DAV UNIVERSITY JALANDHAR

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

1st TO 4th SEMESTER

Syllabi Applicable for Admissions in 2015 and onwards

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	CHE501A	Core	Organic Chemistry-I	4	0	0	4
2	CHE502A	Core	Inorganic Chemistry-I	4	0	0	4
3	CHE503A	Core	Physical Chemistry	4	0	0	4
4	CHE504A	Core	Analytical Chemistry	4	0	0	4
5	CHE505	Core	Organic Chemistry Lab-I	0	0	4	2
6	CHE506	Core	Inorganic Chemistry Lab-I	0	0	4	2
7	Interdisciplinary Course-I						4
Total							24

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

Course Title: Organic Chemistry-I

Course Code: CHE501A

Time: 04 Hours

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 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.

PART A

Nature of Bonding in Organic molecules (6 Hrs)

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of p-molecular orbitals, annulenes, antiaromaticity, homo-aromaticity, PMO approach.

Reaction Mechanism: Structure and Reactivity (6 Hrs)

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

PART B

Aliphatic Nucleophilic Substitution (6 Hrs)

The SN2, SN1, mixed SN1 and SN2 and SET mechanism. The neighboring group mechanism, The Neighboring group participation by π & σ bonds, anchimeric assistance, classical and non-classical carbocations, phenonium ions, norbornyl system, carbocation rearrangements in neighboring group participation. SNi mechanism, Nucleophilic Substitution at an allylic, aliphatic trigonal and vinylic carbon. Reactivity effects of structure, attacking Nucleophile, leaving group and reaction medium, Phase transfer catalyst, ambident nucleophile and regioselectivity.

Aromatic Nucleophilic Substitution (4 Hrs)

The SNAr, SN1 Benzyne and SNR1, Mechanisms, Reactivity effect of substrate structure, leaving group and attacking nucleophile.

Elimination reactions (4 Hrs)

E2, E1, E1cb Mechanisms, Orientation, stereochemistry in elimination, reactivity effect of structure attacking and leaving groups, competition between substitution & elimination, syn eliminations.

PART C

Aliphatic Electrophilic Substitution (4 Hrs)

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.

Aromatic Electrophilic Substitution (6 Hrs)

The arenium ion mechanism, 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 Vilsmeier reaction, Gattermann – Koch reaction, etc.

PART D

Stereochemistry (12 Hrs)

Chirality, elements of symmetry, molecules with more than one chiral centre, diastereomerism. Determination of relative and absolute configuration (octant rule excluded) with special reference to lactic acid, alanine & mandelic acid. Methods of resolution, optical purity, prochirality, enantiotopic and diastereotopic atoms, groups and faces, R / S, E / Z nomenclature, asymmetric synthesis, cram's rule and its modifications, prelog's rule, conformational analysis of cycloalkanes (up to six membered rings), decalins, conformations of sugars, optical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape, geometrical isomerism in alkenes and oximes, methods of determining the configuration.

Suggested Books:

1. March, Jerry. *Advanced Organic Chemistry: Reactions, Mechanism and Structure*, John Wiley, 6th edition, 2007.
2. Carry, F. A. and Sundberg, R.J. *Advanced Organic Chemistry*, Plenum, 3rd edition, 1990.
3. Sykes, Peter. *A Guide Book to mechanism in Organic Chemistry*, Longman, 6th edition, 1989.
4. Morrison, R. T. and Boyd, R. N. *Organic Chemistry*, Prentice Hall, 6th edition, 1992.
5. Kalsi, P. S. *Organic Reactions and their Mechanisms*, New Age International Publishers, 2nd edition, 2000.
6. Mukherji, S.M. and Singh, S.P. *Reactions Mechanism in Chemistry*, Vol. I, II, III, Macmillan, 1985.
7. Nasipuri, D. *Stereochemistry of Organic Compounds*, New Age International Publishers, 2nd edition, 1994.
8. Kalsi, P.S. *Stereochemistry of Organic Compounds*, New Age International, 2nd edition, 1993. Kalsi, P.S. *Stereochemistry: Conformation and Mechanism*, Wiley Eastern Limited, 2nd edition, 1993.

This syllabus is as per national syllabus given by UGC and it covers 20% more syllabus than UGC model curriculum as per the requirement of Hons course.

Course Title: Inorganic Chemistry –I (Transition Metal Chemistry)

Course Code: CHE502A

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Time: 04 Hours

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 the course.

PART A

Symmetry (13 Hrs)

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, qualitative splitting of s, p, d, and f orbitals in octahedral, tetrahedral and square planar fields using character tables and without the use of character tables.

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 σ and π bonding in transition metal complexes.

PART B

Interelectronic Repulsions (10 Hrs)

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

PART C

Free Ions in Medium and Strong Crystal Fields (12 Hrs)

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, selection rules of electronic transitions in transition metal complexes, their proof using group theory, relaxation of the selection rule in Centro symmetric and non-centro symmetric molecules, Orgel diagrams, Tanabe Sugano diagrams, calculation of 10Dq and B with use of Orgel and Tanabe Sugano diagrams, quenching of orbitals angular momentum by ligand field.

PART D

Electronic Spectra of Transition Metal Complexes (12 Hrs)

Variation of the Racah parameter, nephlauxetic 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, 3rd edition.
2. Miessler, G. L. and Tarr, D. A. *Inorganic Chemistry*, Pearson Education, 3rd edition.
3. Figgis, B.N. *Introduction to Ligand Field*, Wiley Eastern.
4. Lever, A.B.P. *Inorganic Electronic Spectroscopy*, Elsevier.
5. Huheey, J.E. *Inorganic Chemistry Principles of Structure and Reactivity*, Harper Interscience.
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, 6th edition.

This syllabus has been designed as per national syllabus suggested by UGC and cover 20% extra syllabus as per requisite of honors degree.

Course Title: Physical Chemistry I

Course Code: CHE503A

Time: 04 Hrs.

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 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 the course.

PART A

Classical Thermodynamics (15 Hrs)

Brief resume of concepts of thermodynamics, free energy, chemical potential and entropy. Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significances. Determination of these quantities. Concept of fugacity and determination of fugacity.

Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficients, Debye-Hückel theory for activity coefficient of electrolytic solutions, determination of activity and activity coefficients, ionic strength. Application of phase rule to three component system

PART B

Statistical Thermodynamics (12 Hrs)

Corresponding distribution laws (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 solids chemical equilibria and equilibrium constant in terms of partition function, F.D. statistics, distribution law and application to metals, Bose-Einstein's statistics, Distribution law & application to Helium**.**

PART C

Macromolecules (10 Hrs)

Polymers-definition, types of polymers, liquid crystal polymers, Molecular mass-number and mass average molecular mass, determination of molecular mass (osmometry, viscosity, diffusion, light scattering, and sedimentation methods), Mechanism and kinetics of step-growth and chain growth polymerization-radical, ionic, coordination and ring opening polymerization, Copolymerization, reactivity ratios, Polymerization techniques and polymer reactions.

PART D

Surface Chemistry (13 Hrs)

Adsorption: Surface tension, capillary action, pressure difference across curved surface (Laplace equation), Vapour pressure of droplets, (Kelvin equation), Gibb's adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (electro kinetic phenomenon), catalytic activity at surfaces.

Micelles: Surface active agents, classification of surface active agents, micellization hydrophobic interactions, critical micellar concentration, factors affecting CMC of surfactants, counter ions binding to micelles, thermodynamics of micellization-phase separation & mass action models, solubilization, microemulsion, reverse micelles.

Suggested Books:

1. Atkins, P.W. *Physical Chemistry,* ELBS, 3rd edition, 1987.

2. Young, R-J and Lovell, P.A. *Introduction to Polymers,* Replika Press Pvt. Ltd., 2nd edition, 1991.

3. Flory, P.J. *Principles of Polymer Chemistry,* Asian Book Private Ltd., 1st edition, 2006.

4. Thomas, E. and Philip, R. *Thermodynamics: Statistical Thermodynamics and Kinetics,* Pearson Education, 1st edition, 2007.

5. Moore, J.W. and Pearson, R.G. *Kinetics and Mechanism,* John Wiley and Sons, 2nd edition, 1981.

6. Moroi, Y. *Micelles: Theoretical and Applied Aspects,* Plenum Press, 1st edition, 1992.

7. Adamson, Arthur W. *Physical Chemistry of Surfaces*, Wiley-Interscience Publication, 4th edition, 1982.

8. Silbey, R.J., Alberty, R.A. and Bawendi, M.G. *Physical Chemistry*, Wiley-Interscience Publication, 4th edition, 2013.

9. Peter, A. and Paula, J. de. *Physical Chemistry*, Oxford University Press, 9th edition, 2011.

10. Castellan, G. W. *Physical Chemistry*, Narosa, 4th edition, 2004.

11. Engel, T. and Reid, P. *Physical Chemistry*, Prentice-Hall, 3rd edition, 2012.

12. McQuarrie, D. A. and Simon, J. D. *Molecular Thermodynamics*, New Delhi: Viva Books Pvt. Ltd., 2004.

This syllabus has been designed as per national syllabus suggested by UGC and cover 20% extra syllabus as per requisite of honors degree.

Course Title: Analytical Chemistry

Course Code: CHE504A

Time: 04 Hours

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.

PART A

Elementary concepts (6 Hrs)

Qualitative and quantitative analysis, Concepts important to quantitative analysis, Classification of methods for quantitative analysis, 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.

Gravimetric Methods of Analysis (8 Hrs)

Precipitation gravimetry, Properties of precipitates and precipitating agents, particle size, Colloidal and crystalline precipitates, Precipitation from homogeneous solutions, Washing and filtration of precipitates, Drying and ignition of precipitates, Inorganic and organic precipitating agents, Applications of gravimetric methods.

PART B

Volumetric (Titrimetric) Methods of Analysis (10 Hrs)

Terms used in volumetric analysis, Precipitation titrimetry, Neutralization titrations and its applications, Complexation titrations, Redox titrations and redox indicators, standard reducing and oxidizing agents.

PART C

Thermo analytical or Thermometric Methods (8 Hrs)

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.

PART D

Chromatography (15 Hrs)

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, 6th 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, 3rd edition, 1985.

4. Bassett, J., Denney, R.C., Jeffery, G.H. and Mendham, J.*Vogel's Textbook of Quantitative Inorganic Analysis (revised)*, Orient Longman, 4th edition, 1978.

5. Willard H.H., Merritt L.L. Jr, Dean J.A. and Settle F.A. Jr.*Instrumental Methods of Analysis*,California: Wadsworth Publishing Company, 7th edition, 1988.

This syllabus has been designed as per national syllabus suggested by UGC and cover 20% extra syllabus as per requisite of honors degree.

Course Title: ORGANIC CHEMISTRY LAB I

Course Code: CHE505

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

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, 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: Inorganic Chemistry Lab -I

Course Code: CHE506

Time: 04 Hrs

L	T	P	Credits	Marks	Pass marks
0	0	4	2	50	20

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 $KMnO_4$ with sodium oxalate and determination of Ca^{2+} ion.
2. Standardization of ceric sulphate with Mohr's salt and determination of Cu^{2+}, NO_2^- and $C_2O_4^{2-}$ ions.
3. Standardization of $K_2Cr_2O_7$ with Fe^{2+} and determination of Fe^{3+} (Ferric alum)
4. Standardization of hypo solution with potassium iodate / $K_2Cr_2O_7$ and determination of available Cl_2 in bleaching powder, Sb^{3+} and Cu^{2+}.
5. Determination of hydrazine with KIO_3 titration.

II. Precipitation Titrations

1. $AgNO_3$ standardization by Mohr's method.
2. Volhard's method for Cl^- determination.
3. Determination of ammonium / potassium thiocyanate.

III. Complexometric Titrations

1. Determination of Cu^{2+} and Ni^{2+} by using masking reagent by EDTA titration.
2. Determination of Ni^{2+} (back titration).

3. Determination of Ca^{2+} (by substitution method).

IV. Gravimetric Analysis

1. Determination of 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 Cu^{2+} as cuprousthiocyanate.

Suggested Books:

1. Svehla, G. and Sivasankar, B. *Vogel's Qualitative Inorganic Analysis (revised),* Pearson, 7^{th} 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	CHE507A	Core	Organic Chemistry-II	4	0	0	4
2	CHE508A	Core	Inorganic Chemistry-II	4	0	0	4
3	CHE509A	Core	Physical Chemistry-II	4	0	0	4
4	CHE510A	Core	Spectroscopy-I	4	0	0	4
5	CHE511	Core	Organic Chemistry Lab-II	0	0	4	2
6	CHE512	Core	Physical Chemistry Lab-I	0	0	4	2
7	Interdisciplinary Course-II						4
Total							24

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

Course Title: Organic Chemistry-II

Course Code: CHE507A

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

Time: 04 Hours

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.

PART A

Addition to Carbon-Carbon Multiple Bonds (6 Hrs)

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 Hrs)

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

PART B

Oxidation Reactions (7 Hrs)

Introduction. Different oxidative processes. Hydrocarbons- alkenes, aromatic rings, saturated C-H groups) activated and inactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxyalic acids. Amines, hydrazines, and sulphides. Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate, DDQ, PCC, CAN, selenium dioxide, peroxyacids, DCC. Baeyer-Villeger reaction, Cannizarro oxidation-reduction reaction.

Reduction Reactions (7 Hrs)

Introduction. Different reductive processes, Hydrocarbons- alkanes, 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, isopinocamphenyl and disiopinocamphenyl borane. Wolf-Kishner reduction, Clemensen reduction.

PART C

Free Radical Reactions (8 Hrs)

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. Reactivity in the attacking radicals, The effect of solvents on reactivity, 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.

PART D

Rearrangements (12 Hrs)

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, Hofman, Curtius, Schmidt, Baeyer- Villiger, Shapiro reaction.

Suggested Books:

1. March, Jerry. *Advanced Organic Chemistry: Reactions, Mechanism and Structure,* John Wiley, 6th edition, 2007.
2. Carry, F. A. and Sundberg, R.J. *Advanced Organic Chemistry,* Plenum, 3rd edition, 1990.
3. Sykes, Peter. *A Guide Book to mechanism in Organic Chemistry,* 6th edition, Longman, 1989.
4. Morrison, R. T. and Boyd, R. N. *Organic Chemistry,* Prentice Hall, 6th edition, 1992.
5. Kalsi, P. S. *Organic Reactions and their Mechanisms,* New Age International Publishers, 2nd edition, 2000.
6. Mukherji, S.M. and Singh, S.P. *Reactions Mechanism in Chemistry,* Vol. I, II, III, Macmillan, 1985.
7. Aggarwal, O.P. *Organic Chemistry Reactions and Reagents,* Krishna Prakashan Media, 47th edition, 2011.

This syllabus is as per national syllabus given by UGC and it covers 20% more syllabus than UGC model curriculum as per the requirement of Hons course.

Course Title: Inorganic Chemistry - II

Course Code: CHE508A

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Time: 04 Hours

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.

PART A (13 Hrs)

Inorganic chains, rings and cages

a) **Chains:** Catenation, heterocatenation, isopolyanions and heteropolyanions.

b) **Rings:** Borazines, phosphazenes, other heterocyclic inorganic ring systems, homocyclic inorganic systems.

c) **Cages:** Cage compounds having phosphours, oxygen, nitrogen and sulphur: boron cage compounds, Boranes, carboranes and metallocene carboranes.

PART B (10 Hrs)

Transition metal cluster compounds

Introduction, metal carbonyl clusters; Low Nuclearity (M_3 andM_4) clusters: isoelectronic and isolobal relaltionships 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.

PART C **(10 Hrs)**

a) Lower halide and chalcogenide clusters, octahedral metal halide, chalocogenide clusters, triangular clusters, and solid state extended arrays.

b) 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.

PART D **(14 Hrs)**

Reaction Mechanisms of Transition Metal Complexes

Introduction, ligand replacement reactions, classification of mechanisms, Water exchange rates, formation of complexes from aqueous ions, catanation, reaction, aquation and base hydrolysis attack on ligands, reactions, of square planar complexes, mechanism of ligand displacement reactions; metal carbonyl reactions, reactions of binuclear carbonyls, associative reactions, species with 17 electron, electron transfer processes outer and inner sphere. 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, stereochemical non-rigidity, 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 Co shells.

Suggested Books:

1. Huheey, J.E. Inorganic Chemistry, Pearson, 3rd Edition, 1983.
2. Cotton, F.A. and Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley eastern, 6th edition.
3. Shriver, D.F., Atkins, P.W. and Langford, C.H. *Inorganic Chemistry*, ELMS, Oxford, 1990
4. William W. Porterfield, Inorganic Chemistry, 1st Edition.
5. K.F. Purcell and J.C. Kotz. An Introduction to Inorganic Chemistry.

This syllabus has been designed as per national syllabus suggested by UGC and cover 20% extra syllabus as per requisite of honors degree.

Course Title: Physical Chemistry II

Course Code: CHE509A

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

Time: 04 Hrs

Course Objectives:

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.

PART A

Chemical Dynamics **(15 Hrs)**

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; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, 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).

PART B

Non Equilibrium Thermodynamics (7 Hrs)

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (for example heat flow, chemical reaction, etc.), generalized forces and fluxes, non-equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electrokinetic phenomena, diffusion, electric conduction, irreversible thermodynamics for biological systems, coupled reactions.

PART C

Solution & Phase Equilibrium (10 Hrs)

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. Triangular method for graphical representation of three component systems; partially miscible three liquid systems, Applications of ternary liquid diagrams; systems composed of two solids and a liquid.

PART D

Colloidal State (10 Hrs)

Classification of colloids, charge and stability of colloidal dispersions, 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. Association colloids; miceller formation, cmc, soap action. Application of colloids.

Corrosion and its Control (5 Hrs)

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, Electroless plating.

Suggested books:

1. Maron, S.H and Prutton, C.F. *Principles of Physical Chemistry,* Oxford and IBH publishing, 1st edition, 1958.

2. Laidler, Keith J. *Chemical Kinetics,* New York: Harper & Row Publishers, 3rd edition, 1987.

3. Atkins, P.W. *Physical Chemistry,* ELBS, 3rd edition, 1987.

4. Thomson, S.J. and Webb, G. *Heterogeneous Catalysis,* Edinburgh; London: Oliver & Boyd, 1968.

5. Moore, J.W. and Pearson, R.G. *Kinetics and Mechanism,* John Wiley and Sons, 2nd edition, 1981.

6. Moroi, Y. *Micelles: Theoretical and Applied Aspects,* Plenum Press, 1st edition, 1992.

7. Bockris, John. Reddy, M., Amulya, K.N. *Modern Electro-Chemistry,* New York: Plenum Press, 2nd edition, 1998.

8. Adamson, Arthur W. *Physical Chemistry of Surfaces,* Wiley-Interscience Publication, 4th edition, 1982.

9. Silbey, R.J., Alberty, R.A. and Bawendi, M.G. *Physical Chemistry,* Wiley-Interscience Publication, 4th edition, 1982.

This syllabus has been designed as per national syllabus suggested by UGC and cover 20% extra syllabus as per requisite of honors degree.

Course Title: Spectroscopy-I

Course Code: CHE510A

Time: 04 Hours

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

Course Objectives:

This course is intended to learn advance 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 postgraduation in this course.

PART A

General Features of Spectroscopy (5 Hrs)

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 Hrs)

PMR: Natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei; The spinning nucleus, effect of external magnetic field, processional 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.

PART B

^{13}C-NMR Spectroscopy (5 Hrs)

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

PART C

Mass Spectra (10 Hrs)

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.

PART D

UV and Visible Spectroscopy of organic molecules (10 Hrs)

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 in Chemistry,* Reinhold Publishing Corporation, 1965.

2. Silverstein, R.M. Bassler, G.C. and Morrill, T.C. *Spectrometric Identification of Organic Compounds,* Wiley, 1991.

3. Kemp, W. *Organic Spectroscopy*, Macmillan, 1987.

4. Dyer, J. R. *Application of Absorption Spectroscopy of Organic Compounds*, Prentice Hall, 1965.

5. Williams, D. H. and Fleming, I. *Spectroscopic Problems in Organic Chemistry*, McGraw Hill, 1967.

6. Barrow, G.M. *Introduction to Molecular Spectroscopy*, McGraw Hill.

7. Banwell, C.N. *Fundamentals of Molecular Spectroscopy*, McGraw Hill, 1966.

8. Pavia, D.L., Lampan, G.M. and Kriz, G. S. *Introduction to Spectroscopy*, Hartcourt College Publishers, 2001.

This syllabus has been designed as per national syllabus suggested by UGC and cover 20% extra syllabus as per requisite of honors degree.

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Title: Organic Chemistry Lab II

Course Code: CHE511

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 tiemann Reaction)
2. Benzoin, Benzil andBenzilic acid.
3. Benzophenone, Benzophenone oxime, 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, 1st edition, 1989.

2. Vogel, A.I. *Text Book of Practical Organic Chemistry*, ELBS, Longman Group Ltd., 4th edition, 1978.

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.

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Title: Physical Chemistry Lab -I

Course Code: CHE512

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 Na^{+}, Ba^{2+}& $A1^{3+}$ ions for As_2S_3 sol.

(ii) To study the 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,* Longman Group Ltd., 9th edition, 1973.

2. Matthews, G. Peter. *Experimental Physical Chemistry,* Oxford University Press, 1st edition, 1985.

3. Shoemaker, D.P., Garland, C.W. and Nibler, J.W. *Experiments in Physical Chemistry,* McGraw Hill Inc., 6th edition (International Edition), 1996.

4. Khosla, B.D., Garg, V.C., and Gulati, A. *Senior Practical Physical Chemistry,* R. Chand and Co., 11th edition, 2002.

5. Yadav, J. B. *Advanced Practical Physical Chemistry,* Krishna Prakashan Media, 32th edition, 2013.

Scheme of Courses M.Sc.

M.Sc. (Hons.) Chemistry
Semester 3

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE601A	Core	Organic Chemistry-III	4	0	0	4
2	CHE602A	Core	Inorganic Chemistry-III	4	0	0	4
3	CHE603A	Core	Physical Chemistry-III	4	0	0	4
4	CHE604A	Core	Spectroscopy-II	4	0	0	4
5	CHE606	Core	Inorganic Chemistry Lab-II	0	0	4	2
6	CHE607	Core	Physical Chemistry Lab-II	0	0	4	2
7	CHE608*	Core	Seminar and Literature Survey	0	0	0	2*
8	CHE620*	Core	Advance Chemistry Lab-I	0	0	8	4*
	Department Elective-I						4
	Total						26/28*
Department Elective-I							
7	CHE605A	Elective	Quantum Chemistry	4	0	0	4
8	CHE617	Elective	Synthetic Organic Chemistry	4	0	0	4
9	CHE614	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 CHE608 of 2 credits and the others will study CHE620 of 4 credits in the third semester.**

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

Course Code: CHE601A

Time: 04 Hrs

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

PART A

Pericyclic Reactions (15 Hrs)

Molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1, 3, 5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions, conrotatory and disrotatory motions in 4n, 4n +2 and allyl system. Cycloadditions-antarafacial suprafacial additions, 4n and 4n+2 systems, 2+2 additiion of ketenes, 1, 3-dipolar cycloadditions and cheleotropic reactions.

PART B

Sigmatropic rearrangements (5 Hrs)

Suprafacial and antarafacial shifts of H. Sigmatropic shifts involving carbon moieties, [3, 3]- and [5, 5]- sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangement. Fluxional tautomerism. Ene reaction.

Photochemical Reactions (4 Hrs)

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Determination of Reaction Mechanism **(4 Hrs)**

Classification, rate constants and life times of reactive energy states – determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions – photo-dissociation, gas-phase photolysis.

PART C

Photochemistry of Alkenes **(6 Hrs)**

Intramolecular reactions of the olefinic bond- geometrical isomerism, cyclisation reactions, rearrangement of 1, 4-dienes,

Photochemistry of Aromatic Compounds **(4 Hrs)**

Isomerisations, additions and substitutions.

PART D

Photochemistry of Carbonyl Compounds **(6 Hrs)**

Intramolecular reactions of carbonyl compounds – saturated, cyclic and acyclic, β, γ-unsaturated and α,β -unsaturated compounds, Cyclohexadienones.

Intermolecular cyloaddition reactions – dimerisations and oxetane formation.

Miscellaneous Photochemical Reactions **(4 Hrs)**

Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photo degradation of polymers. 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,* McGraw Hill, 1972.
4. Horsepool, W. M. *Organic Photochemistry,* Ellis Horwood, 1992.
5. Kalsi, P.S. *Organic Reactions and their Mechanisms,* New Age International, 2nd edition, 2000.

6. Mukherji, S.M. and Singh, S.P. *Reactions Mechanism in Chemistry*, Vol. I, II, III, Macmillan, 1985.

This syllabus is as per national syllabus given by UGC and it covers 20% more syllabus than UGC model curriculum as per the requirement of Hons. Course.

Course Title: Inorganic Chemistry –III (Organometallics)
Course Code: CHE602A

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Time: 04 Hours

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.

PART A (14 Hrs)

Structure and Bonding

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

Alkyl, Aryl and Ligands with Higher Hapticity:

(i) Sigma bonded alkyl groups as ligands: Synthesis of metal-alkyl compounds, β-hydride elimination, σ-bonded η1-aryl ligands.

(ii) Cyclic and acyclic polyenyl π-bonded ligands:

a. Cyclopentdienyl (Cp-), Synthesis of Cp based sandwich compounds, Structure and properties of Cp_2M complexes, The first metal-sandwich compound Ferrocene, Reactions of metal-sandwich compounds, Bent sandwich compounds, Schwartz reagent and hydrozirconation, Chemistry of Cp*, Chemistry of arene sandwich compounds

b. Allyl groups as ligands, 1,3-Butadiene complexes, Cyclobutadiene complexes, Cycloheptatriene and Cyclooctatetraene as ligands. Davies-Green-Mingos (DGM) rules.

c. Ferrocene: Structure and bonding of ferrocenes, Basic chemical reactions of Ferrocene, Reactions of Acetyl Ferrocene and formyl Ferrocene, lithiated ferrocenes and their reactions, (Dimethylaminomethyl)Ferrocene and its methiodide salt, Ferrocene boronic acid and haloferrocenes.

PART B (9 Hrs)

Metal-Carbon multiple bonds

Carbene and Carbyne complexes including N-heterocyclic carbene complexes. Fluxional organometallic compounds including allyl complexes and their characterization.

Recaptulation of Metal Carbonyls

PART C (13 Hrs)

Applications of Organometallic Complexes to Catalysis

Catalysis, Terminology in catalysis, sequences involved in a catalysed reaction, asymmetric synthesis using a catalyst, Hydrogenation catalysts, classification of hydrogenation catalysts, catalytic cycle of Wilkinson's catalyst, catalytic cycles of iridium and ruthenium based catalysts, hydrogenation by lanthanide organometallic compounds, catalytic asymmetric synthesis, Hydroformylation: Cobalt catalysts and phosphine modified cobalt catalysts, Rhodium-phosphine catalysts, factors affecting the n/iso ratio of hydroformylation products; Methanol Carbonylation and Olefin Oxidation: Monsanto, Cativa and Wacker Processes,; Polymerisation and oligomerisation of olefins and dienes, carboxylation of olefins, carbonylation of methanol, Synthetic gas.

PART D (9 Hrs)

Bioorganometallic Chemistry

Role of organometallics in heavy metal poisoning: Mercury and Arsenic poisoning; organometallic compounds as drugs: ruthenium and ferrocene based drugs; Organometallics as radiopharmaceutical, tracers, ionophores and sensors; Organometallic enzymes: cobalamines

Suggested Books:

1. J.E. Huheey, Inorganic Chemistry, Principles of Structure and Reactivity, Harper Inter-Science.
2. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th edition, Wiley Inter-Science.
3. B.D. Gupta and A.J. Elias, Basic Organometallic Chemistry, Universities Press.
4. A. Salzer and E. Elschenbroich, Organometallics, A Concise Introduction, VCH.
5. D. Astruc, Organometallic Chemistry and Catalysis, Springer.

This syllabus has been designed as per national syllabus suggested by UGC and cover 20% extra syllabus as per requisite of honors degree.

Course Title: Physical Chemistry III

Course Code: CHE603A

Time: 04 Hours

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 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.

PART A

Electrochemistry of Solutions I (10 Hrs)

Ion-solvent interactions, the Born model, electrostatic potential at the surface of a charged sphere, Born expression far 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.

PART B

Electrochemistry of Solutions II (15 Hrs)

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.

Electrocatalysis (5 Hrs)

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

PART C

Photochemistry (10 Hrs)

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, energy surface description of molecular photochemistry, Excimers and Exciplexes, kinetics of photochemical reactions, chemiluminescence, solar energy conversion and storage.

PART D

Nanochemistry (10 Hrs)

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

Suggested Books:

1. Bockris, John, Reddy, O.M. and Amulya K.N. *Modern Electro-Chemistry,* Plenum Press, New York, 2nd edition, 1998.
2. Silbey, R. J., Alberty, R. A. and Bawendi, M. G. *Physical Chemistry,* John Wiley & Sons, Inc. 4th edition, 2005.
3. Atkins, P.W and Paula, J.D. *Physical Chemistry,* Oxford University Press, 9th edition, 2011.
4. Barrow, G. M. *Physical Chemistry,* New Delhi: Tata McGraw Hill, 5th edition, 2006.
5. Metz, C. R. *Physical Chemistry,* Tata McGraw-Hill, 2nd edition, 2009.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Title: Spectroscopy -II
Course Code: CHE604A

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Time: 04 Hours

Course Objectives:

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.

PART A

Pure Rotational Spectra **(8 Hrs)**

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 Hrs)**

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 CO_2, SO_2 and H_2O, Fermi resonance, group vibrations.

PART B

(10 Hrs)

Raman Spectroscopy: Introduction, selection rules, anisotropic polarizabilty, Stokes, anti-Stokes lines, vibrational Raman spectra of CO_2 and H_2O, 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.

PART C

Nuclear Quadruple Resonance Spectroscopy (8 Hrs)

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.

PART D

Mossbauer Spectroscopy (8 Hrs)

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, quadruple splitting, additive model, interpretation of Mossbauer spectra of ^{57}Fe, ^{119}Sn.

Suggested Books:

1. R.S. Drago, Physical Methods in Chemistry, W.B. Saunders Company.

2. R.V. Parish, NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, Eds Elis Horwood.

3. Skoog D.A., D.M.West, F.J.Holler, S.R.Crouch, Fundamentals of Analytical chemistry, Pubs: Brooks/Cole, 2004.

4. R.M. Silverstein, G.C. Bassler, T.C. Morrill, “Spectrometric Identification of Organic Compounds, Wiley 1991.
5. W. Kemp, Organic Spectroscopy, Macmillan, 1987.
6. J. R. Dyer, Application of Absorption Spectroscopy of Organic Compounds, Prentice Hall, 1965.
7. D. H. Williams, I. Fleming, Spectroscopic Problems in Organic Chemistry, McGraw Hill, 1967.
8. G.M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill.
9. C.N. Banwell, Fundamentals of Molecular Spectroscopy, McGraw Hill, 1966.
10. D.L. Pavia, G.M. Lampan and G. S. Kriz, Introduction to Spectroscopy, Hartcourt College Publishers, 2001.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Title: Inorganic Chemistry Lab -II

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Code: CHE606

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^{o}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 β 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 selectronic absorption spectral data. Calculation of β 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-(diethyldithiocarbamato)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: CHE607

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

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:

(a) $Zn + Cu^{+2}$ $Zn^{+2} + Cu$

(b) $Zn + Pb^{+2}$ $Zn^{+2} + Pb$

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

3. **Flame Photometry:**

(i) Determination of Na^+ and K^+ when present together.

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

4. **Transition Temperature Determination:**

Determination of transition temperature of $MnCl_2$ by Dielatometric method.

Suggested books:

1. Levitt, B.P. *Findlay's Practical Physical Chemistry*, Longman Group Ltd., 9th edition, 1973.

2. Matthews, G. Peter. *Experimental Physical Chemistry*, Oxford University Press, 1st edition, 1985.

3.Shoemaker, D.P.; Garland, C.W.; Nibler, J.W. Experiments in Physical Chemistry, (International Edition) McGraw Hill Inc., 6th edition 1996.

4. Khosla, B.D., Garg, V.C. and Gulati, A. Senior Practical Physical Chemistry, R. Chand and Co., 11th edition, 2002.

Course Title: Advance Chemistry Lab-I

Course Code: CHE620

L	T	P	Credits	Marks	Pass Marks
0	0	8	4	100	40

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, 7th 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, 3rd 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, A Eleen 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. Christoper Cramer, *Essentials of Computational Chemistry*: Theories and Models, John Wiley & Sons, 2002.

Course Title: Quantum Chemistry

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Course Code: CHE605A

Time: 04 Hours

Course Objectives:

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.

PARTA

Mathematical Preparation (5 Hrs)

Operators and observables, normality and orthogonality of functions, Hermitianoperators. Introduction to differentiation and Integration.

Quantum Theory: Introduction and principles and applications (20 Hrs)

Black Body radiation, planck's radiation law, photoelectric effect, Compton effect, De-Broglie hypothesis, the Heisenberg's uncertainty principle, Rydberg's relation for explaining atomic spectrum of hydrogen. Bohr theory and its limitations. Solution of classical wave equation by separation of variable method, eigen value equation, Hamiltonian operator. Interpretation of Ψ, Solution of particle in one, two and three dimensional box, degeneracy. Postulates of quantum mechanics, the linear harmonic oscillator, and the rigid rotator, quantization of vibrational and rotational energies.

PART B

Angular Momentum (10 Hrs)

Commutative laws, need of polar coordinates, transformation of Cartesian coordinates into polar coordinates. Angular momentum of one particle system, orbital angular momentum, the ladder operator method for angular momentum.

PARTC

The Hydrogen Atom (5 Hrs)

Outline of various steps in the solution of the electronic Schrödinger equation for hydrogen atom, Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. Significance of Quantum numbers, orbital angular momentum and quantum numbers ml and ms.

PART D

The Approximation Methods (5 Hrs)

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

Chemical Bonding (5 Hrs)

Chemical bonding, linear combination of atomic orbitals, overlap integral, coulomb integral, molecular orbital treatment of H_2^+, Bonding and antibonding orbital of H_2^+

Suggested Books:

1. Levine, Ira N. *Quantum Chemistry*, Prentice-Hall International, Inc. 5th edition, 2000.
2. Chandra, A. K. *Introductory Quantum Chemistry*, Tata McGraw-Hill, 2001.
3. House, J. E. *Fundamentals of Quantum Chemistry* USA: Elsevier, 2nd edition, 2004.
4. Lowe, J. P. and Peterson, K. *Quantum Chemistry*, Academic Press, 2005.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Title: Synthetic Organic Chemistry

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Course Code: CHE617

Time: 04 Hours

Course Objectives:

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.

PART-A

(12 Hrs)

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, β–elimination pyrolytic syn elimination, synthesis of allyl alcohol, sulphoxide sulphenate rearrangement, through phosphorous ylid, decarboxylation of β–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 toulene p-sulphonylhydrazones, stereospecific synthesis from – 1,2-diols. Stereoselective route to γ,δ–carbonyl compounds.

PART-B

(11 Hrs)

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.

PART-C

(11 Hrs)

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 spices 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.

PART-D

(11 Hrs)

Two Group Disconnections approach, 1,3-Difunctionalized compound - α-hydroxy carbonyl compounds. α,β-unsaturated carbonyl compounds, 1,3-di carbonyl compounds, α,β-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, 3rd edition, September 1993.

5. Warren, S. *Organic Synthesis: The disconnection approach* John Wiley, 2nd edition, Cambridge, 2008.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Tittle: Molecules of Life

Course Code: CHE614

Time: 04 Hours

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

Objective of the Course: It is the harmonious and synchronous progress of chemical reactions in body 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.

PART A

Carbohydrates (10 Hrs)

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.

PART B

Amino Acids, Peptides and Proteins (15 Hrs)

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 and correlation with drug action

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereo specificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Noncompetitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, -NH2 group, double bond and aromatic ring,

PART C

Nucleic Acids (11 Hrs)

Components of Nucleic acids: Adenine, guanine ,thymine and Cytosine(Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature**), 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).

PART D

Concept of Energy in Bio systems (11 Hrs)

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of food (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate-Glycolysis, Fermentation, Krebs cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

Suggested Books:

1. Morrison, R. T. and Boyd, R. N. *Organic Chemistry*, Pearson Education, 6th edition, 1992.

2. Finar, I. L. *Organic Chemistry* (Volume 1), Pearson Education, 6th edition, 1973.

3. Finar, I. L. Organic Chemistry (Volume 2), Pearson Education, 6th edition, 1973.

4. Nelson, D. L. and Cox, M. M. *Menninger's Principles of Biochemistry*, W. H. Freeman 7th edition, 2004.

5. Berg, J. M., Tymoczko, J. L. and Stryer, L. *Biochemistry*, W. H. Freeman, 6th edition.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Name: Nanoscience and Nanotechnology

Course Code: PHY670

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

Unit I **(15 Hrs)**

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 Hrs)**

Preparation of Nanomaterials: Nucleation and growth of nanostructures: Homogenous and heterogeneous, Top down and bottom upapproaches, 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 Hrs)**

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 Hrs)**

Special Nanomaterials: Carbon: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C_{60}, alkali doped C_{60}; 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*,3rd 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, 3rd edition (2010).

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Scheme of Courses M.Sc.

M.Sc. (Hons.) Chemistry

Semester 4

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE609A	Core	Organic Chemistry-IV	4	0	0	4
2	CHE610A	Core	Bio-Inorganic Chemistry	4	0	0	4
3	CHE612*	Core	Project	0	0	0	6*
4	CHE621*	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)							
4	CHE611A	Elective	Bio-Physical Chemistry	4	0	0	4
5	CHE613A	Elective	Supramolecular Chemistry	4	0	0	4
6	CHE615	Elective	Chemistry of Materials	4	0	0	4
7	CHE616	Elective	Medicinal Chemistry	4	0	0	4
8	CHE618	Elective	Advance Physical Chemistry	4	0	0	4
9	CHE619	Elective	Analytical Techniques	4	0	0	4

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

***The students with research projects will do Project work (CHE612) of 6 credits and the others will study Advance chemistry Lab-II (CHE621) of 4 credits in the fourth semester.**

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

Course Code: CHE609A

Time: 04 Hours

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.

PART A

Terpenoids and Carotenoids **(12 Hrs)**

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination (repeat) stereochemistry, Biosynthesis and synthesis of the following representative molecules: citral, Terpeneol, Farnesol, santonin, phytol, Abietic Acid and Beta-Carotene, vitamin A.

PART B

Alkaloids **(12 Hrs)**

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

Biosynthesis of shikimic acid, aromatic amino acids, cinnamic and benzoic acid, coumarines.

Amino acids, Peptides and Proteins **(5 Hrs)**

Introduction, amino acid classification and structure, chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding secondary structures. - helix and sheet. Tertiary structure of protein folding. Quaternary structure. Biosynthesis of amino acids.

PART C

Steroids **(12 Hrs)**

Occurrence, nomenclature, basic skeleton. Diel's hydrocarbon and Stereochemistry, Isolation, structure determination and synthesis of cholesterol Bile acids, Androsterone Testosterone, Estrone Progestrone Aldosterone Biosynthesis of Steroids

PART D

Plant Pigments **(4 Hrs)**

Occurrence, nomenclature and general methods of structure determinations, isolation and synthesis, Quercetin, Quercetin-3-Glucoside, Vitexin, Diadzein, Cyanidin-7-arabinoside cyanidine, Hirsutidin Biosynthesis of Flavonoids: Acetate path way and shikimic acid path way.

Porphyrins **(2 Hrs)**

Structure and synthesis of Haemoglobin and chlorophyll

Prostaglandins **(4 Hrs)**

Occurrence, nomenclature, classification, biogenesis and physiological effects Synthesis of PGE2 and PGF 2

Pyrethroids and rotenones **(2Hrs)**

Synthesis and reaction of Pyrethroids and rotenones

Suggested Books:

1. Finar, I.L. *Organic Chemistry*, ELBS, Vol. 2, 5th edition, 1975.
2. Nogradi, M. *Stereoselective Synthesis: A Practical Approach*, VCH, 1995.
3. Coffey, S. *Rodd's Chemistry of Carbon Compounds*, Elsevier, 2nd 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.

This syllabus is as per national syllabus given by UGC and it covers 20% more syllabus than UGC model curriculum as per the requirement of Hons course.

Course Title: Bio-Inorganic Chemistry

Course Code: CHE 610A

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Time: 04 Hours

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.

PART A

Inorganic Chemistry of Enzymes - I (12 Hrs)

Introduction, energy sources for life, non-photosynthetic processes, metallopoophyrings, 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-prophyrin biomolecules, structure and function of hemoglobin. Other iron-porphyrin biomolecules, peroxidases and catalases, cytochrome P450 enzymes, other natural oxygen carriers, hemerythrins, electron transfer.

PART B

Inorganic Chemistry of Enzymes - II (12 Hrs)

Respiration and photosynthesis; ferridoxins, and subredonim carboxypeptidase, carbonic anhydrase, metallothioneins. Blue copper proteins, superoxide dismutase hemocyanines photosynthesis, chlorophyll and photosynthetic reaction center.

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).

PART C

Metal Ions in Biological Systems **(12 Hrs)**

Metal complexes of polynucleotides, nucleosides and nucleic acids (DNA & RNA). Template temperature, stability of DNA. Role of metal ions in replication and transcription process of nucleic acids. Biochemistry of dioxygen, bioinorganic chips and biosensors. Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting, neurotransmitter, calcification reclaiming of barren land. 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.

PART D

Inorganic Medicinal Chemistry **(10 Hrs)**

Fundamentals of Toxicity and Detoxification. Nuclear medicines.

Suggested Books:

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

This syllabus has been designed as per national syllabus suggested by UGC and cover 20% extra syllabus as per requisite of honors degree.

Course Title: Advance Chemistry Lab-II

Course Code: CHE621

L	T	P	Credits	Marks	Pass Marks
0	0	8	4	100	40

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}H -NMR, ^{13}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), Benzilic acid from benzoin (Benzillic acid rearrangement), Benzpinacol (photochemical reaction), 7-hydroxy coumarin (Pechman synthesis), Photo-dimerization of maleic anhydride, benzophenone (Friedel-Crafts reaction), Benzanilide (Beckmann rearrangement), Vanillyl alcohol from vanillin ($NaBH_4$ reduction), 2- and 4-nitrophenols (nitration and separation by steam distillation), 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., 5thedition, 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: CHE611A

Time: 04 Hours

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 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.

PART A

Fundamentals of Biological Macromolecules (15 Hrs)

Biological Cell and its Constituents: Biological Cell, structure and functions of proteins, enzymes, DNA and RNA in living systems. Helix coil transition.

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

Statistical Mechanics in Biopolymers: Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structures. Polypeptide and protein structures, introduction to protein folding problem.

Biopolymer Interactions: Forces involved in biopolymer interactions, Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions, Multiple equilibria and various types of binding processes in biological systems, Hydrogen ion titration curves.

PART B

Thermodynamics of Biopolymer Solutions (10 Hrs.)

Biopolymer Solutions Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system.

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

PART C

Structural Determination of Biological Macromolecules (10 Hrs)

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.

Electrophoresis: General principles, Double layer techniques, moving boundary electrophoresis, zonal electrophoresis, isoelectric focusing.

Osmotic Pressure

Second virial coefficient, Donnan effect, molecular mass and geometry from O.P. data.

Optical Properties of Biomacromolecules

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

PART D

Methods for the Separation of Biomolecules (10 Hrs)

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

Suggested Books:

1. Lehninger, A.L. *Principles of Biochemistry,* Worth Publishers.

2. Stryer, L. *Biochemistry*, W.H. Freeman.

3. Voet and Voet, *Biochemistry,* John Wiley.

4. Wold, F. *Macromolecules: Structure and Function,* Prentice Hall.

5. Billmeyer, F.W. *Text Book of Polymer Science*.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

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

Course Title: Supramolecular Chemistry

Course Code: CHE613A

Time: 04 Hours

Course Objectives:

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 the 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.

PART A

Concepts (5 Hrs)

Definition and development of supramolecular chemistry, supramolecular interactions (hydrogen bond, halogen bond, π-π interactions, cation-π, anion-π, metal coordination interactions, metallobhobic interactions). Macrocyclic and macro-bicyclic effect, template effect (illustrated by acyclic, macrocyclic and macropolycyclic ligand systems), supramolecular receptor, molecular and chiral recognition, pre-organization, complementarily, concept of indused fit, allosteric effect.

PART B

Supramolecular Host (10Hrs)

Cation Binding

Binding, selectivity and applications of Crown ethers, Lariat ether, Podands, Cryptands, Spherands, Calixarene and other synthetic receptors. Concept of siderophores.

Anions Binding (5 Hrs)

Anions in environment, challenges in designing anion binding host, biological anion receptors, Guanidinium-based receptors, Neutral receptors, organometallic receptors, Molecular chameleon.

Neutral Molecular Binding (5 Hrs)

Cyclophene, Hemi-carcerand, Cucurbitril, Cyclidextrin, Chemical and photo-chemical reaction inside the cavity of different hosts. Molecular cleft and tweezers, Concept of clathrate, inorganic and organic solid state clathrates, zeolites and their application.

PART C

Applications of Supramolecular Chemistry (10 Hrs)

Applications of supramolecular chemistry in chemical sensing of ions, catalysis, electronic display (liquid crystal), molecular devices, molecular machines and molecular wires Supramolecular assembly in inorganic helical complexes (metal-supramolecular Chemistry), Supramolecular machines based on catenanes and rotaxanes, knots, transition metal-based cationic molecular boxes.

PART D

Crystal Engineering (10 Hrs)

Organic crystal engineering: Crystal structure from molecular structure, Intermolecular interactions and crystal packing, supramolecular synthons and supramolecular synthetic strategies, Functionalized solids, Polymorphism, co-crystal, supramolecular gel and their application.

Inorganic crystal engineering: Coordination polymer vs Metal-Organic Frameworks (MOFs), Synthetic routes to MOFs, Secondary building unit (SBU) concept, potential applications of MOFs (gas storage, separation, magnetism, drug delivery, etc.)

Suggested Books and References:

1. Vögtle, F. *Supramolecular Chemistry: An Introduction*, Wiley, New York, 1993
2. Lehn, J.-M. *Supramolecular Chemistry: Concepts and Perspectives*, WILEY-VCH: Weinheim, 1995.
3. Beer, P. D. , Gale, P. A. and D.K. Smith, *Supramolecular Chemistry*, Oxford University Press, Oxford, 1999.
4. Lehn, J.-M. and Ball, P. *The New Chemistry* Hall, N. Eds. Cambridge Univ. Press, Cambridge, U. K., 2000; pp. 300-351.
5. Dodziuk, H. *Introduction to Supramolecular Chemistry*; Kluwer Academic Publishers, NW, 2004.
6. Steed, J. W. and Atwood, J. L. *Encyclopedia of Supramolecular Chemistry*, CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW, 2004.
7. Steed, J. W. and Atwood, J. L. *Supramolecular Chemistry*, Wiley: Chichester, 2000.
8. Ariga, K. and Kunitake, T. *Supramolecular Chemistry: Fundamentals and Applications*, Springer, Berlin, 2005.
9. Steed, J. W., Turner, D. R. and Wallace, K. J. *Core Concepts in Supramolecular Chemisty and Nanochemistry*, Chichester, Wiley, 2007.

10. Lehn, J.-M. *Angew. Chem. Int. Ed*. 1988, 27, 89-112.
11. Desiraju, G. R. *Crystal Engineering: The Design of Organic Solids*, Elsevier, Amsterdam, 1989.
12. Desiraju, G. R. *Angew. Chem., Int. Ed*. 2007, 46, 8342-8356.
13. Desiraju, G. R., Vittal, J. J. and Ramanan, A. *Crystal Engineering: A Textbook*, IISc Press and World Scientific Publishing, Singapore, 2011.
14. Tiekink, E. R. T. and Vittal, J. J. Eds., *Frontiers in Crystal Engineering*, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, England, 2006.
15. Braga, D. and Grepioni, F. Eds., *Making Crystals by Design Methods, Techniques and Applications*, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2007.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Title: Chemistry of Materials

Course Code: CHE 615

Time: 04 Hours

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 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 postgraduation in this course.

PART A

Solid State Chemistry

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.

PART B

Macromolecules

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, polarones and bipolarons.

PART C

Glasses and Ceramics

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_2O_3 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.

PART D

Smart Materials

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 Tc, 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.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Title: Medicinal Chemistry

Course Code: CHE616

Time: 04 Hours

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 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.

PART A

Enzymes (8 Hrs)

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 Hrs)

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.

PART B

Kinds of Reaction Catalysed by Enzymes (8 Hrs)

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, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

PART C

Co-Enzyme Chemistry (6 Hrs)

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

PART D

Drug Design (18 Hrs)

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 (SAP), 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, 5th edition.
2. Silverman, R. B. *The organic chemistry of drug design and drug action,* Academic press 2nd edition, 2004.
3. Pandeya S. S. and Dimmock, J.R. *An introduction to drug design,* New Age International.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Title: Advanced Physical Chemistry

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

Course Code: CHE618

Time: 04 Hours

Course Objectives:

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.

PART-A (11 Hrs)

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.

PART-B (12 Hrs)

Introduction

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

Kinetics of Polymerizaton

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.

PART-C (11 Hrs)

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 co-efficient and flow properties. Determination of molecular size and mass from diffusion, sedimentation velocity, sedimetation equilibrium and viscosity. Light scattering and small angle X-ray scattering.

PART-D (11 Hrs)

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, 3rd 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, Ithace (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).

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Course Title: Analytical Techniques

Course Code: CHE619

Time: 04 Hours

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 different methods of analysis required in 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 of different methods of analysis required in 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.

PART A

Electroanalytical Techniques (15 Hrs)

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, conductometric titrations.

PART B

Electron Paramagnetic Resonance Spectroscopy (9 Hrs)

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

degeneracy. Qualitative survey of EPR spectra of first row transition metal ion complexes (d1, d2, d3, low spin d5, high spin d6, d7, d9 system). Spectra of triplet states.

PART C

X-ray diffraction methods of analysis (9 Hrs)

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).

PART D

Photoelectron Spectroscopy (9 Hrs)

Introduction, photoelectron spectroscopy, chemical shift, X-ray photoelectron Spectroscopy, molecular orbital diagrams of nitrogen and oxygen and their XPS spectra-ESCA, ultraviolet photoelectron spectroscopy (UPS), PES spectrum of nitrogen sample, vibrational structure in the N_2 UPS spectrum, chemical shifts in XPS, exchange splitting and shake up process

Suggested Books:

1. R.S. Drago, Physical Methods in Chemistry, W.B. Saunders Company.
2. R.V. Parish, NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, Eds Elis Horwood.
3. Skoog D.A., D.M.West, F.J.Holler, S.R.Crouch, Fundamentals of Analytical chemistry, Pubs: Brooks/Cole, 2004.
4. R.M. Silverstein, G.C. Bassler, T.C. Morrill, "Spectrometric Identification of Organic Compounds, Wiley 1991.
5. W. Kemp, Organic Spectroscopy, Macmillan, 1987.
6. J. R. Dyer, Application of Absorption Spectroscopy of Organic Compounds, Prentice Hall, 1965.
7. D. H. Williams, I. Fleming, Spectroscopic Problems in Organic Chemistry, McGraw Hill, 1967.
8. G.M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill.
9. C.N. Banwell, Fundamentals of Molecular Spectroscopy, McGraw Hill, 1966.

10. D.L. Pavia, G.M. Lampan and G. S. Kriz, Introduction to Spectroscopy, Hartcourt College Publishers, 2001.

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Interdisciplinary Courses:

S.No	Paper Code	Course Title	L	T	P	Cr
1	CSA555	Fundamentals of Computer and Programming in C/C++	3	0	0	3
	CSA556	Fundamentals of Computer and Programming in C/C++ Lab	0	0	2	1
2	EVS051	Dynamics of Biogeography	4	0	0	4
3	EVS052	Green Technology	4	0	0	4
4	EVS053	Environmental Toxicology	4	0	0	4
5	BOT505	Forestry	4	0	0	4
6	BOT535	Conservation of Natural Resources	4	0	0	4
7	ENG531	Writing Skills	4	0	0	4
8	ENG532	Creative Writing	4	0	0	4
9	ENG533	Living Literature	4	0	0	4
10	MIC006	Fermentation Microbiology	4	0	0	4
11	MIC007	Microbiology of Diseases	4	0	0	4
12	MGT051	Business Strategy	4	0	0	4
13	MGT052	Principles of Marketing	4	0	0	4
14	MGT053	Research Methodology	4	0	0	4
15	CHE615	Chemistry of Materials	4	0	0	4
16	CHE616	Medicinal Chemistry	4	0	0	4
17	MTH 636	Discrete Mathematics	4	0	0	4
18	MTH 633	Operational Research	4	0	0	4
19	MTH560	Mathematics for Chemists	4	0	0	4