4 | 0 | 0 | 4      |

\*Only 30 students in the class will be enrolled for research projects based upon their merit/performance in MSc first year. The students with research projects will study CHE608B of 2 credits and the others will study CHE620B of 4 credits in the third semester.

## Semester 4

| S.No  | Paper Code            | Course Type | Course Title                | L | T | P | Cr      |
|---|-----------------------|-------------|-----------------------------|---|---|---|---------|
| 1   | CHE609B               | Core        | Organic Chemistry-IV        | 4 | 0 | 0 | 4       |
| 2   | CHE610B               | Core        | Bio-Inorganic Chemistry     | 4 | 0 | 0 | 4       |
| 3   | CHE612B*              | Core        | Project                     | 0 | 0 | 0 | 6*      |
| 4   | CHE621B*              | Core        | Advance Chemistry Lab-II    | 0 | 0 | 8 | 4*      |
| 5   | Departmental Elective |             |                             | 4 | 0 | 0 | 4       |
| 6   | Departmental Elective |             |                             | 4 | 0 | 0 | 4       |
| Total   |                       |             |                             |   |   |   | 20*/22* |
| Departmental Elective ( Choose any Two courses) |                       |             |                             |   |   |   |         |
| 1   | CHE611B               | Elective    | Bio-Physical Chemistry      | 4 | 0 | 0 | 4       |
| 2   | CHE613B               | Elective    | Supramolecular Chemistry    | 4 | 0 | 0 | 4       |
| 3   | CHE615B               | Elective    | Chemistry of Materials      | 4 | 0 | 0 | 4       |
| 4   | CHE616B               | Elective    | Medicinal Chemistry         | 4 | 0 | 0 | 4       |
| 5   | CHE618B               | Elective    | Advance Physical Chemistry  | 4 | 0 | 0 | 4       |
| 6   | CHE619B               | Elective    | Analytical Techniques       | 4 | 0 | 0 | 4       |
| 7   | CHE624                | Elective    | Electroanalytical Chemistry | 4 | 0 | 0 | 4       |

\*The students with research projects will do Project work (CHE612B) of 6 credits and the others will study Advance chemistry Lab-II (CHE621B) of 4 credits in the fourth semester.

Scheme of Courses M.Sc.  
**M.Sc. (Hons.) Chemistry**

**Semester 1**

| S.No         | Paper Code                 | Course Type | Course Title              | L | T | P | Cr        |
|--------------|----------------------------|-------------|---------------------------|---|---|---|-----------|
| 1            | CHE501B                    | Core        | Organic Chemistry-I       | 4 | 0 | 0 | 4         |
| 2            | CHE502B                    | Core        | Inorganic Chemistry-I     | 4 | 0 | 0 | 4         |
| 3            | CHE503B                    | Core        | Physical Chemistry        | 4 | 0 | 0 | 4         |
| 4            | CHE504B                    | Core        | Analytical Chemistry      | 4 | 0 | 0 | 4         |
| 5            | CHE505B                    | Core        | Organic Chemistry Lab-I   | 0 | 0 | 4 | 2         |
| 6            | CHE506B                    | Core        | Inorganic Chemistry Lab-I | 0 | 0 | 4 | 2         |
| 7            | Interdisciplinary Course-I |             |                           |   |   |   | 4         |
| <b>Total</b> |                            |             |                           |   |   |   | <b>24</b> |

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**Course Title: Organic Chemistry-I****Course Code: CHE501B****Total Lectures: 60**

| L | T | P | Credits | Marks | Pass<br>Marks |
|---|---|---|---------|-------|---------------|
| 4 | 0 | 0 | 4       | 100   | 40            |

**Course Objectives:**

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

**UNIT I****Nature of Bonding in Organic molecules****(6 Lectures)**

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, tautomerism.

Aromaticity: Concept of aromaticity, Huckel's rule, Polygon rule, Homo-aromatic, non-aromatic and anti-aromatic systems. Aromaticity in benzenoid and non-benzenoid molecules. alternant and non-alternant hydrocarbons Annulenes & hetero-annulenes. Physical methods to study aromaticity-UV, IR & <sup>1</sup>H NMR.

**Reaction Mechanism: Structure and Reactivity****(9 Lectures)**

Type of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams. Methods of Determining Reaction Mechanism: Kinetic and non-kinetic methods, Identification of products, detection of intermediates, isotopic labeling, stereochemical evidences, cross-over experiments, Limitation of reactions, kinetic evidences and kinetic isotopic effects.

Reaction Intermediates: Generation, structure, stability, reactivity, detection, trapping and reactions of classical and non-classical carbocations, carbanions, free radicals, carbenes, nitrenes and arynes.

## UNIT II

### **Aliphatic Nucleophilic Substitution**

**(6 Lectures)**

Aliphatic Nucleophilic Substitution Reactions: Mechanism and scope of aliphatic nucleophilic substitution reactions-SN1, SN2 and SNi. Stereochemistry of nucleophilic substitution reactions, allylic nucleophilic substitution reactions, Walden inversion, neighbouring group participation & anchimeric assistance, carbocation rearrangements in neighboring group participation. Factors influencing the rates of nucleophilic substitution reactions.

### **Aliphatic Electrophilic Substitution**

**(9 Lectures)**

Bio-molecular mechanisms-SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Elimination Reactions: Discussions of E1, E2 and E1cB mechanisms. Orientation during elimination reactions. Saytzeff and Hofmann rules. Reactivity-effects of substrate structures, attacking base, leaving group and solvent medium.

Pyrolytic Eliminations: Mechanisms of pyrolysis of esters of carboxylic acids. Chugaev reactions, Hofmann degradation, Cope elimination and xanthate pyrolysis.

## UNIT III

### **Aromatic Electrophilic Substitution**

**(9 Lectures)**

Mechanism of aromatic electrophilic substitution reactions - nitration, halogenation, sulphonation, Friedel-Crafts alkylation and acylation, orientation and reactivity, energy profile diagram. The ortho/para ratio, ipso attack, orientation in other ring systems., Naphthalene, Anthracene, Six and five membered heterocycles, Diazonium coupling Mechanism of Vilsmeier-Haack reaction, Mannich reaction, Diazonium coupling, Pechmann reaction and Fries rearrangement, Gattermann – Koch reaction,.

### **Aromatic Nucleophilic Substitution**

**(6 Lectures)**

The S<sub>N</sub>Ar, S<sub>N</sub>1 Benzyne and S<sub>N</sub>R1, Mechanisms, Reactivity effect of substrate structure, leaving group and attacking nucleophile.

## UNIT IV

**Stereochemistry****(15 Lectures)**

Optical Isomerism: Conformation and configuration of molecules, projection formulae, Fischer, Saw-horse, Newman and Flying wedge representations. Interconversion of these formulae. Absolute configuration (D,L) and (R,S) systems. Elements of symmetry, Pseudoasymmetric centres, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, stereospecific and stereoselective synthesis, asymmetric synthesis, Cram's and Prelog's rules. Optical activity in the absence of chiral carbon-biphenyls, allenes and spiranes. Conformational analysis of cycloalkanes and decalins. Effect of conformation on reactivity. Acyclic & cyclic systems-Substituted cyclohexanes, cyclohexanones, cyclohexanols, Stereochemistry of compounds containing nitrogen, sulphur and phosphorus.

Geometrical Isomerism: Cis-trans isomerism resulting from double bonds, monocyclic compounds & fused ring systems. E,Z-notations, determination of configuration of geometrical isomers, syn & anti isomers.

**Suggested Books:**

1. March, Jerry. *Advanced Organic Chemistry: Reactions, Mechanism and Structure*, John Wiley, 7<sup>th</sup> edition, 2013.
2. Carey, F. A. and Sundberg, R.J. *Advanced Organic Chemistry*, Plenum, 5<sup>th</sup> edition, 2008.
3. Sykes, Peter. *A Guide Book to mechanism in Organic Chemistry*, Longman, 6<sup>th</sup> edition, 2003.
4. Morrison, R. T. and Boyd, R. N. *Organic Chemistry*, Prentice Hall, 7<sup>th</sup> edition, 2010.
5. Kalsi, P. S. *Organic Reactions and their Mechanisms*, New Age International Publishers, 2<sup>nd</sup> edition, 2000.
6. Mukherji, S.M. and Singh, S.P. *Reactions Mechanism in Chemistry*, Vol. I, II, III, Macmillan, Revised edition, 2007.
7. Nasipuri, D. *Stereochemistry of Organic Compounds*, New Age International Publishers, 2<sup>nd</sup> edition, 1994.
8. Kalsi, P.S. *Stereochemistry of Organic Compounds*, New Age International, 2<sup>nd</sup> edition, 2008.
9. Kalsi, P.S. *Stereochemistry: Conformation and Mechanism*, Wiley Eastern Limited, 2<sup>nd</sup> edition, 2019.
10. <https://swayam.gov.in/explorer?category=Chemistry>
11. <https://nptel.ac.in/course.html>



**Course Title: Inorganic Chemistry –I (Transition Metal Chemistry)****Course Code: CHE502B****Total Lectures: 60****Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of

Inorganic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in the course.

**UNIT I****Symmetry****(15 Lectures)**

Symmetry elements, symmetry operations and their matrix representation, group postulates and types, multiplication tables, point group determination, determination of reducible and irreducible representations, character tables, construction of character tables for  $C_{2v}$ ,  $C_{3v}$ , use of symmetry in obtaining symmetry of orbitals in molecules, Determination of hybridization, vibrational modes and selection rules for electronic transitions in molecules using Character table

**Molecular Orbital Theory for Metal Complexes**

Ligands symmetry orbitals and metal orbitals involved in molecular orbitals formation in octahedral complexes, MOEL diagrams for octahedral, tetrahedral and square planar complexes showing  $\sigma$  and  $\pi$  bonding in transition metal complexes.

**UNIT II****Inter-electronic Repulsions****(15 Lectures)**

Spin-spin, orbital-orbital and spin orbital coupling, LS and jj coupling schemes, determination of all the spectroscopic terms of  $p^n$ ,  $d^n$  ions, determination of the ground state terms for  $p^n$ ,  $d^n$ ,  $f^n$  ions using L.S. scheme, determination of total degeneracy of terms, order of interelectronic repulsions and crystal field strength in various fields, two type of electron repulsion parameters,

spin orbit coupling parameters ( $\lambda$ ) energy separation between different j states, The effect of octahedral and tetrahedral fields on S, P, D and F terms (with the help of character table). Splitting patterns of G, H and I terms

### UNIT III

#### Free Ions in Medium and Strong Crystal Fields (15 Lectures)

Strong field configurations, transition from weak to strong crystal fields, evaluation of strong crystal field terms of  $d^2$  configuration in octahedral and tetrahedral crystal fields (using group theory), construction of the correlation energy level diagrams of  $d^2$  configuration in octahedral field, study of energy level diagrams for higher configurations, Orgel diagrams, Tanabe Sugano diagrams, calculation of  $10Dq$  and  $B$  with use of Orgel and Tanabe Sugano diagrams.

### UNIT IV

#### Electronic Spectra of Transition Metal Complexes (15 Lectures)

Variation of the Racah parameter, nephelauxetic effect-central field covalency, symmetry restricted covalency, differential radial expansion, spectrochemical series, band intensities, factors influencing band widths, Magnetic properties of transition metal ions and free ions presentive, Effects of L-S coupling on magnetic properties, Temperature independent paramagnetism (TIP) in terms of crystal field theory CFT and molecular orbital theory (MOT), Quenching of orbital angular momentum by crystal fields in complexes in terms of term-splitting. Effect of spin-orbit coupling and A, E & T states mixing, first order and second order Zeeman effects.

#### Suggested Books:

1. Cotton, F.A. Chemical Application of Group Theory, Wiley Eastern, 4<sup>th</sup> edition.
2. Miessler, G.L. and Tarr, D.A. Inorganic Chemistry, Pearson Education, 5<sup>th</sup> edition.
3. Figgis, B.N. Introduction to Ligand Field, WileyEastern.
4. Lever, A.B.P. Inorganic Electronic Spectroscopy, Elsevier.
5. Huheey, J.E. Inorganic Chemistry, Pearson, 5<sup>th</sup> Edition, 2009.
6. Drago, R.S. Physical Method in Chemistry, W.B. Saunders Company.
7. Cotton F.A. and Wilkinson, G. Advanced Inorganic Chemistry, Wiley Inter-science, 6<sup>th</sup> edition.
8. Symmetry and Spectroscopy of Molecules by Kadaru Veera Reddy, Revised Second Edition.
9. <http://www.reciprocalnet.org/edumodules/symmetry/operations/index.html>
10. <http://symmetry.otterbein.edu/tutorial/identity.html>
11. <http://chemtube3d.com/solidstate/table.htm>

**Course Title: Physical Chemistry I****Course Code: CHE503B****Total Lectures: 60****Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of

Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post graduation in the course.

**UNIT I****Partial Molar Properties****(20 Lectures)**

Recapitulation of thermodynamic laws, Partial molar quantities, chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential of an ideal gas mixture (s), determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential.

**Real Gases: Concept of Fugacity and Activity**

Concept of fugacity, methods for determining the fugacity of a real gas and its variation with temperature and pressure, activity, choice of standard states, dependence of activity on temperature and pressure.

**UNIT II****Solution & Phase Equilibrium****(15 Lectures)**

Solubility and factors affecting solubility, types of solutions, ideal solution, vapour pressure of ideal solutions, boiling point diagrams of binary miscible mixtures and their Distillation diagrams, azeotropes, critical solution temperatures, solubility of gases in liquids, Henry's law, Nernst distribution law, number of extractions, solutions of solids in liquids & chemical

equilibrium. Derivation of Gibb's phase rule, phase equilibria of two component systems showing eutectic congruent and incongruent melting points.

### UNIT III

#### Statistical Thermodynamics

(15 Lectures)

F.D. statistics, distribution law, Bose Einstein's statistics. (using Lagrange's method of undetermined multipliers).

**Partition functions:** Translational, Rotational, Vibrational, Electronic partitions functions. Calculation of Thermodynamic properties in terms of partition functions, Heat capacity, behavior of equilibrium constant in terms of partition function.

### UNIT IV

#### Non Equilibrium Thermodynamics

(10 Lectures)

Meaning and scope of irreversible thermodynamics. Thermodynamic criteria for non-equilibrium states, Phenomenological laws-linear laws, Gibb's equation, Onsager's reciprocal relation, Entropy production-specific laws of entropy production, Non-equilibrium stationary states, Prigogine's principle of entropy production, Coupled phenomena, Some important applications.

#### ESSENTIAL BOOKS:

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub, 6th ed.2018.
2. Physical Chemistry, P.W. Atkins, Oxford University Press, 9th ed.2010.
3. Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press, 2008.
4. Chemical Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin, Wiley, 1994.

**Course Title: Analytical Chemistry**

**Course Code: CHE504B**

**Total Lectures: 60**

**Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of Analytical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of analytical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in the course.

## UNIT I

**Elementary concepts**

**(15 Lectures)**

Qualitative and quantitative analysis, Concepts important to quantitative analysis, Classification of methods for quantitative analysis, the Choice of method for analysis, Sampling, Preparation of samples for analysis, Calibration standards, Solution concentration in terms of various conventions, Simple equilibrium calculations, Calibration of analytical weights and glass wares, Significance of calibration. Evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors.

**Electroanalytical Techniques**

Electrogravimetry: Without potential control and controlled potential, applications. Coulometric methods and applications. Voltammetry and polarography: linear sweep Voltammetry, voltammetric electrodes, voltammograms, voltammograms for mixtures. Polarography: currents, dropping mercury electrodes, pulse polarography, cyclic Voltammetry, stripping methods, amperometric titrations.

## UNIT II

**X-ray diffraction methods of analysis**

**(15 Lectures)**

Production of X-rays, solid state symmetry, reciprocal lattice, Bragg's law in reciprocal space, the powder method, interpretation of powder pattern of a cubic system, particle size determination by powder method, qualitative and quantitative analysis using powder method. X-ray fluorescence spectroscopy, X-rays emission method, applications (qualitative and quantitative).

### UNIT III

#### **Thermo analytical or Thermometric Methods (15 Lectures)**

Thermogravimetric analysis (TGA): Principle and method, automatic analysis, factors affecting results. Derivative Thermogravimetric analysis (DTG), applications. Differential thermal analysis (DTA): Principle and working, theory, simultaneous DTA-TGA curves, applications.

### UNIT IV

#### **Chromatography (15 Lectures)**

Introduction, terminology and basic principle, Gas chromatography (GC): Instrumentation for Gas-Liquid chromatography, columns, stationary phases, applications, Gas-Solid chromatography. High-Performance Liquid Chromatography (HPLC), instrumentation, partition chromatography, Ion-Exchange chromatography, Size-Exclusion chromatography, Comparison of HPLC and GC.

#### **Suggested Books**

1. Christian G.D. *Analytical Chemistry*, John Wiley, 6<sup>th</sup> edition, 1994.
2. Skoog D.A., West, D.M., Holler, F.J. and Crouch, S.R. *Fundamentals of Analytical chemistry*, Brooks/Cole, 2004.
3. Skoog D.A. *Principles of Instrumental Analysis*, Holt-Saunders International edition, 6<sup>th</sup> edition, 2016.
4. Bassett, J., Denney, R.C., Jeffery, G.H. and Mendham, J. *Vogel's Textbook of Quantitative Inorganic Analysis (Revised)*, Orient Longman, 5<sup>th</sup> edition, 1989.
5. Willard H.H., Merritt L.L. Jr, Dean J.A. and Settle F.A. Jr. *Instrumental Methods of Analysis*, California: Wadsworth Publishing Company, 7<sup>th</sup> edition, 2004.

**Course Title: ORGANIC CHEMISTRY LAB I****Course Code: CHE505B****Time: 04 Hours**

**Course Objectives:** This course is intended to learn the basic experimental concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in the course.

1. Organic Lab- (i) Safety: Eye, Fire and Chemicals (ii) Glassware (iii) Non-glass equipment (iv) Heating devices (v) Cleaning Glassware
2. To determine corrected melting points of an unknown organic compound (Calibration of thermometer).
3. Synthesis of Adipic acid from cyclohexanol (oxidation).
4. Synthesis of Aspirin from Salicylic acid.
5. Synthesis of benzyl alcohol and benzoic acid (Cannizzaro's reaction).
6. Synthesis of Dibenzal acetone from benzaldehyde (Claisen-Schmidt reaction).
7. Synthesis of Cinnamic acid from benzaldehyde (Knoevenaegal reaction).
8. Synthesis of Acetanilide and bromoacetanilide.
9. Synthesis of p-chlorotoluene from p-toludine
10. Synthesis of Benzanilide (Schotten-Baumann reaction).
11. Synthesis of o-Benzoylbenzoic acid (Friedel-Craft's reaction).

**Suggested Books:**

1. Harwood, L.M. and Moody, C.J. *Experimental Organic Chemistry*, Blackwell Scientific Publishers, 1<sup>st</sup> edition, 1989.
2. Vogel, A.I. *Text Book of Practical Organic Chemistry*, ELBS, Longman Group Ltd., 5<sup>th</sup> edition, 1978.
3. Mann, F.G. and Saunders, B.C. *Practical Organic Chemistry*, New Impression, Orient Longman Pvt. Ltd., 4<sup>th</sup> edition, 1975.
4. Leonard, J. and Lygo, B. *Advanced Practical Organic Chemistry*, Chapman and Hall, 1995.

**Course Title: Inorganic Chemistry Lab –I**

**Course Code: CHE506B**

**Time: 04 Hrs**

**Course Objectives:** This course is intended to learn the basic concepts of Inorganic Chemistry Laboratory. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various experiments have been designed to enhance laboratory skills of the postgraduate students.

**Expected Prospective:** The students will be able to understand the basic objective of experiments in inorganic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

**I. Oxidation-Reduction Titrations**

1. Standardization of  $\text{KMnO}_4$  with sodium oxalate and determination of  $\text{Ca}^{2+}$  ion.
2. Standardization of ceric sulphate with Mohr's salt and determination of  $\text{Cu}^{2+}$ ,  $\text{NO}_2^-$  and  $\text{C}_2\text{O}_4^{2-}$
3. Standardization of  $\text{K}_2\text{Cr}_2\text{O}_7$  with  $\text{Fe}^{2+}$  and determination of  $\text{Fe}^{3+}$  (Ferric alum)
4. Standardization of hypo solution with potassium iodate /  $\text{K}_2\text{Cr}_2\text{O}_7$  and determination of available  $\text{Cl}_2$  in bleaching powder,  $\text{Sb}^{3+}$  and  $\text{Cu}^{2+}$ .
5. Determination of hydrazine with  $\text{KIO}_3$  titration.

**II. Precipitation Titrations**

1.  $\text{AgNO}_3$  standardization by Mohr's method.
2. Volhard's method for  $\text{Cl}^-$  determination.
3. Determination of ammonium / potassium thiocyanate.

**III. Complexometric Titrations**

1. Determination of  $\text{Cu}^{2+}$  and  $\text{Ni}^{2+}$  by using masking reagent by EDTA titration.
2. Determination of  $\text{Ni}^{2+}$  (back titration).
3. Determination of  $\text{Ca}^{2+}$  (by substitution method).

**IV. Gravimetric Analysis**

1. Determination of  $\text{Ba}^{2+}$  as its chromate.
2. Estimation of lead as its lead sulfate.
3. Estimation of Nickel (II) as its nickel dimethyl glyoximate.
4. Estimation of  $\text{Cu}^{2+}$  as cuprous thiocyanate.

**Suggested Books:** Svehla, G. and Sivasankar, B. *Vogel's Qualitative Inorganic Analysis*, Pearson, 7<sup>th</sup> edition, 1996.



**Scheme of Courses M.Sc.**  
**M.Sc. (Hons.) Chemistry**  
**Semester 2**

| S.No         | Paper Code                  | Course Type | Course Title             | L | T | P | Cr        |
|--------------|-----------------------------|-------------|--------------------------|---|---|---|-----------|
| 1            | CHE507B                     | Core        | Organic Chemistry-II     | 4 | 0 | 0 | 4         |
| 2            | CHE508B                     | Core        | Inorganic Chemistry-II   | 4 | 0 | 0 | 4         |
| 3            | CHE509B                     | Core        | Physical Chemistry-II    | 4 | 0 | 0 | 4         |
| 4            | CHE510B                     | Core        | Spectroscopy-I           | 4 | 0 | 0 | 4         |
| 5            | CHE511B                     | Core        | Organic Chemistry Lab-II | 0 | 0 | 4 | 2         |
| 6            | CHE512B                     | Core        | Physical Chemistry Lab-I | 0 | 0 | 4 | 2         |
| 7            | Interdisciplinary Course-II |             |                          |   |   |   | 4         |
| <b>Total</b> |                             |             |                          |   |   |   | <b>24</b> |

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**Course Title: Organic Chemistry-II****Course Code: CHE507B****Total Lectures: 60****Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

**UNIT I****Addition to Carbon-Carbon Multiple Bonds (7 Lectures)**

Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic ring. Hydroboration. Michael reaction, Sharpless asymmetric epoxidation.

**Addition to Carbon-Heteroatom Multiple Bonds (8 Lectures)**

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds acids, esters and nitriles. Addition of Grignard reagents, organozinc, organolithium, organocuprate reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction, Horner-Wadsworth-Emmons (HWE) reaction. Mechanism of condensation reactions involving enolates-Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

**UNIT II****Oxidation Reactions (15 Lectures)**

Introduction. Different oxidative processes. Oxidation of Hydrocarbons- alkenes, aromatic rings, aryl methanes, allylic oxidation of olefins. Oxidation of alcohols: Swern Oxidation, PCC, PDC oxidation, Oxidations with ruthenium tetroxide, iodobenzene diacetate and thallium (III) nitrate, DDQ, CAN, selenium dioxide, peroxyacids, DCC. Baeyer-Villiger reaction, Cannizzaro oxidation-reduction reaction.

### UNIT III

#### Reduction Reactions

(10 Lectures)

Introduction. Different reductive processes, Hydrogenation of alkenes, alkynes and aromatic rings, Carbonyl compounds – aldehydes, ketones, acids, ester and nitriles. Epoxides, Nitro, nitroso, azo and oxime groups, Hydrogenolysis. Sodium borohydride, sodium cyano borohydride, LAH, disobutyl aluminium hydride, tin hydride, trialkyl tinhydride, trialkyl silanes, alkoxy substituted LAH, DIBAL, diborane, diisoamyl borane, hexyl borane, 9-BBN, isopinocampheyl and disopinocampheyl borane. Wolf-Kishner reduction, Clemensen reduction.

#### Free Radical Reactions

(5 Lectures)

Types of free radical reactions, free radical substitution mechanism at an aromatic substrate, neighbouring group assistance, Reactivity for aliphatic and aromatic substrates at a bridgehead. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation. Coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction, Free Radical Rearrangement, Hunsdiecker reaction.

### UNIT IV

#### Rearrangements

(15 Lectures)

General mechanistic considerations-nature of migration, migratory aptitude, memory effects A detailed Study of the following rearrangements Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil- Benzilic Acid, Favorskii, Arndt Eistert synthesis, Neber, Beckmann, Hoffman, Curtius, Schmidt, Baeyer- Villiger, Shapiro reaction, Cope rearrangement, Claisen rearrangement, dienone-phenol, Wolf, Stevens (in cyclic systems) .

**Suggested Books:**

1. Carruthers, W. and Coldham, I. *Some Modern Methods of Organic Synthesis*, IV edition, Cambridge University Press, 2004.
2. March, Jerry. *Advanced Organic Chemistry: Reactions, Mechanism and Structure*, John Wiley, 7<sup>th</sup> edition, 2013.
3. Carey, F. A. and Sundberg, R.J. *Advanced Organic Chemistry*, Plenum, 5<sup>th</sup> edition, 2008.
4. Sykes, Peter. *A Guide Book to mechanism in Organic Chemistry*, Longman, 6<sup>th</sup> edition, 2003.
5. Morrison, R. T. and Boyd, R. N. *Organic Chemistry*, Prentice Hall, 7<sup>th</sup> edition, 2010.
6. Kalsi, P. S. *Organic Reactions and their Mechanisms*, New Age International Publishers, 2<sup>nd</sup> edition, 2000.
7. Mukherji, S.M. and Singh, S.P. *Reactions Mechanism in Chemistry*, Vol. I, II, III, Macmillan, 2003.
8. Aggarwal, O.P. *Organic Chemistry Reactions and Reagents*, Krishna Prakashan Media, 47<sup>th</sup> edition, 2011.
9. Mundy, B. P. *Name Reactions and Reagents in Organic Synthesis*, 2nd edition, 2005
10. <https://nptel.ac.in/course.html>

**Course Title: Inorganic Chemistry – II**

**Course Code: CHE508B**

**Total Lectures: 60**

| L | T | P | Credits | Marks | Pass<br>Marks |
|---|---|---|---------|-------|---------------|
| 4 | 0 | 0 | 4       | 100   | 40            |

**Course Objectives:** This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

### UNIT I

**Inorganic chains, rings and cages (15 Lectures)**

- Chains:** Catenation, heterocatenation (Silicate structures, silicate minerals, Zeolites), Intercalation Chemistry, One - dimensional semiconductors, isopolyanions and heteropolyanions.
- Rings:** Borazines, phosphazenes, phosphazenes polymers, other heterocyclic inorganic ring systems, homocyclic inorganic systems.
- Cages:** Cage compounds having phosphours, oxygen, nitrogen and sulphur: boron cage compounds, Boranes, Symmetric and asymmetric cleavage in diborane and tetraborane, STYX rule, carboranes and metallocene carboranes.

### UNIT II

**Transition metal cluster compounds (15 Lecture)**

Introduction, metal carbonyl clusters; Low Nuclearity ( $M_3$  and  $M_4$ ) clusters: isoelectronic and isolobal relationships high nuclearity carbonyl clusters; hetero atoms in metal atom clusters, electron counting schemes for HNCC: HNCC of Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt. Hexanuclear clusters, Lower halide and chalcogenide clusters, octahedral metal halide, chalcogenide clusters, triangular clusters, and solid state extended arrays, Compounds with M-M multiple bonds; Major structural types; quadrupole bonds, other bond orders in the tetragonal context, relation of clusters to multiple bonds, one dimensional solids.

**UNIT III****Reaction Mechanisms of Transition Metal Complexes I****(15 Lectures)**

Introduction, Ligand substitution reactions: Rates of ligand substitution, The classification of mechanisms, Ligand substitution in square-planar complexes, The nucleophilicity of the entering group, The shape of the transition state, Ligand substitution in octahedral complexes, Rate laws and their interpretation, The activation of octahedral complexes, Base hydrolysis, Redox reactions: The classification of redox reactions, The inner-sphere mechanism, The outer-sphere mechanism, Metal carbonyl reactions, reactions of binuclear carbonyls, associative reactions, species with 17 electron,

**UNIT IV****Reaction Mechanisms of Transition Metal Complexes II****(10****Lectures)**

The Marcus theory, doubly bridged inner-sphere transfer, other electron transfer reactions; two electron transfers, Non-complementary reaction, Ligand exchange via electron exchange, reductions by hydrated electrons, stereochemically non-rigid coordination compounds, Trigonal bipyramidal molecules, systems with coordination number six or more, isomerization and recombination's, tris chelate complexes, metal carbonyl scrambling cluster, rotation within Coshells.

**Nuclear Chemistry****(5 Lectures)**

Introduction, Nuclear Reactions: fusion and fission, radio-analytical techniques and activation analysis, Radiation chemistry of Inorganic Solids.

**Suggested Books:**

1. Huheey, J.E. Inorganic Chemistry, Pearson, 5<sup>th</sup> edition, 2009.
2. Cotton, F.A. and Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley eastern, 6<sup>th</sup> edition.
3. Shriver, D.F., Atkins, P.W. and Langford, C.H. *Inorganic Chemistry*, ELMS, Oxford, 6<sup>th</sup> edition.
4. William W. Porterfield, Inorganic Chemistry, 1<sup>st</sup> edition.
5. K.F. Purcell and J.C. Kotz. An Introduction to Inorganic Chemistry.
6. Handbook of Nuclear Chemistry: Chemical applications of nuclear reactions and radiations, Volume 3, By Rezső G. Lovas, 2003
7. <https://www.adichemistry.com/inorganic/p-block/group-14/silicates/silicates-2.html>

**Course Title: Physical Chemistry II****Course Code: CHE509B****Total Lectures: 60****Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

**UNIT I****Chemical Kinetics****( 15 Lectures)**

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation, concept of energy of activation, potential energy surfaces, steady state kinetics, Lindemann-Christiansen hypothesis, Hinshelwood treatment and Rice Ramsperger-Kassel-Marcus (RRKM) theories of unimolecular reactions, General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and nuclear magnetic resonance method, Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen bromine and hydrogen-chlorine reactions).

**UNIT II****Electrochemistry****(15 Lectures)**

Debye-Hückel theory of ion-ion interaction and activity coefficient, ionic strength, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte.

Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye-Falkenhagen effect, Wein effect, D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation.

### UNIT III

#### Surface Chemistry and Catalysis

(20 Lectures)

Gibbs adsorption equation, Langmuir adsorption isotherm, BET adsorption isotherm, its derivation and applications.

Study of surfaces by STM, SEM, Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons, activation energy for surface reactions.

#### Colloidal State

Classification of colloids, Hardy-Schulze Law, gold number, electrical properties of colloids, electrical double layer and its structure, Stern's theory of double layer, zeta-potential, electrophoresis and electro osmosis, emulsions and their classification, emulsifiers, gels and their classification, Thixotropy, Application of colloids.

**Micelles:** Surface active agents, classification of surface active agents, micellisation, hydrophobic interactions, critical micellar concentration, thermodynamics of micellization-phase separation & mass action models, reverse micelles.

### UNIT IV

#### Macromolecules

( 10 Lectures)

Basic concepts, Kinetics of Polymerization, Mechanism and Kinetics of chain growth polymerization, free-radical, cationic, anionic and coordination polymerization, Mechanism and Kinetics of step-growth polymerization, Molecular mass of polymers, Significance of average molecular mass, Poly-dispersity, Determination of molecular mass by (osmometry, viscosity, diffusion, light scattering, and sedimentation methods.

#### Suggested books:

1. Chemical Kinetics, K.J. Laidler, McGraw Hill.
2. Kinetics and Mechanism, A. A. Frost and R.G. Pearson, John Wiley and Sons.
3. Electrochemistry, S. Glasstone, Affiliated East-West Press, 2007.
4. Physical Chemistry, G.W. Castellan, Narosa, 2004.



5. Heterogeneous Catalysis: Fundamentals and Applications, Julian R.H. Ross, Wiley-Pub, 2016
6. Concepts of Modern Catalysis and Kinetics, I. Chorkendorff and J. W. Niemantsverdriet, 2007.
7. Micelles: Theoretical and Applied Aspects, Moroi, Y. Plenum Press.
8. Modern Electro-Chemistry, Bockris, John O'M; Reddy, Amulya K.N. Plenum Press, New York, 2001.
9. Physical Chemistry of Surfaces, Adamson, W.A. Arthur, Wiley-Interscience Publication, 6th ed.
10. Polymer Chemistry, Billmayer, Wiley Interscience, 2007
11. Principles of Polymerization, Geroge Odian, 2004

**Course Title: Spectroscopy-I****Course Code: CHE510B****Total Lectures: 60**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

**Course Objectives:** This course is intended to learn advanced spectroscopy. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the advance spectroscopy and its applications. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post graduation in this course.

**UNIT I****General Features of Spectroscopy (5 Lectures)**

Units and conversion factors. Introduction to spectroscopy, Nature of radiation. Energies corresponding to various kinds of radiation, Experimental techniques, intensities of spectral lines, Selection rules and transition moments, Line widths, broadening.

**Nuclear Magnetic Resonance Spectroscopy (20 Lectures)**

PMR: Natural abundance of  $^{13}\text{C}$ ,  $^{19}\text{F}$  and  $^{31}\text{P}$  nuclei; The spinning nucleus, effect of external magnetic field, precessional motion and frequency, Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect; Integrals of protons, proton exchange, spin-spin coupling- splitting theory, one, two and three bond coupling, virtual, long range and allylic coupling, magnitude of coupling constant; factors affecting the coupling constant, Chemical and magnetic equivalence, First and second order spectra,  $A_2$ ,  $AB$ ,  $AX$ ,  $AB_2$ ,  $AX_2$ ,  $A_2B_2$  and  $A_2X_2$  spin systems, Simplification of complex spectra (solvent effect, field effect, double resonance and lanthanide shift reagents), CW and FT NMR, Relaxation processes, T1 and T2 measurements, Applications of PMR in structural elucidation of simple and complex compounds.

**UNIT II** **$^{13}\text{C}$ -NMR Spectroscopy (10 Lectures)**

Resolution and multiplicity of  $^{13}\text{C}$  NMR,  $^1\text{H}$ -decoupling, noise decoupling, broadband decoupling; Deuterium, fluorine and phosphorus coupling; NOE and origin of nuclear overhauser effect, off-resonance, proton decoupling, Structural applications of  $^{13}\text{C}$ -NMR, pulse sequences, pulse widths, spins and magnetization vectors, DEPT, INEPT, Introduction to 2D-NMR, COSY, NOESY, HSQC spectra.

### UNIT III

#### Mass Spectrometry

(15 Lectures)

Introduction, methods of ionization EI & CI, Brief description of LD, FAB, SIMS, FD etc., Ion analysis methods (in brief), isotope abundance, Metastable ions, general rules predicting the fragmentation patterns. Nitrogen rule, determination of molecular ion peak, index of H deficiency, fragmentation patterns for aliphatic compounds, amines, aldehydes, Ketones, esters, amides, nitriles, carboxylic acids ethers, aromatic compounds etc.

### UNIT IV

#### UV and Visible Spectroscopy of organic molecules

(10 Lectures)

Measurement techniques, Beer – Lambert's Law, molar extinction coefficient, oscillator strength and intensity of the electronic transition, Franck-Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect, transitions in organic molecules, Woodward rules for conjugated dienes, unsaturated carbonyl groups, extended conjugation and aromatic sterically hindered systems, Quantitative applications.

#### Suggested Books:

1. Drago, R.S. *Physical Methods for Chemists*, 2nd Edition, 2016.
2. Silverstein, R.M. Bassler, G.C. and Morrill, T.C. *Spectrometric Identification of Organic Compounds*, Wiley, 8th Edition.
3. Kemp, W. *Organic Spectroscopy*, Macmillan, 3rd Edition, 2019.
4. Dyer, J. R. *Application of Absorption Spectroscopy of Organic Compounds*, 1978.
5. Williams, D. H. and Fleming, I. *Spectroscopic Problems in Organic Chemistry*, 6th Ed, 2007.
6. Barrow, G.M. *Introduction to Molecular Spectroscopy*, McGraw Hill, 1962.
7. Banwell, C.N. *Fundamentals of Molecular Spectroscopy*, McGraw Hill, 2017, 4th Edition.
8. Pavia, D.L., Lampan, G.M. and Kriz, G. S. *Introduction to Spectroscopy*, Hartcourt College Publishers, 5<sup>th</sup> Edition, 2013.

**Course Title: Organic Chemistry Lab II****Course Code: CHE511B****Time: 04 Hours****Course Objectives:**

This course is intended to learn the basic experimental concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post-graduation in this course.

**Preparation of the following organic compounds:**

1. Hydroxynaphthaldehyde (Reimer tiemannReaction)
2. Benzoin, Benzil and Benzilic acid.
3. Benzophenone, Benzophenoneoxime, Benzanilide (Beckmann Rearrangement).
4. Alkylation of diethyl malonate with benzyl chloride

**Qualitative Analysis of mixtures of organic solids:**

Separation of the compounds and their identification through various steps, derivative preparation, checking the purity of components by melting point.

**Suggested Books:**

1. Harwood, L.M. and Moody, C.J. *Experimental Organic Chemistry*, Blackwell Scientific Publishers, 1<sup>st</sup> edition, 1989.
2. Vogel, A.I. *Text Book of Practical Organic Chemistry*, ELBS, Longman Group Ltd., 4<sup>th</sup> edition, .
3. Mann, F.G. and Saunders, B.C. *Practical Organic Chemistry*, 4th edition, New Impression, Orient Longman Pvt. Ltd., 1975.
4. Leonard, J. and Lygo, B. *Advanced Practical Organic Chemistry*, Chapman and Hall, 1995.

**Course Title: Physical Chemistry Lab -I****Course Code: CHE512B****Time: 04 Hours****Course Objectives:**

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**Expected Prospective:**

The students will be able to understand the basic objective of experiments in organic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

**1. Viscosity:**

- (i) Determination of percentage composition of a liquid mixture by viscosity measurement.
- (ii) Determination of molecular weight of a high polymer (say polystyrene) by viscosity measurement.

**2. Surface Tension:**

- (i) Determination of Parachor value of  $>CH_2$  group.
- (ii) To measure interfacial tension and to test the validity of Antonoff's rule.
- (iii) To compare cleansing power of two detergents.
- (iv) To determine the critical micelle concentration of a soap by surface tension method.

**3. Solubility:**

- (i) Determination of solubility of an inorganic salt in water at different temperatures and hence to draw the solubility curve.
- (ii) To study the effect of addition of an electrolyte on the solubility of an organic acid.
- (iii) To study the variation of solubility of  $Ca(OH)_2$  in NaOH solution and hence determine the solubility product.

**4. Colloidal State:**

- (i) To compare the precipitation power of  $\text{Na}^+$ ,  $\text{Ba}^{2+}$  &  $\text{Al}^{3+}$  ions for  $\text{As}_2\text{S}_3$  sol.
- (ii) To study interaction between arsenious sulphide and ferric hydroxide sol.

**5. Density:**

Determine the partial molar volume of ethanol in dil. aqueous solution at room temperature.

**Suggested Books:**

1. Levitt, B.P. *Findlay's Practical Physical Chemistry*, 9th edition, Longman Group Ltd., 1973.
2. Matthews, G. Peter *Experimental Physical Chemistry*, 1st edition, Oxford University Press, 1985.
3. Shoemaker, D.P.; Garland, C.W.; Nibler, J.W. *Experiments in Physical Chemistry*, 6th edition (International Edition) McGraw Hill Inc., 1996.
4. Khosla, B.D.; Garg, V.C. Gulati, A. *Senior Practical Physical Chemistry*, 11<sup>th</sup> edition, R. Chand and Co., 2002.
5. Yadav, J. B. *Physical Chemistry Practical*, 2015

**Scheme of Courses M.Sc.**  
**M.Sc. (Hons.) Chemistry**  
**Semester 3**

| S.No                         | Paper Code | Course Type | Course Title                   | L | T | P | Cr     |
|------------------------------|------------|-------------|--------------------------------|---|---|---|--------|
| 1                            | CHE601B    | Core        | Organic Chemistry-III          | 4 | 0 | 0 | 4      |
| 2                            | CHE602B    | Core        | Inorganic Chemistry-III        | 4 | 0 | 0 | 4      |
| 3                            | CHE603B    | Core        | Physical Chemistry-III         | 4 | 0 | 0 | 4      |
| 4                            | CHE604B    | Core        | Spectroscopy-II                | 4 | 0 | 0 | 4      |
| 5                            | CHE606B    | Core        | Inorganic Chemistry Lab-II     | 0 | 0 | 4 | 2      |
| 6                            | CHE607B    | Core        | Physical Chemistry Lab-II      | 0 | 0 | 4 | 2      |
| 7                            | CHE608B*   | Core        | Seminar and Literature Survey  | 0 | 0 | 0 | 2*     |
| 8                            | CHE620B*   | Core        | Advance Chemistry Lab-I        | 0 | 0 | 8 | 4*     |
| <b>Department Elective-I</b> |            |             |                                |   |   |   | 4      |
| <b>Total</b>                 |            |             |                                |   |   |   | 26/28* |
| <b>Department Elective-I</b> |            |             |                                |   |   |   |        |
| 7                            | CHE605B    | Elective    | Advanced Electrochemistry      | 4 | 0 | 0 | 4      |
| 8                            | CHE617B    | Elective    | Synthetic Organic Chemistry    | 4 | 0 | 0 | 4      |
| 9                            | CHE614B    | Elective    | Molecules of Life              | 4 | 0 | 0 | 4      |
| 10                           | PHY670     | Elective    | Nanoscience and Nanotechnology | 4 | 0 | 0 | 4      |

L: Lectures T: Tutorial P: Practical Cr: Credits

\*Only 30 students in the class will be enrolled for research projects based upon their merit/performance in MSc first year. The students with research projects will study CHE608B of 2 credits and the others will study CHE620B of 4 credits in the third semester.

**Course Title: Organic Chemistry-III (Pericyclic Reactions and Photochemistry)**

**Course Code: CHE601B**

**Total Lectures: 60**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

**Course Objectives:**

This course is intended to teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. (2nd Year) in the subject of Chemistry has been framed as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Pericyclic Reaction. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

**UNIT I**

**Pericyclic Reactions**

**(18 Lectures)**

Introduction, Construction of molecular orbitals and its symmetry in conjugated polyenes (ethylene, 1,3-butadiene, 1,3,5-hexatriene), & in conjugated ions and radicals (allyl, pentadienyl, and heptatrienyl system). Frontier molecular orbitals and theory of pericyclic reactions. Classification of pericyclic reactions and their complete description. Woodward-Hoffmann correlation diagrams of pericyclic reactions. Description of pericyclic reactions by Frontier molecular orbitals (FMO) and Perturbation molecular orbitals (PMO) methods. Electrocyclic reactions and its theory (conrotatory and disrotatory motions in  $4n$ ,  $4n+2$  and in conjugated ions and radicals). Cycloadditions reactions and its theory (stereochemistry, orientation effect, intermolecular, and intramolecular reactions)- antara facial and suprafacial additions in  $4n$  and  $4n+2$  systems. 2+2 cycloaddition reactions, Chelotropic reactions and 1,3-dipolar cycloadditions reactions.

**UNIT II**

**Sigmatropic rearrangements**

**(12 Lectures)**



Introduction, Classification of sigmatropic shift, Mechanism of sigmatropic shift reactions with FMO and PMO method. Sigmatropic shifts of hydrogen and carbon moieties (Suprafacial and antarafacial shift). [3,3] and [5,5] sigmatropic rearrangements and its stereochemistry. Cope, Oxa-Cope, Claisen, and Aza-Cope rearrangement. Fluxional tautomerism or molecules. Intermolecular and intramolecular group transfer reactions (Ene reaction).

### **Photochemical Reactions**

**(5 Lectures)**

Introduction and basic principles of photochemistry, Electronic transitions, spin multiplicity. Types of excitations, the fate of excited molecule (Jablonski diagram), Description of physical processes. Photosensitization and quenching. Laws of Photochemistry. Quantum yield – actinometry, and its description.

### **UNIT III**

#### **Photochemistry of Alkenes and Dienes**

**(5 Lectures)**

Photochemistry of alkenes: *Cis-Trans* isomerization and dimerization of alkenes. Photochemistry of conjugated dienes.

#### **Photochemistry of Aromatic Compounds**

**(5 Lectures)**

Photoisomerization of benzene and substituted benzene. Photoaddition of alkenes to aromatic benzenoid compounds. Photosubstitution of aromatic compound.

### **UNIT IV**

#### **Photochemistry of Carbonyl Compounds**

**(10 Lectures)**

<- Cleavage (Norrish type-I reaction) of acyclic saturated ketone, saturated cyclic ketone (cyclohexanones, cyclopentanones, cyclobutanones).  $\otimes$ -cleavage reaction. Norrish type-II reaction. Intramolecular hydrogen abstraction ( $\odot$  hydrogen abstraction). Intermolecular hydrogen abstraction (Photoreduction). Paterno-Buchi reactions. Cyclohexenone rearrangement (Lumiketone rearrangement and Di- $\square$  methane type rearrangement). Rearrangement of dienones. Photo rearrangement of  $\otimes$ ,  $\odot$ -unsaturated ketones (1,2-acyl shift and 1,3-acyl shift). Aza-Di- $\square$  methane rearrangement. Di- $\square$  methane rearrangement.

**Miscellaneous Photochemical Reactions****(5 Lectures)**

Rearrangement of aromatic compounds (Photo-Friesrearrangement). Photochemical oxidations. The Barton reaction. The Hoffmann-Loeffler-Freytag reaction. Photochemical formation of smog. Photochemistry of vision.

**Suggested Books:**

1. Mukherji, S.M. *Pericyclic reactions*, Macmillan, 1979.
2. Turro, N.J. and Benjamin, W.A. *Molecular Photochemistry*, University Science Books, U.S., 1991.
3. Cox, A. and Camp, T. *Introductory Photochemistry*, McGrawHill, 1972.
4. Horsepool, W.M. *Organic Photochemistry*, Ellis Horwood, 1992.
5. Kalsi, P.S. *Organic Reactions and their Mechanisms*, New Age International, 2<sup>nd</sup> edition, 2000.
6. Singh, J and Singh, J: *Photochemistry and pericyclic reactions*, Revised 3rd edition, 2012.
7. <https://nptel.ac.in/courses/104106077/>

**Course Title: Inorganic Chemistry–III (Organometallics)**
**Course Code: CHE602B**
**Total Lectures: 60**
**Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of

Inorganic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

### UNIT I

#### Structure and Bonding (15 Lectures)

*Organometallic chemistry:* The 18 Valence Electron Rule: Introduction, 18 electron rule, counting of electrons and finding metal-metal bonds, Violation of 18 electron rule and related problems.

*Ligands with Higher Hapticity:*  $\sigma$ -bonded aryl ligands. Cyclic and acyclic polyenyl  $\pi$ -bonded ligands: Cyclopentadienyl (Cp-) ligands, Synthesis of Cp based sandwich compounds, Structure and properties of Cp<sub>2</sub>M complexes, Reactions of other metal-sandwich compounds, Bent sandwich compounds, Schwartz reagent and hydrozirconation, Chemistry of Cp\*, Chemistry of arene sandwich compounds. Allyl groups as ligands, 1,3-Butadiene complexes, Cyclobutadiene complexes, Cycloheptatriene and Cyclooctatetraene as ligands. Davies-Green-Mingos (DGM) rules.

### UNIT II

#### Complexes with Metal-Carbon multiple bonds (15 Lectures)

Carbene and carbynes: Structure of Fischer and Schrock carbenes, synthesis of Fischer and Schrock carbene complexes. Tebbe's reagent and Petasis reagent Importance of metal carbene complexes. Structure, synthesis and properties carbyne complexes

Neutral spectator ligand: Phosphines and N-Heterocyclic Carbene

Metal clusters: binuclear and polynuclear, metal metal bond in low nuclearity and high nuclearity carbonyl clusters. Capping rule: limitation and exceptions of capping rule, polyhedral skeletal electron pair approach. Metal Clusters with main group elements, Jemmis' mno rules

### UNIT III

#### **Applications of Organometallic Complexes to Catalysis (15 Lectures)**

Catalysis, Thermodynamics of catalysis, Terminology in catalysis-turnover, turnover number, turnover frequency, enantioselectivity and regioselectivity of catalyst. Sequences involved in a catalyzed reaction, Heterogeneous catalysis, catalytic converter in automobiles.

**Olefin metathesis:** A synthetic tool, olefin metathesis catalysts and properties. Synthesis of Grubbs and Schrock catalysts. Ring opening metathesis, cross metathesis, Ring closing metathesis, Ring opening metathesis polymerisation.

**Catalytic hydrogenation:** classification of hydrogenation catalysts, catalytic cycle of iridium and ruthenium based catalysts, directing effects in catalytic hydrogenation, Hydrogenation by lanthanide organometallic compounds. Palladium catalyzed C-C and C-N coupling reactions: Heck reaction, Suzuki-Miyaura coupling, Sonogashira coupling, Negishi coupling, Buchwald-Hartwig C-N cross coupling.

### UNIT IV

#### **Bioorganometallic Chemistry (15 Lectures)**

Vitamin B<sub>12</sub> coenzyme: discovery and structure, Role of organometallics in heavy metal poisoning: Mercury and Arsenic poisoning; organometallic compounds as drugs: ruthenium based anticancer drugs. Ferrocene based drugs: ferroquine and ferrocifen; Organometallic radiopharmaceutical, Organometallics tracers, ionophores and sensors.

#### **Suggested Books:**

1. J.E. Huheey, Inorganic Chemistry, Principles of Structure and Reactivity, Harper Inter-Science 4th edition.
2. B.D. Gupta and A.J. Elias, Basic Organometallic Chemistry, Universities Press.
3. Organometallic Chemistry. Third Edition. Gary O. Spessard and Gary L. Miessler.
4. <https://nptel.ac.in/courses/104108062/>
5. [https://home.cc.umanitoba.ca/~budzelaa/CHEM4680/CHEM4680\\_lectures.html](https://home.cc.umanitoba.ca/~budzelaa/CHEM4680/CHEM4680_lectures.html)
6. <http://people.fas.harvard.edu/~chem253/>

**Course Title: Physical Chemistry III****Course Code: CHE603B****Total Lectures: 60****Course Objectives:**

| L | T | P | Credits | Marks | Pass<br>Marks |
|---|---|---|---------|-------|---------------|
| 4 | 0 | 0 | 4       | 100   | 40            |

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

**UNIT I****Mathematical Preparation****( 15 Lectures)**

Operators and observables, normality and orthogonality of functions, Hermitian operators.

**Quantum Theory: Introduction and principles and applications**

Black Body radiation, Planck's radiation law, photoelectric effect, Compton effect, De-Broglie hypothesis, Heisenberg's uncertainty principle, eigenvalue equation, Hamiltonian operator, Interpretation of  $\Psi$ , Solution of particle in one, two and three dimensional box, degeneracy. Postulates of quantum mechanics, the linear harmonic oscillator, and the rigid rotator, Ladder operator method for angular momentum.

**UNIT II****The Approximation Methods****(15 Lectures)**

Need for approximation methods, Perturbation and Variation methods and their application to Helium atom.

**Chemical Bonding**

Chemical bonding, linear combination of atomic orbitals, overlap integral, coulomb integral, bond order, charge density calculations for ethylene, allyl system, butadiene system, cyclo butadiene, cyclo propenyl system.

**UNIT III**

**Nanochemistry****(12 Lectures)**

Properties of nanomaterials, General Method of synthesis, Characterization of nanomaterials, Material Self-assembly, Quantum dot, Nanoscale Materials, Fullerenes, Carbon nanotubes, nanowires, Nanorods, Dendrimers, Biological Nanomaterials, General Applications of Nanochemistry.

**UNIT IV****Nuclear and Radiochemistry****(18 Lectures)**

Nuclear stability and binding energy, Mass and binding energy, Nuclear fission and nuclear fusion, fission cross section, chain fission, fission product and fission yield. Interaction of nuclear radiation with matter,

**Photochemistry**

Difference between thermal photochemical reactions, laws of photochemistry, Jablonski diagram, qualitative description of fluorescence, phosphorescence, non- radiative processes (IC, ISC), quantum yield, photosensitized reactions, nuclear geometries of electronically excited states, Excimers and Exciplexes, kinetics of photochemical reactions, chemiluminescence.

**Books Suggested:**

1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill, 2017.
2. Quantum Chemistry, I.M. Levine, Prentice Hall, 2016.
3. Essentials of Nuclear Chemistry, , H.J. Arnikaar, Wiley Eastern, New Delhi, 2011.
4. Nuclear & Radiochemistry, G. Fridlander, J.W. Kennedy, E. S. Macias, and J. M. Miller, John Wiley, New York.
5. Quantum Chemistry, R. K. Parsad,2010

**Course Title: Spectroscopy -II****Course Code: CHE604B****Total Lectures: 60**

| L | T | P | Credits | Marks | Pass<br>Marks |
|---|---|---|---------|-------|---------------|
| 4 | 0 | 0 | 4       | 100   | 40            |

This course is intended to learn the basic concepts of Spectroscopy. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Spectroscopy. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post-graduation in this course.

**UNIT I****Pure Rotational Spectra****(8 Lectures)**

Classification of molecules according to their moment of inertia. Rotational spectra of diatomic molecules (rigid rotator), Intensities of spectral lines, isotopic substitution effects, non-rigid rotator, polyatomic linear and symmetric top molecules, Stark effect.

**Vibrational Spectroscopy****(8 Lectures)**

**Theory of Infrared Absorption:** Harmonic and anharmonic oscillators, absorptions of radiation by molecular vibrations, selection rules, force constant, frequency of vibrational transitions of HCl, vibrations in a polyatomic molecule,  $3N-6$  and  $3N-5$  rules, types of vibrations, overtones, combination and difference bands, examples of  $\text{CO}_2$ ,  $\text{SO}_2$  and  $\text{H}_2\text{O}$ , Fermi resonance, group vibrations.

**UNIT II****(10 Lectures)**

**Raman Spectroscopy:** Introduction, selection rules, anisotropic polarizability, Stokes, anti-Stokes lines, vibrational Raman spectra of  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , polarized and depolarized Raman Lines, rule of mutual exclusion.

**Determination of IR/Raman Active Modes:** Significance of nomenclature: used to describe various vibrations, use of symmetry considerations to determining the number of active infrared and Raman Lines ( $C_{2v}$  molecules).

**Applications:** Physical state of a sample, cells used, Application of IR in structure elucidation of organic compounds-carbonyls and effect of substituents on it, C-H, NH, O-H vibrations and H-bonding- unsaturated, mono- and disubstituted aromatic compounds, metal-ligand vibrations, group frequencies of complex ligands-CN stretching and effect of coordination on it, nitro and nitrite and C=O ligands and effect of their coordination with metal ions.

### UNIT III

**Nuclear Quadrupole Resonance Spectroscopy (8 Lectures)**

Introduction, experimental considerations, fundamentals of NQR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the asymmetry parameter, effects of the magnetic field, interpretation of the spectra, application of the technique to halogen compounds, group elements, transition metals.

**Mossbauer Spectroscopy (8 Lectures)**

Experimental considerations, the spectrum and its parameters, simple spin states ( $I = 1/2, 3/2$ ), higher spin states ( $I > 3/2$ ), magnetic splitting significance of parameters obtained from spectra, quadrupole splitting, additive model, interpretation of Mossbauer spectra of  $^{57}\text{Fe}$ ,  $^{119}\text{Sn}$ .

### UNIT IV

**Electron Paramagnetic Resonance Spectroscopy (9 Lectures)**

Introduction, principle, Presentation of spectrum, hyperfine splitting in isotropic systems involving more than one nucleus, ESR spectrum of benzene radical anion, methyl radical, cyclopentadienyl radical, cycloheptatrienyl radical, pyrazine anion, pyrazine anion with  $^{23}\text{Na}$  and  $^{39}\text{K}$  counter ion and Nitrosyl nitroxide, Factors affecting magnitude of g values, zero field splitting and Kramer's degeneracy.

**Photoelectron Spectroscopy (9 Lectures)**

Introduction, photoelectron spectroscopy, chemical shift, X-ray photoelectron Spectroscopy, ESCA, ultraviolet photoelectron spectroscopy (UPS), exchange splitting and shake up process.

**Suggested Books:**



1. Drago, R.S. *Physical Methods for Chemists*, 2nd Edition, 2016.
2. Silverstein, R.M. Bassler, G.C. and Morrill, T.C. *Spectrometric Identification of Organic Compounds*, Wiley, 8th Edition.
3. Kemp, W. *Organic Spectroscopy*, Macmillan, 3rd Edition, 2019.
4. Dyer, J. R. *Application of Absorption Spectroscopy of Organic Compounds*, Prentice Hall, 1978.
5. Williams, D. H. and Fleming, I. *Spectroscopic Problems in Organic Chemistry*, McGraw Hill, 6th Edition, 2007.
6. Barrow, G.M. *Introduction to Molecular Spectroscopy*, McGraw Hill, 1962.
7. Banwell, C.N. *Fundamentals of Molecular Spectroscopy*, McGraw Hill, 2017, 4th Edition.
8. Pavia, D.L., Lampan, G.M. and Kriz, G. S. *Introduction to Spectroscopy*, Hartcourt College Publishers, 5<sup>th</sup> Edition, 2013.
9. Parish, R.V. *Spectroscopy in Inorganic Chemistry*, Ellis Horwood Limited, 1990.

**Course Title: Inorganic Chemistry Lab -II****Course Code: CHE606B****Time: 04 Hrs****Course Objectives:**

This course is intended to learn the basic concepts of Inorganic Chemistry Laboratory. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various experiments have been designed to enhance laboratory skills of the postgraduate students.

**Expected Prospective:**

The students will be able to understand the basic objective of experiments in inorganic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

**EXPERIMENT**

- 1** Preparation of mercury tetraisothiocyanatocobaltate (II). Determination of its magnetic moment and interpretation of its IR spectrum.
- 2** Preparation of nitro-and nitrito-pentaamminecobalt (II) chlorides from chloropentaamine cobalt (III) chloride. Recording and interpreting their electronic and IR spectra.
- 3** Heating the nitro and nitrito isomers at serial 2 to 15°C in an oven for 3 h and recording the infrared spectra again and compare those with the spectra recorded before the isomers were heated.
- 4** Preparation and resolution of tris (ethylenediamine)cobalt(II) ion. Measurement of optical rotation of these resolved complexes.
- 5** Preparation of diaquotetraacetatedicopper (II). Determination of its magnetic susceptibility and interpretation of E.P.R., electronic absorption and IR spectra.
- 6** Preparation of bis (2,4-pentanedione)vanadium(IV) acetate and its piperidine or pyridine complex. Study of both the complexes with the help of infrared, UV-vis spectroscopy and magnetic susceptibility.
- 7** Preparation of hexaamminenickel(II)chloride and tris(ethylenediamine)nickel(II) chloride. Interpretation of their electronic absorption spectral data and calculation of  $\beta$  and  $10Dq$  values. Measurement of magnetic susceptibility, calculation and interpretation of the values.

**8** Preparation of lead tetraacetate.

**9** Preparation of potassium trioxalatoaluminate(III) trihydrate. Its TGA and DTA studies and its interpretation of its IR data.

**10** Preparation of disulphur dichloride.

**11** Preparation of sodium tetrathionate, potassium dithionate, and interpretation of their IR spectra.

**12** Preparation of cis-and trans-potassium dioxalatodiaquochromate (III). Interpretation of their IR and electronic absorption spectral data. Calculation of  $\beta$  and  $10 Dq$  values.

**13** Preparation of iron (II) oxalate and potassium trioxalateferrate(III). Interpretation of their magnetic data, E.P.R. and Mossbauer spectra.

**14** Preparation of nitrosylbis-(diethyldithiocarbamate)iron(II) and interpretation of its IR and EPR spectra.

**15** Preparation of chromium (II) acetate hydrate.

**16** Preparation of Manganese (II) phthalocyanine. Interpretation of its IR, and electronic absorption spectra.

**Suggested Books:**

**1** Marr, G. and Rockett, B.W. *Practical Inorganic Chemistry*, Van Nostrand Reinhold Company.

**2** Jolly, W.L. *The Synthesis and Characterization of Inorganic Compounds*. Prentice Hall.

**Course Title: Physical Chemistry Lab -II**

**Course Code: CHE607B**

**Time: 04 Hours**

**Course Objectives:**

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**Expected Prospective:** The students will be able to understand the basic objective of experiments in organic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**1. Polarimetry:**

To study the inversion of cane sugar by optical rotation measurement.

**2. Potentiometry:**

- (i) Determination of valence of mercurous ion.
- (ii) Determination of pH value using quinhydrone electrode.
- (iii) Determination of heat of reaction, equilibrium constant and other thermodynamic functions for:



- (iv) Determination of hydrolysis constant of aniline hydrochloride electrometrically.

**3. Flame Photometry:**

(i) Determination of  $\text{Na}^+$  &  $\text{K}^+$  when present together.

(ii) Determination of Lithium/ Calcium/ Barium/ Strontium.

#### **4. Transition Temperature Determination:**

Determination of transition temperature of  $\text{MnCl}_2$  by Dilatometric method.

#### **Suggested books:**

1. Levitt, B.P. *Findlay's Practical Physical Chemistry*, 9th edition, Longman Group Ltd., 1973.
2. Matthews, G. Peter *Experimental Physical Chemistry*, 1st edition, Oxford University Press, 1985.
3. Shoemaker, D.P.; Garland, C.W.; Nibler, J.W. *Experiments in Physical Chemistry*, 6th edition (International Edition) McGraw Hill Inc., 1996.
4. Khosla, B.D.; Garg, V.C. Gulati, A. *Senior Practical Physical Chemistry*, 11<sup>th</sup> edition, R. Chand and Co., 2002.

**Course Title: Advance Chemistry Lab-I****Course Code: CHE620B****Time: 08 Hours****Course Objectives:**

To teach the advance techniques in the Chemistry lab. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**Expected Prospective:** The students will be able to understand the advance techniques required to synthesize, analyze different chemical compounds, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

**Advance Inorganic Chemistry Lab**

1. Synthesis of first row transition Metal complexes with reduced Schiff base ligands and their characterisation with various techniques, like UV-Visible spectroscopy, IR spectroscopy and Thermogravimetric analysis.
2. Synthesis of Cu (I) and Ag (I) salts with different counter anions and their characterization with IR spectroscopy.
3. Learning various methods of crystallisation (slow evaporation, layering, solvent diffusion, slow cooling, vapour diffusion and vacuum sublimation) and growing crystals of reduced Schiff base ligands and metal complexes as synthesised in steps 1 and 2.
4. Synthesis of ZnO and CdO nanoparticles and their characterization by powder X-ray studies and scanning electron microscopy.
5. Study for the effect of Crystal field stabilization energy on the electronic spectra of transition metal complexes using UV-Visible spectroscopy.

**Reference Books**

1. Jolly, W.L. *The Synthesis and Characterization of Inorganic Compounds*. Prentice Hall.
2. Marr, G. and Rockett, B.W. *Practical Inorganic Chemistry*, Van Nostrand Reinhold Company.

3. Pass, G. and Sutcliffe, H *Practical Inorganic Chemistry: Preparations, reactions and instrumental methods*, Springer Netherlan
4. Girolami, G. S., Rauchfuss, T. B., and Angelici, R. J. *Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual* 3rd Edition, University Science Books
5. Svehla, G. and Sivasankar, B. *Vogel's Qualitative Inorganic Analysis (revised)*, Pearson, 7<sup>th</sup> edition, 1996

### **Advanced Physical Chemistry Lab**

1. Understanding error, accuracy and precision by measuring physical parameters.
2. Determination of physical properties of materials
3. Advanced experiments involving chemical thermodynamics, chemical equilibria, chemical Kinetics, electro chemistry, spectroscopy, photochemistry and macromolecules.

#### **Reference Books**

1. Halpern, A. M.; McBane, G. C. *Experimental Physical Chemistry: A Laboratory Prescribed Book*, W. H. Freeman, 3<sup>rd</sup> edition, 2006.
2. Viswanathan, B.; Raghavan, P. S.; *Practical Physical Chemistry*, Viva Books, 2010.
3. Hein, M.; Peisen, J. N.; Miner, R. L.; *Foundations of College Chemistry in the Laboratory*, John Wiley & Sons Inc., 2011.
4. Dave, R. K.; *Experiments in Physical Chemistry*, Campus Books International, 2011.

### **Computational Chemistry Laboratory**

Experiments involving optimization of molecular energies and geometries, calculation of thermodynamic parameters, kinetic parameters, prediction of spectral data.

#### **Reference Books**

1. J.B. Foresman, AEleen Frisch, *Exploring Chemistry with Electronic Structure Methods*, Gaussian, Inc., 2nd Ed., 2000
2. Frank Jensen, *An Introduction to Computational Chemistry*, John Wiley & Son Ltd., 1998.
3. Christopher Cramer, *Essentials of Computational Chemistry: Theories and Models*, John Wiley & Sons, 200

**Course Title: Advanced Electrochemistry**

**Course Code: CHE605B**

**Total Lectures: 60**

**Course Objectives:**

| L | T | P | Credits | Marks | Pass<br>Marks |
|---|---|---|---------|-------|---------------|
| 4 | 0 | 0 | 4       | 100   | 40            |

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post-graduation in this course.

## UNIT I

### Electrochemistry of Solutions I

(22 Lectures)

Ion-solvent interactions, the Born model, electrostatic potential at the surface of a charged sphere, Born expression for the free energy of ion-solvent interactions, structural treatment of ion-solvent interactions, ion-dipole moment, evaluation in the ion-dipole approach to heat of solvation, solvation number, static and dynamic pictures of ion-solvent interactions, hydration number, dielectric constant of water and ionic solutions, dielectric constant of liquids containing associated dipoles, ion – solvent nonelectrolyte interactions, change in solubility of non-electrolyte due to primary and secondary solvations.

## UNIT II

### Electrochemistry of Solutions II

(18 Lectures)

Debye-Huckel treatment, and its extension, ion solvent interaction, Debye-Huckel-Jerrum model, Thermodynamics of electrified interface equations, derivation of electro capillarity, Lippmann equations (surface excess), Methods of determining structures of electrified interfaces, Guoy-Chapman, Stern. Over potentials, exchange current density, derivation of Butler-volmer equation. Tafel plots. Quantum aspects of charge transfer at electrode solution interfaces,



quantization of charge transfer, tunnelling Semiconductor interfaces- theory of double layer interfaces, effects of light at semiconductor solution interface.

### UNIT III

#### **Electro catalysis**

**(8 Lectures)**

Influence of various parameters, Hodges-Huxley equation, Nernst-Planck equation, H-electrode, polarography, theory of Ilkovic eqn, (excluding derivation), Half wave potential & its significance, electrocardiography

### UNIT IV

#### **Corrosion and its Control**

**(12 Lectures)**

Corrosion in Metal and alloys, causes of corrosion, Effects of Corrosion, Corrosion cell, Types of corrosion, Electrochemical corrosion, Corrosion control, Protective Coatings, Metal Finishing, Electroplating, Effect of plating variables on the Nature of Electro deposit, Surface preparation, Electroplating of Chromium, silver, Electro less plating.

#### **Suggested Books:**

1. Electrochemistry, S. Glasstone, Affiliated East-West Press.
2. Modern Electrochemistry, J. O' M. Bockris & A.K.N. Reddy, Vol. II, A Plenum/Rosetta Edition.
3. Electrochemical methods, Allen J. Bard, Wiley India.
4. Handbook of Electrochemistry, Cynthia Zoski, 1st Ed., Elsevier.

**Course Title: Synthetic Organic Chemistry****Course Code: CHE617B****Total Lectures: 60****Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of Synthetic Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Synthetic Organic Chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers.

### UNIT I (18 Lectures)

An introduction of synthesis and synthetic equivalents. General principle of disconnection approach; Importance of order of event in organic synthesis. Introductory meaning of one CX and two C-X groups disconnection. Reversal of polarity (umpolung), New application of organosilicone compounds, cyclization reactions of carbene and nitrenes.

Protective Groups :Principle of protection of alcoholic, amino, carbonyl and carboxylic groups with suitable examples from synthetic point of view.

Synthesis of alkene,  $\beta$ -elimination pyrolytic syn elimination, synthesis of allyl alcohol, sulphoxidesulphenate rearrangement, through phosphorous ylid, decarboxylation of  $\beta$ -lactum stereo selective synthesis of tri-tetra substituted alkenes through use of acetylenes. Use of nitro compounds in organic synthesis. Fragmentation of sulphonates, oxidative decarboxylation of carboxylic acids. Decomposition of toluene p-sulphonylhydrazones, stereospecific synthesis from - 1,2-diols. Stereoselective route to  $\gamma,\delta$ -carbonyl compounds.

### UNIT II (12 Lectures)

C-C bond formation: Generation and importance of enolate ion, regioselectivity, stereoselectivity. Generation of dianion and their alkylation, alkylation of relatively acidic

methylene groups. Hydrolysis and decarboxylation of alkylated product, O-Vs-C alkylation, C-alkylation of vinyl group, aryl group. Formation of enamines and alkylation. Alkylation of carbon by conjugate additions.

One group C-C - disconnection: Disconnection of simple alcohols, of simple olefins, carbonyl compounds control in synthesis, friedal craft's type examples.

### UNIT III (15 Lectures)

Reaction of carbon nucleophiles with carbonyl group: Condensation process favoured equilibrium by dehydration of aldol products, under acidic and basic conditions, Amine catalysed condensation, Mannich Reaction, Nucleophilic addition, Cyclization process, Derzen, Perkin, Stobbe reaction. Sulphur slides, phosphorous ylides and related species as nucleophiles.

Diels Alder Reaction: General feature dienophile diene, intramolecular Diels Alder reaction stereochemistry and mechanisms, photo sensitized Diels Alder Reaction, homo Diels Alder reaction, ene synthesis, cycloaddition reaction of allyl cations/anions. Retro-Diels Alder's Reaction.

### UNIT IV (15 Lectures)

Two Group Disconnections approach, 1,3-Difunctionalized compound - $\alpha$ -hydroxy carbonyl compounds.  $\alpha,\beta$ -unsaturated carbonyl compounds, 1,3-di carbonyl compounds,  $\alpha,\beta$ -unsaturated lactones 1,5-dicarbonyl compounds michael disconnection, use of Mannich Reaction in disconnection, Robinson's annelation.

Synthesis of the following natural products using disconnection approach. Caryophyllene, Pencilline, Cephalosporin, 11-Oxoprogestrone, 11-Hydroxy progesterone, Aphidicaline and Juvabione.

#### **Suggested Books:**

1. Carruther, W. *Some Modern Method of Organic Synthesis*. Cambridge University Press, 1986
2. House, H. O. *Modern Synthetic Reactions* W. A. benjamin; 2nd edition, June 1972.
3. Finar, I. L. *Organic Chemistry*, Vol.2. Pearson publisher, 1956.
4. Norman, R.O.C, Coxon, J.M. *Principles of Organic Synthesis* CRC Press, 3<sup>rd</sup> edition, September 1993.
5. Warren, S. *Organic Synthesis: The disconnection approach* John Wiley, 2<sup>nd</sup> edition, Cambridge, 2008.
6. Michael C. Pirrung, *Synthetic Organic Chemistry*, 2<sup>nd</sup> Edition, Elsevier.

**Course Title: Molecules of Life**
**Course Code: CHE614B**
**Total Lectures: 60**
**Objective of the Course:** It is the harmonious and synchronous progress of chemical reactions in body

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

which leads to life. These chemical reactions involve certain molecules called biomolecules or molecules of life. These molecules constitute the source of energy in the body, build the body, act as catalyst in many processes and also responsible for the transfer of characters to off-springs. In this course one would get the information about the structures of these molecules and their role in life related processes. The basic types of molecules included are carbohydrates, proteins, enzymes, lipids and nucleic acids.

**Expected Prospective:** This course will equip students of interdisciplinary subjects with the necessary chemical knowledge concerning the fundamentals in the basic areas of natural science. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post graduation in this course.

**UNIT I**
**Carbohydrates**
**(10 Lectures)**

Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structures. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

**UNIT II**
**Amino Acids, Peptides and Proteins**
**(20 Lectures)**

Classification of Amino Acids, Zwitter ion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C-terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (tbutyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

**Enzymes**

Introduction, nomenclature and classification of enzymes, Mechanism of enzyme action, Specificity of enzyme action (Including stereo specificity), Enzyme kinetics, Michaelis-Menten equation, factors affecting enzyme action, Activators and Coenzymes (NAD, FAD and Acetyl coenzyme), cofactors and their role in biological reactions, Isozymes, Enzyme inhibition, role of enzymes in pharmaceuticals.

### UNIT III

#### Nucleic Acids

(15 Lectures)

Components of Nucleic acids, structure and functions of purines and pyrimidine bases, nucleosides and nucleotides, Base pairing, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

**Lipids** Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

### UNIT IV

#### Concept of Energy in Bio systems

(15 Lectures)

Introduction to Metabolism (catabolism and anabolism), Carbohydrate metabolism (Glycolysis, Krebs cycle and fermentation). Protein metabolism, lipid metabolism, beta oxidation of fatty acids, Inter-relationships in the metabolic pathways of Proteins, Fats and Carbohydrates. Energy production through different metabolic processes (ATP production). Calorific value of food. Standard caloric content of carbohydrates, proteins and fats.

#### Suggested Books:

1. Morrison, R. T. and Boyd, R. N. *Organic Chemistry*, Pearson Education, 6<sup>th</sup> Ed, 1992.
2. Finar, I. L. *Organic Chemistry* (Volume 1), Pearson Education, 6<sup>th</sup> edition, 1973.
3. Finar, I. L. *Organic Chemistry* (Volume 2), Pearson Education, 6<sup>th</sup> edition, 1973.
4. Nelson, D. L. and Cox, M. M. *Menninger's Principles of Biochemistry*, W. H. Freeman 7<sup>th</sup> edition, 2004.
5. Berg, J. M., Tymoczko, J. L. and Stryer, L. *Biochemistry*, W. H. Freeman, 6<sup>th</sup> edition.
6. Russ Hodge, *Molecules of Life: DNA, RNA and Proteins*.

**Course Name: Nanoscience and Nanotechnology**

**Course Code: PHY670**

**Total Lectures: 60**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

**UNIT I (15 Lectures)**

**Introductory Aspects:** Free electron theory and its features, Idea of band structure - metals, insulators and semiconductors. Density of state and its variation with energy, Effect of crystal size on density of states and band gap. Electron confinement in one, two and two-dimensions, Nanostructures and its types, role of size, quantum confinement, surface to volume ratio, Size-dependent properties and applications, Single electron tunneling.

**UNIT II (15 Lectures)**

**Preparation of Nanomaterials:** Nucleation and growth of nanostructures: Homogenous and heterogeneous, Top down and bottom up approaches, Chemical route: Chemical precipitation, Sol-gel, Microemulsions or reverse micelles, Solvothermal/hydrothermal, Electrochemical, Self-Assembly Monolayers (SAM), Physical routes - Inert gas condensation, Sputtering, Laser ablation, Ball Milling, Molecular beam epitaxy, Chemical and Molecular vapour deposition methods, Lithography.

**UNIT III (15 Lectures)**

**Characterization Techniques:** X-ray diffraction (XRD), determination of particle size, study of texture and microstructure, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM) - Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM) Transmission Electron Microscopy (TEM), Optical characterization – UV-Visible, Photoluminescence, Vibrational spectroscopy, Magnetic resonance spectroscopy.

**UNIT IV (15 Lectures)**

**Special Nanomaterials:** Carbon: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C<sub>60</sub>, alkali doped C<sub>60</sub>; Carbon nanotubes: fabrication, structure, electrical properties, vibrational properties, mechanical properties, application of carbon nanotubes: field emission and shielding, computers, fuel cells, chemical sensors, catalysis, Graphene – fabrication and properties

**Reference Books:**

1. Chow, G.M. and Gonsalves, K.E., *Nanotechnology - Molecularly Designed Materials*, American Chemical Society (1996).
2. Jain, K.P., *Physics of Semiconductor Nanostructures*, Narosa (1997).
3. Cao, G., *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, Imperial College Press (2004).
4. B. D. Cullity, *Elements of X –ray Diffraction*, Prentice Hall, 3<sup>rd</sup> edition (2001).
5. R.F. Egerton, *Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM* F. Egerton, Springer (2005).
6. Nalwa, H.S. *Encyclopedia of Nanotechnology*, Springer (2012).
7. Bhusan, B. *Springer Handbook of Nanotechnology*, Springer, 3<sup>rd</sup> edition (2010).

**Course Title: Industrial Chemistry**
**Course Code: CHE622**
**Total Lectures: 60**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

**Course Objectives:**

This course is intended to learn the basic concepts of Industrial Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in areas of Industrial Chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

### UNIT I

**Drugs and Pharmaceuticals**
**(15 Lectures)**

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIVAIDS related drugs (AZT- Zidovudine).

**Fermentation Industries**

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Pencillin, Cephalosporin, Chloromycetin and Streptomycin

### UNIT II

**Cosmetics and Perfumes**
**(15 Lectures)**

A general study including preparation and uses of the following: Hair dye, hair spray, Shampoo, Sun-tan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil,  $\alpha$ -phenylethyl alcohol, Jasmone, Civetone, Muscone.

### UNIT III



**Petroleum and Petrochemical Industry (15 Lectures)**

Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

**UNIT IV****Industrial Gases and Inorganic Chemicals (15 Lectures)**

(a) **Industrial Gases:** Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

(b) **Inorganic Chemicals:** Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

**Suggested books**

1. G.L. Patrick: Introduction to *Medicinal Chemistry*, Oxford University Press, UK.
2. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi
5. Cosmetics P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.
7. Petroleum O. P. Vermani, A. K. Narula: *Industrial Chemistry*, Galgotia Publications Pvt. Ltd., New Delhi.
8. S. C. Bhatia: *Chemical Process Industries*, Vol. I & II, CBS Publishers, New Delhi.
9. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
10. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
11. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

**Course Title: Physical Organic Chemistry****Course Code: CHE623****Lectures: 60**

| L | T | P | Credits | Marks | Pass<br>Marks |
|---|---|---|---------|-------|---------------|
| 4 | 0 | 0 | 4       | 100   | 40            |

**Course Objectives:**

This course is intended to learn the physical concepts involve in organic synthesis. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the Post-graduate students.

**Expected Prospective:**

This course will provide students with physical concept involve in every organic reactions, various thermodynamic parameters that drive the reaction and stereochemistry which is very advantageous and exciting to understand. The students will able to pursues their career objectives in advance education, scientific research and teaching.

**UNIT I****Principles of Reactivity****15 lectures**

Mechanistic significance of entropy, enthalpy and Gibb's free energy. Arrhenius equation.

Transition state theory. Uses of activation parameters, Hammond's postulate. Bell-Evans Polyanyi principle. Potential energy surface model. Marcus theory of electron transfer. Reactivity and selectivity principles.

**Steric and Conformational Properties**

Various type of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates. Steric LFER. Conformational barrier to bond rotation spectroscopic detection of individual conformers. Acyclic and monocyclic systems.

**UNIT II****Stereochemistry****15 lectures**

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis. Zopectical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

Rotation around partial double bonds. Winstein-Holness and Curtin-Hammett principle.

**UNIT III****Kinetic Isotope Effect****15 lectures**

Theory of isotope effects. Primary and secondary kinetic isotope effects. Heavy atom isotope effects. Tunneling effect. Solvent effects.

**Structural Effects on Reactivity**

Linear free energy relationships (LFER). The Hammett equation, substituent constants, theories of substituent effects. Interpretation of  $\rho$ -values. Reaction constant  $\rho$ . Deviations from Hammett equation. Dual-parameter correlations, inductive substituent constant. The Taft model,  $\sigma_I$ - and  $\sigma_R$ -scales.

**UNIT IV****Solvation and Solvent Effects****15 lectures**

Qualitative understanding of solvent-solute effects on reactivity. Thermodynamic measure of solvation. Effects of solvation on reaction rates and equilibria. Various empirical indexes of solvation based on physical properties, solvent-sensitive reaction rates, spectroscopic properties and scales for specific solvation. Use of solvation scales in mechanistic studies. Solvent effects from the curve-crossing model.

**Acids, Bases, Electrophiles, Nucleophiles and Catalysis**

Acid-base dissociation. Electronic and structural effects, acidity and basicity. Acidity function and their applications. Hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity. The  $\alpha$ -effect. Ambivalent nucleophiles. Acid-base catalysis- specific and general catalysis. Bronsted catalysis. Nucleophilic and electrophilic catalysis. Catalysis by non-covalent binding micellar catalysis.

**Books Suggested:**

1. Mechanism and Theory in Organic Chemistry, T.H. Lowry and K.C. Richardson, Harper and Row.
2. Introduction to Theoretical Organic Chemistry and Molecular Modelling, W.B. Smith, VCH, Weinheim.
3. Physical Organic Chemistry, N.S. Isaacs, ELBS/Longman
4. Supramolecular Chemistry, Concepts and Perspectives, J.M. Lehn, VCH
5. The Physical Basis of Organic Chemistry, H. Maskill, Oxford University Press.

## Scheme of Courses M.Sc.

**M.Sc. (Hons.) Chemistry**
**Semester 4**

| S.No   | Paper Code            | Course Type | Course Title               | L | T | P | Cr      |
|--|-----------------------|-------------|----------------------------|---|---|---|---------|
| 1  | CHE609B               | Core        | Organic Chemistry-IV       | 4 | 0 | 0 | 4       |
| 2  | CHE610B               | Core        | Bio-Inorganic Chemistry    | 4 | 0 | 0 | 4       |
| 3  | CHE612B*              | Core        | Project                    | 0 | 0 | 0 | 6*      |
| 4  | CHE621B*              | Core        | Advance Chemistry Lab-II   | 0 | 0 | 8 | 4*      |
| 5  | Departmental Elective |             |                            | 4 | 0 | 0 | 4       |
| 6  | Departmental Elective |             |                            | 4 | 0 | 0 | 4       |
| Total  |                       |             |                            |   |   |   | 20*/22* |
| <b>Departmental Elective ( Choose any Two courses)</b> |                       |             |                            |   |   |   |         |
| 4  | CHE611B               | Elective    | Bio-Physical Chemistry     | 4 | 0 | 0 | 4       |
| 5  | CHE613B               | Elective    | Supramolecular Chemistry   | 4 | 0 | 0 | 4       |
| 6  | CHE615B               | Elective    | Chemistry of Materials     | 4 | 0 | 0 | 4       |
| 7  | CHE616B               | Elective    | Medicinal Chemistry        | 4 | 0 | 0 | 4       |
| 8  | CHE618B               | Elective    | Advance Physical Chemistry | 4 | 0 | 0 | 4       |

L: Lectures T: Tutorial P: Practical Cr: Credits

\*The students with research projects will do Project work (CHE612B) of 6 credits and the others will study Advance chemistry Lab-II (CHE621B) of 4 credits in the fourth semester.

**Course Title: Organic Chemistry-IV (Chemistry of Natural Products)**

**Course Code: CHE609B**

**Total Lectures: 60**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

**Course Objectives:**

This course is intended to teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc (2nd Year) in the subject of Chemistry has been framed as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

### UNIT I

**Terpenoids and Carotenoids (12 Lectures)**

General introduction, occurrence, methods of isolation and importance. Classification and nomenclature. Isoprene rule and Gem-dialkyl rule. Structure determination, stereochemistry and synthesis of the following representative molecules: citral, Terpineol, Farnesol, santonin, phytol, Abietic Acid and Beta-Carotene, vitamin A.

### UNIT II

**Alkaloids (12 Lectures)**

Definition, occurrence, isolation, nomenclature, classification based on nitrogen heterocyclic ring, physiological action and medicinal importance of alkaloids, general method of structure elucidation, degradation. Structure elucidation and synthesis of the following: Hygrine, Nicotine, Ephedrine, (+)- Conine, Atropine, Quinine and Morphine.

**Amino acids, Peptides and Proteins (8 Lectures)**

Introduction, amino acid classification and structure, general properties of amino acids and methods of synthesis. Classification of proteins, chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Solid phase peptide synthesis. Structure of proteins and forces responsible for holding protein structure.

**UNIT III****Steroids (14 Lectures)**

Occurrence, nomenclature, basic skeleton. Diel's hydrocarbon. Stereochemistry and structure determination of cholesterol. Structure, biological importance and physiological effects of steroids, Vitamin D, Bile acids, Androgens, Oestrogens, Gestogens and Adrenocortical hormones. Synthesis of Cholesterol, Testosterone and Progesterone.

**UNIT IV****Vitamins (14 Lectures)**

Structure, synthesis and biological importance of Vitamin B complex, Vitamin C, Vitamin E and Vitamin K.

**Porphyryns:** Structure, importance and synthesis of Haemoglobin and chlorophyll

**Prostaglandins:** Occurrence, classification and physiological effects. Synthesis of PGE<sub>2</sub> and PGF<sub>2</sub>.

**Suggested Books:**

1. Finar, I.L. *Organic Chemistry*, ELBS, Vol. 2, 5<sup>th</sup> edition, 1975.
2. Nogradi, M. *Stereoselective Synthesis: A Practical Approach*, VCH, 1995.
3. Coffey, S. *Rodd's Chemistry of Carbon Compounds*, Elsevier, 2<sup>nd</sup> Edition.
4. Hostettmann, Kurt, Gupta, M.P. and Marston, A. *Chemistry, Biological and Pharmacological Properties of Medicinal Plants*, Americas, Harwood Academic Publishers.
5. Aggarwal, O.P. *Chemistry of Organic Natural Products*, Vol. 1 & 2, Goel Publishing House, 2009.
6. Rohm, B.A. *Introduction to Flavonoids*, Harwood Academic Publishers, 1998.
7. Rahman, A. and Choudhary, M.I. *New Trends in Natural Product Chemistry*, Harwood Academic Publishers, 1998.
8. Dev, Sukh. *Insecticides of Natural Origin*, Harwood Academic Publishers, 1997.
9. Mann, J. Davidson, R.S., Hobbs, J.B., Banthrope, D.V. and Harborne, J.B. *Natural Products: Chemistry and Biological Significance*, Longman, Essex, 1994.
10. <https://www.sciencedirect.com/bookseries/studies-in-natural-products-chemistry>

**Course Code: CHE 610A****Total Lectures: 60**

| L | T | P | Credits | Marks | Pass<br>Marks |
|---|---|---|---------|-------|---------------|
| 4 | 0 | 0 | 4       | 100   | 40            |

**Course Objectives:** This course is intended to learn the basic concepts of Inorganic Chemistry.

The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

**UNIT I**

**Inorganic Chemistry of Enzymes - I (18 Lectures)**

Introduction, energy sources for life, non-photosynthetic processes, metalloporphyrins, cytochromes, biochemistry of iron, iron storage and transport, ferritin transferring, bacterial iron transport, hemoglobin and myoglobin, nature of heme-dioxygen binding, model systems, cooperativity in hemoglobin, physiology of myoglobin and hemoglobin, structure and function of hemoglobin. Other iron-porphyrin biomolecules, peroxidases and catalases, cytochrome P450 enzymes, other natural oxygen carriers, hemerythrins, electron transfer.

**UNIT II**

**Inorganic Chemistry of Enzymes - II (18 Lectures)**

Respiration and photosynthesis (chlorophyll and photosynthetic reaction center); ferridoxins, and subredonim carboxypeptidase, carbonic anhydrase, Blue copper proteins, superoxide dismutase hemocyanines, Enzymes: Structure and function, inhibition and poisoning Vitamin B12 and B12 coenzymes metallothioneins, nitrogen fixation, in-vitro and in-vivo nitrogen fixation, bio-inorganic chemistry of Mo and W, nitrogenases: other elements V, Cr, Ni (essential and trace elements in biological systems).

**UNIT III**

**Metal Ions in Biological Systems (14 Lectures)**

Biochemistry of dioxygen, bioinorganic chips and biosensors. Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting, neurotransmitter, Metals in the regulation of biochemical events. Transport and storage of metal ions in vivo. Metal complexes as probes of structure and reactivity with metal substitution. Roles of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$  and Ion pumps.

#### UNIT IV

##### **Inorganic Medicinal Chemistry**

**(10 Lectures)**

Fundamentals of Toxicity and Detoxification, Nuclear medicines, Chelation Therapy, Cancer Treatment, Anti-arthritis Drugs, Imaging agents

##### **Suggested Books:**

1. Huheey, J. E., Keiter, E. A. and Keiter, R.L. Inorganic Chemistry Principles of Structure and Reactivity, 4 th edition, Haper Collins.
2. Douglas, B., McDaniel, D. and Alexander, J. Concepts and Models of Inorganic Chemistry, John Wiley and Sons, 3<sup>rd</sup> edition.
3. Cotton, F.A. and Wilkinson, G. Advanced Inorganic Chemistry: A Comprehensive Text, John Wiley, 5<sup>th</sup> edition.
4. Elschenbroich, Ch. and Salzer, A. Organometallics. A Concise Introduction, VCH, 2<sup>nd</sup> edition.
5. Shriver, D.F. and Atkins, P.W. Inorganic Chemistry, Oxford University Press, 3<sup>rd</sup> edition.
6. Cowan, J.A. Inorganic Biochemistry, Wiley – VCH, 2<sup>nd</sup> edition.
7. Lippard, S. J. Progress in Inorganic Chemistry, Vols. 18 and 38, Wiley-Interscience, 1991.
8. K. Hussain Reddy, Bioinorganic Chemistry, New age International Limited, Publisher, 2007.



**Course Title: Advance Chemistry Lab-II**

**Course Code: CHE621B**

**Time: 08 Hours**

**Course Objectives:**

To teach the advance techniques in the Chemistry lab. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**Expected Prospective:** The students will be able to understand the advance techniques required to synthesize, analyze different chemical compounds, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

### **Advance Organic Chemistry Lab**

#### **1. Spectroscopic identification of organic compounds and Chromatographic purification:**

- a. Identification of unknown organic compounds by interpretation of IR, UV,  $^1\text{H}$ -NMR,  $^{13}\text{C}$  NMR and mass spectral data. A minimum of 5 representative examples should be studied.
- b. Thin layer chromatography: Determination of purity of a given sample, monitoring the progress of chemical reactions, identification of unknown organic compounds by comparing the  $R_f$  values of known standards.
- c. Separation by column chromatography: Separation of a mixture using silica gel as adsorbent. Column chromatography should be monitored by TLC.

#### **2. Synthesis of organic molecules & isolation of natural products**

##### **(A) Laboratory synthesis of the following compounds:**

2-Phenyl indole (Fischer indole synthesis), 7-hydroxy-3-methyl flavone (Baker – Venkatraman reaction), 2,5-Dihydroxy acetophenone (Fries reaction), 4- Chlorotoluene from p-toluidine (Sandmeyer reaction), Benzpinacol (photochemical reaction), 7-hydroxy coumarin (Pechman synthesis), Pictet-Spengler reaction, Photo-dimerization of maleic anhydride,

benzophenone (Friedel-Crafts reaction), Vanillyl alcohol from vanillin ( $\text{NaBH}_4$  reduction), Acridone from Phthalic anhydride.

**(B) Isolation of the following natural products:**

Caffeine from tea-leaves (solvent extraction), Eucalyptus oil from leaves (steam distillation), Lycopene from tomatoes.

**3. Protection/deprotection strategy of functional groups in organic synthesis:**

Protection/deprotection of alcohol and amines in the synthesis of small organic molecules.

**Suggested Books:**

1. Harwood, L.M. and Moody, C.J. *Experimental Organic Chemistry*, Blackwell Scientific Publishers, 1st edition, 1989.
2. Vogel, A.I. *Text Book of Practical Organic Chemistry*, ELBS, Longman Group Ltd., 5th edition, 1978.
3. Mann, F.G. and Saunders, B.C. *Practical Organic Chemistry*, New Impression, Orient Longman Pvt. Ltd., 4th edition, 1975.
4. Leonard, J. and Lygo, B. *Advanced Practical Organic Chemistry*, Chapman and Hall, 1995.

**Course Title: Bio-Physical Chemistry**

**Course Code: CHE611B**

**Total Lectures: 60**

**Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post graduation in this course.

### UNIT I

**Fundamentals of Biological Macromolecules (15 Lectures)**

**Biological Cell and its Constituents:** Biological Cell, structure and functions of proteins, enzymes, DNA and RNA in living systems

**Bioenergetics:** Standard free energy change in biochemical reactions, exergonic, endergonic, Hydrolysis of ATP, synthesis of ATP from ADP, coupled reactions, degree of coupling.

**Biopolymer Interactions:** Forces involved in biopolymer interactions, Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions, Hydrogen ion titration curves.

### UNIT II

**Thermodynamics of Biopolymer Solutions (10 Lectures)**

**Biopolymer Solutions** Thermodynamics of biopolymer solutions, osmotic pressure, Donnan membrane equilibrium, muscular contraction and energy generation in mechano chemical system.

**Cell Membrane and Transport of Ions** Structure and functions of cell membrane, Active transport across cell membrane, irreversible thermodynamics treatment of membrane transport.

### UNIT III

**Structural Determination of Biological Macromolecules**

**(25 Lectures)**

**Bio-polymers and their Molecular Weights**

Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques.

**Viscosity:** Measurement, relation to geometry and correlation with hydrodynamic properties.

**Diffusion:** Fick's Law of diffusion, diffusion coefficient and its interpretation, frictional coefficient.

**Ultracentrifugation:** Svedberg equation, sedimentation equilibrium, density gradient sedimentation.

**Osmotic Pressure:** Second virial coefficient, Determination of Molecular weight of bio polymers

**Optical Properties of Biomacromolecules**

Light Scattering, fundamental concepts, Rayleigh Scattering, Scattering by Larger particles.

**UNIT IV**

**Methods for the Separation of Biomolecules**

**(10 Lectures)**

General principles, including Chromatography; Sedimentation, Moving Boundary Sedimentation, Zonal Sedimentation, Electrophoresis, Isoelectric focusing, Capillary electrophoresis, MALDI-TOF.

**Suggested Books:**

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers, 2013.
2. Biochemistry, L. Stryer, W.H. Freeman, 2011
3. James P. Allen, Biophysical Chemistry, a John-Wiley and Sons Publications, 2008.
4. Biochemistry, Voet and Voet, John Wiley, 2012
5. Macromolecules: Structure and Function, F.Wold., Prentice Hall.
6. Text Book of Polymer Science, F.W. Billmeyer, 2007
7. Physical Chemistry of Polymers, A. Tager.
8. Biophysical Chemistry, Vol. 1-3, C. R. Cantor & Schimmel
9. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by D. M. Freifelder
10. Biophysical Chemistry: Principles and Techniques by A. Upadhyay, Himalaya Publishing House, 2016.

**Course Title: Supramolecular Chemistry**
**Course Code: CHE613B**
**Total Lectures: 60**
**Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of supramolecular chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for undergraduate students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the supramolecular chemistry and its applications. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in the course.

### UNIT I

**Concepts**
**(15 Lectures)**

Definition and Concepts of supramolecular chemistry. Development of Supramolecular Chemistry. Various types of non-covalent interactions (Hydrogen bonds,  $\pi$ - $\pi$  interactions, cation- $\pi$  interactions, Closed shell interactions, solvation and hydrophobic effects, Van der Waals interactions.

Macrocyclic and macro-bicyclic effect, template effect (illustrated by acyclic, macrocyclic and macropolycyclic ligand systems), supramolecular Host-Guest chemistry, Lock and Key Analogy. Binding constant and measurement of binding constant. Cooperativity and chelate effect, molecular and chiral recognition, pre-organization and complementarity, concept of induced fit, allosteric effect. Concept of host design.

### UNIT II

**Crystal Engineering**
**(15 Lectures)**

Concept of crystallization and crystal engineering. Supramolecular tectones and synthons, Mechanochemistry and Topochemistry, Graph Set analysis, CSD database of CCDC.

Polymorphism: types and applications in the pharmaceutical industry.

Crystal Engineering of Pharmaceutical Co-crystals: Introduction, Preparation, Relevance in the Context of APIs, Case Study: Pharmaceutical Co-crystals of Carbamazepine

### UNIT III

#### Supramolecular Host

(15 Lectures)

##### Cation Binding

Crown ethers: Discovery, Scope and Synthesis, Conformational Characteristics of Crown Ethers, Donor Group Orientation and Chelate Ring Size Effects, Cation Binding by Crown Ethers, Solution Applications of crown ethers.

Lariat ether, Bibracchial Lariat Ethers, and Podands: Cation Binding by Lariat Ethers.

Cryptands: Discovery, Scope and Synthesis, Cation Binding by Cryptands, Sepulchrates and sarcophagenes

Spherands: Discovery, Scope and Synthesis,

Ditopic Receptors, Chiral Recognition, Amphiphilic Receptors, The Siderophores

The calixarenes Cation Complexation by Calixarenes

##### Anions Binding

Anions in environment, challenges in designing anion binding host, Guanidinium-based receptors, Neutral receptors, organometallic receptors

##### Neutral Molecular Binding

Cyclodextrin: Introduction and Properties, Preparation, Inclusion Chemistry, Industrial Applications

##### Molecular Clefts and Tweezers

Cyclophane: General Aspects, Cyclophane Nomenclature, Cyclophane Synthesis

**Carcerands and Hemicarcerands:** Definitions and Synthesis

### UNIT IV

#### Applications of Supramolecular Chemistry

(15 Lectures)

**Network Solids: What Are Network Solids?** Concepts and Classification, Network Topology, Porosity

**Inorganic Porous Materials: Zeolites** - Composition and Structure, Synthesis, MFI Zeolites in the Petroleum Industry

**Inorganic-Organic Hybrid materials:** Coordination Polymers, Metal Organic Frameworks and Other Terminology, 0D Coordination Clusters, 1D, 2D and 3D Structures. Interpenetrated Structures, Catalysis by MOFs, Hydrogen Storage by MOFs

**Catenanes and Rotaxanes:** Overview, Statistical Approaches to Catenanes and Rotaxanes, Molecular Necklaces

**Molecular Knots:** The Topology of Knots, Trefoil Knots, Borromean Rings

**Molecular Devices and Molecule-Based Electronics:** Molecular Electronic Devices, Molecular Wires, Molecular Switches

**Liquid Crystals:** Nature and Structure, Design of Liquid Crystalline Materials, Supramolecular Liquid Crystals

**Supramolecular Gels:** concept, types, properties, and applications

### Reference

1. Steed, J. W. and Atwood, J. L. *Supramolecular Chemistry*, Wiley: Chichester, 2000.
2. Ariga, K. and Kunitake, T. *Supramolecular Chemistry: Fundamentals and Applications*, Springer, Berlin, 2005.
3. Steed, J. W., Turner, D. R. and Wallace, K. J. *Core Concepts in Supramolecular Chemistry and Nanochemistry*, Chichester, Wiley, 2007.
4. *Frontiers in Crystal Engineering* by E.R.T. Tiekink, J.J. Vittal
5. <https://nptel.ac.in/courses/104103018/module1/lec4/2.html>
6. <https://www.internetchemistry.com/chemistry/supramolecular-chemistry.php>
7. <https://nptel.ac.in/courses/112106227/>
8. <https://iversity.org/en/courses/the-fascination-of-crystals-and-symmetry>
9. <https://www.facebook.com/crystalmooc/>

**Course Title: Chemistry of Materials**

**Course Code: CHE615B**

**Total Lectures: 60**

**Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of material science. The present

syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the students.

**Expected Prospective:** This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Industrial chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post graduation in this course.

### UNIT I

#### Solid State Chemistry

(15 Lectures)

Types of solids, band and bond theories, crystal lattice energy, point defects in metals and ionic compounds, energy and entropy of defects, their concentration, diffusion and electrical conduction via defects, non-stoichiometry types, colour centres and electrical properties of alkali halides, electron theories for metal conduction in metals, in insulators, impurity semi-conductors, reactions in organic solids, photochemical reactions, solid-solid reactions, decomposition and dehydration reaction.

### UNIT II

#### Macromolecules

(15 Lectures)

Types of polymers, regular and irregular polymers, synthesis of polymers by chain and step reactions, physical properties of solid polymers (crystallinity, plasticity and elasticity), vulcanization of rubbers, molecular mass determination by osmometry, viscometer, light scattering and ultracentrifuge methods, number and mass average molecular masses, polymer solutions, factors affecting the solubility of polymers, conducting polymers, doping of polymers, mechanism of conduction, polarons and bipolarons.

### UNIT III



**Glasses and Ceramics****(15 Lectures)**

Factors affecting glass formation, oxide glasses, electronegativity and bond type, viscosity, structural effects (Zachariasen's rule (1932), criteria of SUN and Rawson, thermodynamics of glass formation, behavior of liquids on cooling, kinetics of crystallization and glass formation, structure of glasses: vitreous silica, silicate glasses, vitreous B<sub>2</sub>O<sub>3</sub> and borate glasses, viscosity, electrical conductivity of glasses and the mixed alkali effect, commercial silicate and borate glasses, metallic glasses, glass ceramics, refractories, important glass-ceramics compositions, properties of glass ceramics, applications.

**UNIT IV****Smart Materials****(15 Lectures)**

Methods of preparation- conventional ceramic methods, hot pressing and hot static pressing techniques, precursor method, gel method, co-precipitation method, glass crystallization methods, vacuum techniques- chemical vapor deposition method, organic superconductors, magnetism in organic materials, magnetic nanomaterials, energy storage materials, nanomaterials for targeted drug delivery, fullerenes as superconductors. High temperature ceramic superconductors, electrical and magnetic properties of superconductors, critical temperature T<sub>c</sub>, thermodynamics of superconductors, London equation, BCS theory, applications.

**Suggested Books:**

1. Cornell, P. J. Flory. *Principles of polymer chemistry*, University Press.
2. Tager, A. J. *Physical chemistry of polymers*, Mir Publishers.
3. Dekker, A. J. *Solid state physics*, MacMillan Publishers.
4. West, A. R. *Solid state chemistry and its applications*, Wiley Publishers.
5. Byrn, S. R. *Solid state chemistry of drugs*, Academic Press.
6. Puri, Sharma and Pathania, *Principles of physical chemistry*, Vishal Publishers.
7. Gray, G. W. *Thermotropic Liquid crystals*, John Wiley.
8. Malcolm, P and Stevens, *Polymer Chemistry*, Oxford University Press.
9. Keer, H. V. *Principles of Solid States*, Wiley Eastern.

**Course Title: Medicinal Chemistry****Course Code: CHE616B****Total Lectures: 60**

| L | T | P | Credits | Marks | Pass<br>Marks |
|---|---|---|---------|-------|---------------|
| 4 | 0 | 0 | 4       | 100   | 40            |

**Course Objectives:**

This course is intended to learn the basic concepts of Medicinal Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic interest.

**Expected Prospective:** This course will equip students with the necessary medicinal chemistry knowledge concerning the fundamentals in the basic areas of pharmaceutical sciences. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

**UNIT I****Enzymes****(15 Lectures)**

Basic considerations. Proximity effects and molecular adaptation. Introduction and historical prospective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

**Mechanism of Enzyme Action****(5 Lectures)**

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonucleases, lysozyme and carboxypeptidase A.

**UNIT II****Kinds of Reaction Catalysed by Enzymes****(10 Lectures)**

Nucleophilic displacement on a phosphorus atom, multiple displacement reaction and the coupling of ATP cleavage to endergonic processes. Transfer of sulphates, addition and

elimination reactions, enolic intermediates in isomerization reactions,  $\beta$ -cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

### UNIT III

#### Co-Enzyme Chemistry

(10 Lectures)

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD<sup>+</sup>, NADP<sup>+</sup>, FMN, FAD, LIPOIC ACID, vitamin B12. Mechanisms of reactions catalysed by the above cofactors.

### UNIT IV

#### Drug Design

(20 Lectures)

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptors interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials. LD-50, ED-50 (Mathematical equations excluded)

#### Suggested Books:

1. Lehninger, *Principles of Biochemistry*, WH-Freeman, 5<sup>th</sup> edition.
2. Silverman, R. B. *The organic chemistry of drug design and drug action*, Academic press 2<sup>nd</sup> edition, 2004.
4. Pandeya S. S. and Dimmock, J.R. *An introduction to drug design*, New Age International.

**Course Title: Advanced Physical Chemistry**

**Course Code: CHE618B**

**Total Lectures: 60**

**Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn advanced physical chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the advances in physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

**UNIT I (12 Lectures)**

**Surfactant Aggregation**

Micelles, Surface active agents, Classification of surface active agents, Micellization, Hydrophobic interaction, Critical micellar concentration (cmc), Factors affecting the concentration of surfactants, Counter-ion binding of micelle, Thermodynamics of micellization, Phase separation and Mass action models, Solubilization Emulsions, Mechanism of formation of microemulsion and their stability, Phase maps, Physical techniques, Applications.

**UNIT II (18 Lectures)**

**Introduction**

Macromolecular concept. Molar mass averages, distribution of molecular mass.

**Kinetics of Polymerization**

Kinetics of step growth polymerization, size distribution in linear polymers. Kinetics of free radical addition polymerization, distribution of molar masses, effect of temperature. Ionic polymerization, kinetics of cationic and anionic polymerization.

**Statistics of Linear Polymer Chains**

Polymer chain flexibility and internal rotation, random flight analysis of end-to end distance for freely jointed chain in one dimension and three dimensions. Effect of bond angle and restricted

rotation on chain dimensions. Unperturbed chains. Long-range interactions and effect of solvent. Distribution of chain segments relative to centre of mass.

### UNIT III

(15 Lectures)

#### Thermodynamics of Macromolecular Solutions

Flory-Huggins theory. Flory-Krigbaum theory of dilute solutions, partial molar quantities. Osmotic pressure.

#### Characterization of Macromolecules

Flow properties, generalized flow equation. Frictional coefficient and flow properties. Determination of molecular size and mass from diffusion, sedimentation velocity, sedimentation equilibrium and viscosity. Light scattering and small angle X-ray scattering.

### UNIT IV

(15 Lectures)

#### Nanomaterials:

Definition, historical perspective and effects of nanoscience and nanotechnology on various fields. Synthesis of nanoparticles by chemical routes and characterization techniques: Thermodynamics and kinetics of nucleation; Growth of polyhedral particles by surface reaction, Ostwald ripening, size distribution; TEM; SEM; AFM; Light scattering; XPS. Properties of nanostructured materials: Optical properties; magnetic properties; chemical properties. Overview of applied chemistry of Nanomaterials.

#### Suggested Books

1. Young R.J. and Lovell P.A., *Introduction to Polymers*, Pubs: Chapman and Hall, London, 2nd ed., New Delhi (2004).
2. Billmeyer F.W. Jr., *Text book of polymers science*, Pubs: Wiley-Interscience, 3<sup>rd</sup> edn., (1984).
3. Myers D., *Surfactant Science and Technology*, Pubs: VCH Publishers (1988).
4. Flory P.J., *Principles of polymer chemistry*, Pubs: Cornell Univ. Press, Ithaca (Indian Print 2006).
5. Tager A., *Physical Chemistry of polymers*, Pubs: Mir Publishers, Moscow (1971).
6. R.J., *Foundations of Colloid Science*, Vols. I & II, Pubs: Oxford Science Publications (1989).

**Course Title: Electroanalytical Chemistry****Course Code: CHE624****Total Lectures: 60****Course Objectives:**

| L | T | P | Credits | Marks | Pass Marks |
|---|---|---|---------|-------|------------|
| 4 | 0 | 0 | 4       | 100   | 40         |

This course is intended to learn the basic concepts of electroanalytical chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

**Expected Prospective:**

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of electroanalytical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post-graduation in this course.

**UNIT I****(15 Lectures)****Potentiometry**

Accuracy of direct potentiometer measurements. The Glass pH electrode – Theory, construction, standard buffers, accuracy of pH measurements, measurements with the pH-meter, pH titration of unknown soda ash.

**Electrogravimetry**

Basic principles of electrogravimetry, Instrumentation, electrogravimetry determination with constant applied voltage and at constant current. Applications of electrogravimetry. Problems based on effect of concentration on electrode potentials, calculation of theoretical cathode potential at the start of deposition, effect of pH in electrolytic separations.

**UNIT II****(15 Lectures)****Coulometry**

Basic principles, Types of coulometers, constant current coulometric analysis, Coulometric titrations – principle, circuit and cell for coulometry, Application to neutralization, Redox,

precipitation, complexometric titrations, Advantages of coulometric titrations and errors. Controlled potential coulometry – Technique & applications of inorganic & organic compounds. Current voltage relationship during an electrolysis, operating cell an at fixed applied potential, Electrolysis at constant working electrode potential, Coulometric methods of analysis, Faradays laws of electrolysis, Instrumentations-Constant current and constant voltage instruments, potentiostatic coulometry-Instrumentation and applications, Coulometric titrations (Amperostatic coulometry)-Apparatus and applications, advantages and limitations, problems.

### UNIT III

(15 Lectures)

#### **Polarography (linear scan polarography)**

Polarographic principles, Instrumentation (different types of microelectrode such as dropping mercury electrode, the static drop mercury electrode, rotating disc and ring disc electrode, cell for polarography, reference and counter electrode and circuit diagram), polarogram and polarographic currents, charging or capacitive current, role of supporting electrolyte, factors affecting on polarographic wave, Ilkovic Equation, advantages and disadvantages of DME, polarographic maxima and maxima suppressors, interference due to dissolved oxygen, Applications (qualitative analysis, quantitative analysis by calibration curve and standard addition methods), specific examples of analysis – analysis of Cu, Cd, Zn, Pb, etc. from tap water and alloys., problems.

#### **Hydrodynamic voltammetry and applications of hydrodynamic voltammetry**

voltammetric detectors in chromatography and flow injection analysis, voltammetric oxygen sensors, amperometric titration).

### UNIT IV

(15 Lectures)

#### **Pulse Polarography**

different types of excitation signals in pulse polarography, differential pulse polarography, square wave polarography, Stripping method. Voltammetry with ultra-microelectrode, Applications of these technique Cu and Zn from tap water by differential pulse polarography and by square wave polarography, Vitamin-C by differential pulse polarography, Determination of Pb in tap water by stripping method)

**Cyclic Voltammetry**

Principle of cyclic voltammetry, cyclic voltamogram of  $K_3[Fe(CN)_6]$ , and parathion, criteria of reversibility of electrochemical reactions, quasi-reversible and irreversible processes.

**Amperometry**

Principle, Instrumentation, typical applications, amperometric titrations, chrono-amperometry and chrono-potentiometry.

**Books Recommended:**

- 1.R.D. Braum, Introduction to Instrumental Analysis, 2<sup>nd</sup> Edition, 2014.
2. Willard, DeRitt, Dean and Settle, Instrumental methods of Analysis, 7<sup>th</sup> Edition, 2004.
3. Skoog, West, Holler and Crouch, Instrumental methods of Analysis, 7<sup>th</sup> Edition, 2018.
4. F. J. Welcher, Standard Methods of chemical Analysis Vol.3, Part A & B, 6<sup>th</sup> Revised Edition.
5. G.W. Ewing, Instrumental Methods of Analysis, 5th editions, 1985.
6. Chatawal and Anand, Instrumental Methods of Analysis, 2<sup>nd</sup> Edition, Himalaya Publishing House, 1984.
7. Bassett, Denney-Jeffer and Mendham, Vogel's Textbook of Quantitative Inorganic Analysis, 4<sup>th</sup> Edition, 1978.
8. Nurnberg H.W. Electro-analytical chemistry, 1975.



**Interdisciplinary Courses:**

| <b>S.No</b> | <b>Paper Code</b> | <b>Course Title</b>  | <b>L</b> | <b>T</b> | <b>P</b> | <b>Cr</b> |
|-------------|-------------------|--|----------|----------|----------|-----------|
| <b>1</b>    | <b>CSA555</b>     | <b>Fundamentals of Computer and Programming in C/C++</b>     | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b>  |
|             | <b>CSA556</b>     | <b>Fundamentals of Computer and Programming in C/C++ Lab</b> | <b>0</b> | <b>0</b> | <b>2</b> | <b>1</b>  |
| <b>2</b>    | <b>EVS051</b>     | <b>Dynamics of Biogeography</b>                              | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>3</b>    | <b>EVS052</b>     | <b>Green Technology</b>                                      | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>4</b>    | <b>EVS053</b>     | <b>Environmental Toxicology</b>                              | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>5</b>    | <b>BOT505</b>     | <b>Forestry</b>  | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>6</b>    | <b>BOT535</b>     | <b>Conservation of Natural Resources</b>                     | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>7</b>    | <b>ENG531</b>     | <b>Writing Skills</b>  | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>8</b>    | <b>ENG532</b>     | <b>Creative Writing</b>                                      | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>9</b>    | <b>ENG533</b>     | <b>Living Literature</b>                                     | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>10</b>   | <b>MIC006</b>     | <b>Fermentation Microbiology</b>                             | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>11</b>   | <b>MIC007</b>     | <b>Microbiology of Diseases</b>                              | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>12</b>   | <b>MGT051</b>     | <b>Business Strategy</b>                                     | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>13</b>   | <b>MGT052</b>     | <b>Principles of Marketing</b>                               | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>14</b>   | <b>MGT053</b>     | <b>Research Methodology</b>                                  | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>15</b>   | <b>CHE615B</b>    | <b>Chemistry of Materials</b>                                | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>16</b>   | <b>CHE616B</b>    | <b>Medicinal Chemistry</b>                                   | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>17</b>   | <b>MTH 636</b>    | <b>Discrete Mathematics</b>                                  | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>18</b>   | <b>MTH 633</b>    | <b>Operational Research</b>                                  | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>19</b>   | <b>MTH580</b>     | <b>Mathematics for Chemists</b>                              | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |
| <b>20</b>   | <b>ZOO701</b>     | <b>Biology for Chemists</b>                                  | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>  |