

Department of Chemistry
Curriculum of M.Sc. (Chemistry)

FIRST SEMESTER

Sl.No	Sub. Code	Subjects	L-T- P	Credits
1	CY 511	Stereochemistry and Reaction Mechanism	3-1-0	4
2	CY 521	Principles of Inorganic Chemistry	3-1-0	4
3	CY 531	Thermodynamics & Chemical Equilibria	3-1-0	4
4		Professional Elective I	3-0-0	3
5		Open Elective I	3-0-0	3
6	CY 571	Organic Chemistry Laboratory	0-0-9	6
7	CS 171	Computing Laboratory- I	0-0-3	2
TOTAL				26

SECOND SEMESTER

Sl.No	Sub. Code	Subjects	L-T- P	Credits
1	CY 512	Structure and Functions of Biomolecules	3-1-0	4
2	CY 522	Chemistry of Transition and Non-transition Elements	3-1-0	4
3	CY 532	Chemical Kinetics	3-1-0	4
4		Professional Elective II	3-0-0	3
5		Open Elective II	3-0-0	3
8	CY 572	Inorganic Chemistry Laboratory	0-0-9	6
9	CS 172	Computing Laboratory-II	0-0-3	2
TOTAL				26

THIRD SEMESTER

Sl.No	Sub. Code	Subjects	L-T- P	Credits
1	CY 533	Quantum Chemistry	3-1-0	4
2		Professional Elective III	3-0-0	3
3		Professional Elective IV	3-0-0	3
4		Open Elective III	3-0-0	3
5	CY 573	Physical Chemistry Laboratory	0-0-9	6
6	CY 591	Research Project -I	0-0-6	4
7	CY 593	Seminar & Technical Writing-I	0-0-3	2
8	CY 595	Short term Industrial/ Research Experience	0-0-0	2
TOTAL				27

FOURTH SEMESTER

Sl.No	Sub. Code	Subjects	L-T- P	Credits
1	CY 514	Environmental Chemistry	3-1-0	4
2		Professional Elective V	3-0-0	3
3		Professional Elective VI	3-0-0	3
4		Open Elective IV	3-0-0	3
5	CY 574	Environmental Chemistry Laboratory	0-0-9	6
6	CY 592	Research Project-II	0-0-9	6
7	CY 594	Seminar & Technical Writing-II	0-0-3	2
8	CY 596	Comprehensive Viva-voce	0-0-0	2
TOTAL				29

LIST OF PROFESSIONAL ELECTIVES

Sl.No	Sub. Code	Subjects	L-T- P	Credits
1.	CY 515	Spectroscopic Methods of Analysis	3-0-0	3
2.	CY 516	Industrial Organic Chemistry	3-0-0	3
3.	CY 517	Chemistry of Natural Products	3-0-0	3
4.	CY 518	Polymer Chemistry	3-0-0	3
5.	CY 519	Methods in Organic Synthesis	3-0-0	3
6.	CY 523	Industrial Inorganic Chemistry	3-0-0	3
7.	CY 524	Group Theory and Molecular Orbitals	3-0-0	3
8.	CY 525	Advanced Co-ordination Chemistry	3-0-0	3
9.	CY 526	Bio-inorganic Chemistry	3-0-0	3
10.	CY 527	Supramolecular Chemistry	3-0-0	3
11.	CY 534	Principles of Heterogeneous Catalysis	3-0-0	3
12.	CY 535	Electrochemistry	3-0-0	3
13.	CY 536	Colloids and Surface Chemistry	3-0-0	3
14.	CY 537	Advanced Solid State Chemistry	3-0-0	3
15.	CY 538	Molecular Spectroscopy	3-0-0	3
16.	CY 539	Biophysical Chemistry	3-0-0	3
17.	CY 541	Chemistry of Heterocyclic Compounds	3-0-0	3
18.	CY 542	Pericyclic Reactions and Photochemistry	3-0-0	3
19.	CY 543	Molecular Rearrangement	3-0-0	3
20.	CY 544	Instrumental Methods of Analysis	3-0-0	3
21.	CY 558	Organometallic Chemistry	3-0-0	3

Department of Chemistry

SUMMARY OF COURSES

Sub Discipline: Core Courses

CY 101	Chemistry	3-1-0	4
--------	-----------	-------	---

Sub Discipline: Organic Chemistry

CY 211	Name Reactions & Rearrangements	3-0-0	3
CY 311	Concerted Reactions	3-0-0	3
CY 413	Spectroscopic Methods of Analysis	3-0-0	3
CY 511	Stereochemistry and Reaction Mechanism.	3-1-0	4
CY 512	Structure and Functions of Biomolecules	3-1-0	4
CY 514	Environmental Chemistry	3-1-0	4

Sub Discipline: Inorganic Chemistry

CY 322	Supramolecular Chemistry	3-0-0	3
CY 521	Principles of Inorganic Chemistry	3-1-0	4
CY 522	Chemistry of Transition & Non-transition Elements	3-1-0	4

Sub Discipline: Physical Chemistry

CY 232	Chemical Kinetics	3-0-0	3
CY 431	Chemistry of Nanomaterials	3-0-0	3
CY 432	Introduction to Nanobiotechnology	3-0-0	3
CY 531	Thermodynamics & Chemical Equilibria.	3-1-0	4
CY 532	Chemical Kinetics	3-1-0	4
CY 533	Quantum Chemistry	3-1-0	4

Sub Discipline: Laboratory Courses

CY 170	Chemistry Laboratory	0-0-3	2
CY 272	Organic Chemistry Laboratory	0-0-3	2
CY 571	Organic Chemistry Laboratory	0-0-9	6
CY 572	Inorganic Chemistry Laboratory	0-0-9	6
CY 573	Physical Chemistry Laboratory	0-0-9	6
CY 574	Environmental Chemistry Laboratory	0-0-9	6

Sub Discipline: Project, Seminar and Special Courses

CY 581	Special Topics in Chemistry – I	3-1-0	4
CY 582	Special Topics in Chemistry – II	3-1-0	4
CY 583	Special Laboratory in Chemistry – I	0-0-3	2
CY 584	Special Laboratory in Chemistry – II	0-0-3	2
CY 591	Research Project-I	0-0-6	4
CY 592	Research Project – II	0-0-9	6
CY 593	Seminar & Technical Writing-I	0-0-3	2
CY 594	Seminar & Technical Writing-II	0-0-3	2
CY 595	Short term Industrial/ Research Experience	0-0-0	2
CY 596	Comprehensive Viva-voce	0-0-0	2

COURSES OFFERED AS OPEN ELECTIVES

Sl.No.	Sub. Code	Subject	L-T- P	Credits
1	CY 211	Name Reactions & Rearrangements	3-0-0	3
2	CY 232	Chemical Kinetics	3-0-0	3
3	CY 272	Organic Chemistry Laboratory	0-0-3	2
4	CY 311	Concerted Reactions	3-0-0	3
5	CY 322	Supramolecular Chemistry	3-0-0	3
6	CY 413	Spectroscopic Methods of Analysis.	3-0-0	3
7	CY 431	Chemistry of Nanomaterials	3-0-0	3
8	CY 432	Introduction to Nanobiotechnology	3-0-0	3

DETAILED CONTENT OF SYLLABI OF COURSES

Sub. Code	Subject	L-T-P	Credits
CY 101	Chemistry	3-1-0	4
CY 170	Chemistry Laboratory	0-0-3	2
CY 211	Name Reactions & Rearrangements	3-0-0	3
CY 232	Chemical Kinetics	3-0-0	3
CY 272	Organic Chemistry Laboratory	0-0-3	2
CY 311	Concerted Reactions	3-0-0	3
CY 322	Supramolecular Chemistry	3-0-0	3
CY 413	Spectroscopic Methods of Analysis	3-0-0	3
CY 431	Chemistry of Nanomaterials	3-0-0	3
CY 432	Introduction to Nanobiotechnology	3-0-0	3
CY 511	Stereochemistry and Reaction Mechanism.	3-1-0	4
CY 512	Structure and Functions of Biomolecules	3-1-0	4
CY 514	Environmental Chemistry.	3-1-0	4
CY 515	Spectroscopic Methods of Analysis	3-0-0	3
CY 516	Industrial Organic Chemistry	3-0-0	3
CY 517	Chemistry of Natural Products	3-0-0	3
CY 518	Polymer Chemistry	3-0-0	3
CY 519	Methods in Organic Synthesis	3-0-0	3
CY 521	Principles of Inorganic Chemistry	3-1-0	4
CY 522	Chemistry of Transition & Non-transition Elements.	3-1-0	4
CY 523	Industrial Inorganic Chemistry	3-0-0	3
CY 524	Group Theory and Molecular Orbitals	3-0-0	3
CY 525	Advanced Co-ordination Chemistry	3-0-0	3
CY 526	Bio-inorganic Chemistry	3-0-0	3
CY 527	Supramolecular Chemistry	3-0-0	3
CY 531	Thermodynamics & Chemical Equilibria.	3-1-0	4
CY 532	Chemical Kinetics	3-1-0	4
CY 533	Quantum Chemistry	3-1-0	4
CY 534	Principles of Heterogeneous Catalysis	3-0-0	3
CY 535	Electrochemistry	3-0-0	3
CY 536	Colloids and Surface Chemistry	3-0-0	3
CY 537	Advanced Solid State Chemistry	3-0-0	3
CY 538	Molecular Spectroscopy	3-0-0	3
CY 539	Biophysical Chemistry	3-0-0	3
CY 541	Chemistry of Heterocyclic Compounds	3-0-0	3
CY 542	Pericyclic Reactions and Photochemistry	3-0-0	3
CY 543	Molecular Rearrangement	3-0-0	3
CY 544	Instrumental Methods of Analysis	3-0-0	3
CY 558	Organometallic Chemistry	3-0-0	3
CY 571	Organic Chemistry Laboratory	0-0-9	6
CY 572	Inorganic Chemistry Laboratory	0-0-9	6

CY 573	Physical Chemistry Laboratory	0-0-9	6
CY 574	Environmental Chemistry Laboratory	0-0-9	6
CY 581	Special Topics in Chemistry – I	3-1-0	4
CY 582	Special Topics in Chemistry – II	3-1-0	4
CY 583	Special Laboratory in Chemistry – I	0-0-3	2
CY 584	Special Laboratory in Chemistry – II	0-0-3	2
CY 591	Research Project-I	0-0-6	4
CY 592	Research Project – II.	0-0-9	6
CY 593	Seminar & Technical Writing-I	0-0-3	2
CY 594	Seminar & Technical Writing-II	0-0-3	2
CY 595	Short term Industrial/ Research Experience	0-0-0	2
CY 596	Comprehensive Viva-voce	0-0-0	2

CY 101	CHEMISTRY	4 Credits [3-1-0]
---------------	------------------	--------------------------

Electrochemistry : Electro chemical cells, galvanic cells, general equation for emf of cells, Electrode potentials and its relevance to oxidation and reduction, measurement of EMF, determination of PH, dry cells, fuel cells and storage battery ; Metallic Corrosion : Types of corrosion, mechanism of corrosion, Galvanic corrosion, principle of corrosion control; Introduction to Polymer Chemistry : Introductory concepts, definition, common system chemistry and classification of polymers, resins, rubber, plastics. Characterization: molecular weight studies and molecular weight distribution. Mechanistic aspects: addition, ionic, condensation polymerization, polymerization techniques; Atomic Structure - Wave-particle duality and principle of Indeterminacy, Schrodinger wave equation, atomic orbitals, degeneracy, radial and angular dependence of hydrogen orbitals and probability distribution, Spectroscopy and Instrumentation :Introduction, basic principles and instrumentations of rotational, vibrational, electronic spectroscopy. Chemical Kinetics- First and Second order reactions, Determination of a reaction. Consecutive, concurrent and chain reactions. Influence of rate constant. Theory of reaction rate. Principles of Organic chemistry: Inductive effects, resonance, homolytic and heterolytic fission of covalent bonds, reaction intermediates, addition, elimination and substitution reactions. Principles of catalysts and catalysis, industrial and biocatalysis.

Essential Reading:

1. S. Glasstone , *Text Book of Physical Chemistry*, MACMILLAN 1974.
2. T. W. Graham Solomon, C. B. Fryhle, *Organic Chemistry*, John-Wiley and Sons, 2004.
3. C. N. Banwell and E. M. McCash, *Molecular spectroscopy*, Tata McGraw-Hill, 7th reprint, 1999.

Supplementary Reading:

1. G. N. Mukherjee and A. Das, *Elements of Bioinorganic Chemistry*, U. N. Dhar and Sons Pvt. Ltd., Kolkata, Revised Second Edition, 2002.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, *Inorganic Chemistry, Principles of structure and reactivity*, Harper Collins 1993.
3. Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, Oxford, 2001.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of physical Chemistry*, Shoban Lal Nagin Chand & Co., 2001.

CY 170	CHEMISTRY LABORATORY	2 Credits [0-0-3]
---------------	-----------------------------	--------------------------

LIST OF EXPERIMENTS

1. Determinations of hardness of water.
2. Determinations of percentage purity of lime stone sample.
3. Determinations of dissolved oxygen in water.
4. Determinations of sodium carbonate & sodium bicarbonate in a mixture.
5. Determinations of sodium carbonate & sodium hydroxide in a mixture.
6. Determinations of iron content in a sample.
7. Determinations of chloride content of water.
8. Determinations of proximate analysis of coal.
9. Determinations of carbon residue of an oil by conradson's apparatus.

- Determinations of flash point of an oil by penskymartein's closed cup flash point apparatus.
- Determinations of viscosity of an oil by redwood viscometer.
- Determination of Dissociation constant of weak acids by conductometric Titration.
- Determination of pH of an electrolyte by potentiometric Titration.

Essential Reading:

Material supplied in the laboratory.

CY 211	NAME REACTION & REARRANGEMENTS	3 Credits [3-0-0]
---------------	---	--------------------------

Name reactions in organic synthesis : Demijanov, Pinacol-Pinacolone rearrangement, Favorski Rearrangement, Fries rearrangement, Wagner-Meerwein Rearrangement, Benzil-Benzilic Acid Rearrangement, Beckmann Reaction, Curtius, Schmidt, Lossen and Wolff Reaction, Cope Reaction, Chugev Reaction, Perkin, Stobb, Hofmann, Reimer-Tiemann, Reformatsky, Grignard reaction, Diels-alder reaction, Aldol Condensation, Claisen condensation, Dieckmann condensation, Claisen rearrangement, Friedel-craft reaction, Witting reaction, Meerwein-Pondroff-Verley and Birch reduction, Clemmenson reduction, Wolf-kishner reduction.

Essential Reading:

- A. R. Parikh, H. Parikh and K. Parikh, *Name reactions in Organic Synthesis*, Foundation Books, 2006.
- S. N. Sanyal, *Reactions, Rearrangements and Reagents*, Bharati Bhawan, 2000.

Supplementary Reading:

- J. J. Li, *Name reactions in organic synthesis*, 3rd Edition, SPRINGER 2006.
- M. Smith, *Organic Synthesis*, Mc Graw Hill, 2nd Ed. 2004.

CY 232	CHEMICAL KINETICS	3 Credits [3-0-0]
---------------	--------------------------	--------------------------

Chemical Kinetics : Methods of determining rate laws. Mechanisms of photochemical, chain and oscillatory reactions. Collision theory of reaction rates; steric factor, treatment of unimolecular reactions. Theory of absolute reaction rates, comparison of results with Eyring and Arrhenius equations, ionic reactions; salt effect. Homogeneous catalysis and Michaelis – Menten kinetics; heteroge – neous catalysis. Kinetics in the excited electronic states : Laws of light absorption, Photoelectric effect, photo chemical equivalence, fluorescence, Phosphorescence, Chemiluminiscence, Photosensitization, pre-dissociation and quantum efficiency of photochemical reaction, photodissociation. Isomerisation and cycloaddition, Flash phtolysis, Chemistry of vision.

Essential Reading:

- M. R. Wright, *An Introduction to Chemical Kinetics*, John Wiley & Sons, 2005.
- J. Raja Ram, and J. C. Kuriacose, *Kinetics and Mechanism of Chemical Transformations*, MacMillan Indian Ltd., New Delhi, 1993.

Supplementary Reading:

- R. I. Masel, *Chemical Kinetics & Catalysis, Wiley-Interscience*; 1st Edition, 2001.
- K. K. Rohatgi, S. Mukherjee, *Fundamentals of Photochemistry*, Wiley, New York, 3rd Edition, 1978.

CY 272	ORGANIC CHEMISTRY LABORATORY	2 Credits [0-0-3]
---------------	-------------------------------------	--------------------------

Elemental Analysis of Organic Compounds (C, H, N, O, S) Identification of organic compounds having at least two functional groups. Estimation: Nitrogen, Carbon and hydrogen, Spectrophotometric analysis of Keto group Synthesis of Aspirin and methylorange and check its purity by paper chromatography and extinction coefficient measurement.

Essential Reading:

1. V. K. Ahluwalia and R. Aggarwal, *Comprehensive practical organic chemistry*, University press 2000.
2. A. Sethi, *Systematic Lab Experiments in Organic Chemistry*, New Age International Publishers, 2003.

Supplementary Reading:

1. B. S. Furniss, *Vogel's Text Book of Practical Organic Chemistry*, ELBS Longman, 5th edition, 1996.

CY 311	CONCERTED REACTIONS	3 Credits [3-0-0]
---------------	----------------------------	--------------------------

Molecular orbitals and symmetry operations; Pericyclic reactions, Frontier orbital approach, Aromatic transition state approach (Huckel and Mobius systems) Woodward Hofmann rule for pericyclic reactions); Electrocyclic Reactions, correlation diagram; Cycloaddition reaction, [4+2]-cycloaddition reaction (Diels-Alder reaction), regioselectivity of Diels-Alder reaction, [2+2]-cycloaddition reaction; 1,3 dipolar cycloaddition reaction; Sigmatropic reactions : Orbital description, [1,5], [2,3], [3,3] sigmatropic rearrangement, Claisen rearrangement, Cope rearrangement.

Essential Reading:

1. T. L. Gilchrist and R. C. Storr, *Organic Reactions and Orbital Symmetry*, Cambridge University Press, 1972.
2. I. Fleming, *Frontier Orbitals and Organic Chemical Reactions*, Wiley, 1976.

Supplementary Reading:

1. B. B. Woodward and Hoffman, *Conservation of Orbital Symmetry*, Verlag Chemie Academic Press, 1971.
2. M. Smith, *Organic Synthesis*, Mc Graw Hill, 2nd Ed. 2004.

CY 322	SUPERMOLECULAR CHEMISTRY	3 Credits [3-0-0]
---------------	---------------------------------	--------------------------

From molecular to supramolecular chemistry: factors leading to strong binding, hydrogen bonding and stacking interactions. Molecular models of biological receptors, biomimetic chemistry, design, synthesis and binding studies of synthetic receptors. Metal guided self assembly reactions, molecular knot with double helical complexes of Cu(I). Self assembly of polynuclear metal complexes. New molecular receptors: crown ethers, siderophores, cyclophanes, cyclodextrin and their application in specific recognition processes. Anion coordination chemistry and recognition. Supramolecular reactivity and catalysis, supramolecular devices.

Essential Reading:

1. J.W. Steed, J. L. Atwood, *Supramolecular Chemistry*, John Wiley, 2000.
2. H. W. Roesky, *Rings, Clusters & Polymers of the main group & Transition Elements*, Elsevier, 2003.

Supplementary Reading:

1. P. Beer, P. Gale and D. Smith, *Supramolecular Chemistry*, Oxford Chemistry Primers, 1999.
2. J. M. Lehn, *Supramolecular Chemistry*, VCH, New York, 1973.

CY 413	SPECTROSCOPIC METHODS OF ANALYSIS	3 Credits [3-0-0]
---------------	--	--------------------------

General introduction to electromagnetic spectrum and molecular spectroscopy, spectroscopy, spectrometry, and spectrum, Nature of electromagnetic radiation and spectrum, Absorption of electromagnetic radiation by organic molecule. Types of molecular energy and molecular spectroscopy. IR, Basic theory and instrumentation, important useful term of IR spectroscopy, few simple application UV-Visible, Basic concepts and instrumentation Mass Spectroscopy, Principle, Instrumentation, Problem involving these techniques for structural determination other application.

Essential Reading :

1. D. C. Pavia, G. M. Lampman, G. S. Kriz, *Introduction to Spectroscopy, 3rd Edition*, THOMSON, 2007.
2. J. Mohan, *Organic Spectroscopy*, Narosa Publishing House, 2004

Supplementary Reading:

1. B. H. Williams, I. Flemming, *Spectroscopy Methods in Organic Chemistry*, McGraw Hill, 2005.
2. Bessler and Silverstein, *Spectroscopy of Organic Compounds*, JOHN WILEY, 2001.

CY 431	CHEMISTRY OF NANOMATERIALS	3 Credits [3-0-0]
---------------	-----------------------------------	--------------------------

Introduction to Nanoparticles and Nanotechnology, Methods of Preparation, top down and bottom up approach, Characterization methods, Properties and size effect of nanomaterials, electrical, Mechanical, Magnetic, Optical and catalytic properties, Applications of nanotechnology in industry.

Essential Reading:

1. G. Ozoin, *Nanochemistry: A Chemical approach to nanomaterials*, Springer-Verlag, 2005.
2. C. N. R Rao, A. Muller, A. K Cheetham, *Nanomaterials Chemistry*, Wiley-VCH, 2007.

Supplementary Reading:

1. M. Hosokawa, K. Nogi, M. Naito, Y. Yokoyama, *Nanoparticles Technology Handbook*, Elsevier, 2007.

CY 432	INTRODUCTION TO NANOBIO TECHNOLOGY	3 Credits [3-0-0]
---------------	---	--------------------------

Introduction to nanomaterials, nanobiotechnology, nanoparticle production by microbes, DNA and Protein based nanostructures, Application of nanoparticles in Biological Detection, gold nanoparticle conjugates, Application of luminescent quantum dots in biological imaging, Emerging Nanotechnologies: nano labels, biosensors, medicines.

Essential Reading:

1. C. M. Niemeyer and C. A. Mirkin, *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley Interscience Publications, 2005.
2. M. A. Stroschio and M. Dutta, *Bioelectric Engineering Vol II, Biological nanostructures and Applications of Nanostructures in Biology: Electrical, Mechanical, and Optical Properties*, Kluwer academic publications, 2000.

Supplementary Reading:

1. C. A. Mirkin and C. M. Niemeyer *Nanobiotechnology II: More Concepts and Applications*, Wiley Intersciences Publications, 2008.

CY 511	STEREOCHEMISTRY AND REACTION MECHANISM	4 Credits [3-1-0]
---------------	---	--------------------------

Stereochemistry : Classification, racemic modification, molecules with one, two or more chiral centres; Configuration nomenclature, D L, R S and E Z nomenclature, conformations and stability of cyclohexanes (mono-, di-, and trisubstituted), cyclohexenes, cyclohexanones. Reaction intermediates, Carbocation, carbanion, Free radicals and carbene and nitrene (generation, structure, stability and reactions). Substitution Reaction: Classification, Aliphatic nucleophilic substitution reaction: S_N1 , S_N2 , S_Ni reactions, solvent effect, neighboring group participation reactions. Aromatic Nucleophilic substitution reactions, benzyne mechanism. Aliphatic Electrophilic substitution reactions, aromatic electrophilic substitution reaction, orientation and reactivity in substituted benzene ring ortho-para ratio. Addition to Carbon, Carbon Multiple Bonds, addition to carbon-hetero multiple bonds. Electrophilic, nucleophilic and free radical addition reactions. Elimination Reactions E1, E2 and E1cB mechanisms. Stereospecificity, regioselectivity and stereoselectivity of elimination reactions. Relative reactivity of diastereoisomers in ionic elimination, intermolecular rearrangements and neighboring group participation reactions.

Essential Reading:

1. J. March, *Advanced Organic Chemistry: Reactions Mechanism and Structure* , 4th Ed., John-Wiley and Sons, 1999.
2. J. Wade and S Singh, *Organic Chemistry*, 6th Ed, Pearson Edu.(LPE), 2006.

Supplementary Reading

1. Clayden, Greeves, Warren and Wothers, *Organic Chemistry*; Oxford, 2001.
2. J. M. Coxan, *Principles of Organic Synthesis*, 3rd Ed. Thomson Science, 1998.

CY 512

STRUCTURE AND FUNCTIONS OF BIOMOLECULES

4 Credits [3-1-0]

Carbohydrates: Ring and open chain structure of glucose and fructose. Reactions of glucose and fructose. mutarotation. Inter conversion reactions- aldose to ketose, ketose to aldose, chain elongation and chain degradation, epimerization. Disaccharides: sucrose, Lactose, cellobiose, Reducing and non-reducing sugars, Polysaccharide: Starch, glycogen, Cellulose and Chitin, analysis of carbohydrates. Aminoacids, Proteins and nucleic acid: Proteins (*structure and functions*): Amino acids, structural features, optical activity, essential and non-essential amino acids, iso-electric point, synthesis and chemical properties of α amino acids. Peptides and it's structure determination. Polypeptides or proteins: classifications, primary, secondary, tertiary and quaternary structure of proteins, glycoproteins, denaturation and folding, enzymes. Nucleic acids: Nitrogenous base and pentose sugars, Nucleosides, nucleotides, Chemical and enzymatic hydrolysis, structure and functions of nucleic acids; DNA, RNA (m-RNA, t-RNA, r-RNA), an overview of gene expression (replication, transcription and translation), genetic code (origin, Wobble hypothesis and other important features), genetic errors, Central dogma, Protein synthesis.

Essential Reading:

1. D. L. Nelson and M. M. Cox, *Lehninger Principles of Biochemistry*, W. H. Freeman publisher, 4th Ed, 2004.
2. T. K. Lindhorst, *Essentials of Carbohydrate Chemistry and Biochemistry* (Wiley-VCH), 2nd Revised Edition, 2003.

Supplementary Reading:

1. U. Satyanarayan , *Biochemistry*, New Central Book Agency, 3rd ed., 2006.
2. L. Stryer, J. Berg, J. L. Tymoczko , *Biochemistry*, W.H. Freeman Publisher, 6th Ed., 2006.

CY 514

ENVIRONMENTAL CHEMISTRY

4 Credits [3-1-0]

Chemistry of Environment : Environmental segments, atmospheric structure Chemistry of lower and upper atmosphere, radiation balance of earth .Major air pollutant, sources and their effect. Green house effect, acid rain, depletion of ozone layer, global warming .Air pollution abatement technology. Chemistry of water environment: Classification of water pollutants, characteristics of waste water, water quality parameters and their measurements. Waste water treatment: preliminary, primary, secondary, tertiary treatment . Waste water from some typical industries ,sources, characteristics , effect and treatment option: textiles, refinery, leather, foods, sugar, fermentation, paper and pulp ,fertilizer ,soap and detergents , electroplating and pharmaceuticals. Solid waste disposal and management: classification and origin, methods of solid waste disposal. Microbiology involved in solid waste disposal. Soil pollution :Chemical composition of the soil, the exploitation of the mineral resources and abuse of the earth, soil pollution due to natural and artificial agencies and its effects, remedial measures to check the pollution. Energy and Environment: Energy sources, renewable and non-renewable, primary and secondary fossil fuels, their occurrence and estimation of reserves.

Essential Reading:

1. Mani Vasakam, *Physico Chemical Examination of Water, Sewage and Industrial effluents*, Pragati, 1991.
2. A. K. Dey, *Environmental Chemistry*, Wiley Eastern, 2002.

Supplementary Reading:

1. L.T. Pryde, *Environmental Chemistry – An Introduction*, MenloPark, 1973.
2. *Environmental Chemistry: A Global Prospective*, Oxford University, 2000.

CY 515 SPECTROSCOPIC METHODS OF ANALYSIS**3 Credits [3-0-0]**

General introduction to electromagnetic spectrum and molecular spectroscopy, spectroscopy, spectrometry, and spectrum, Nature of electromagnetic radiation and spectrum, Absorption of electromagnetic radiation by organic molecule. Types of molecular energy and molecular spectroscopy: IR, Basic theory and instrumentation, Important useful term of IR spectroscopy, Frequency variation with force constant, Special features of major Functional Groups. application of IR. UV-Visible, Basic concepts and instrumentation. Factors affecting the position of UV bands, Characteristic absorption of Organic compounds, Application of UV spectroscopy. NMR, Spin active nuclei, orientation of spinning nuclear magnets, chemical shift, factor affecting the chemical shift, Spin-spin splitting theory, application of NMR spectroscopy. Mass Spectroscopy, Principle, Instrumentation, General methods of fragmentation, interpretation and application of mass spectra. Problem involving these techniques for structural determination, Recent development in the above field.

Essential Reading:

1. Bessler and Silverstein, *Spectroscopy of Organic Compounds*, John Wiley, 2001.
2. D. C. Pavia, G. M. Lampman, G. S. Kriz, *Introduction to Spectroscopy*, 3rd Edition, THOMSON, 2007

Supplementary Reading:

1. J. Mohan, *Organic Spectroscopy*, Narosa Publishing House, 2004.
2. B. H. Williams, I. Flemming, *Spectroscopy Methods in Organic Chemistry*, McGraw Hill, 2005.

CY 516 INDUSTRIAL ORGANIC CHEMISTRY**3 Credits [3-0-0]**

Basic products of industrial syntheses, chemicals from natural gases, petrochemicals and coal; chemicals of industrial importance: olefins, diolefines, acetylene, halocompounds, alcohols, aromatics, amides, polyamides, organic reactions in industrial synthesis (oxidation, hydration, hydrogenation, dehydrogenation, hydroformylation and polymerization) fermentation technology, polymers, thermoplastics, thermosetting resins, polymerization techniques, polymer characterization, polymer degradation, paints, pigments and coating.

Essential Reading:

1. K. Weissert, H. I. Arpe, C. R. Lindley, *Industrial Organic Chemistry*, 4th Edition, Wiley-Interscience 2003.
2. A. Wittcoff, B. G. Reuben, and J. S. Plotkin, *Industrial Organic Chemistry*, 2nd Edition, Wiley-Interscience, 2004.
3. F. W. Billmeyer, *Text book of Polymer Science*, John Wiley and Sons Publication, 3rd Edition, 1984

Supplementary Reading:

1. K. Weissert, H. J. Prpe; *Industrial Organic Chemistry*, Wiley-VCH, 2002.

2. P. J. Chenier, *Survey of Industrial Chemistry*, 3rd Edition, Springer, 2002.

CY 517 CHEMISTRY OF NATURAL PRODUCTS

3 Credits [3-0-0]

Alkaloids: Introduction, Occurrence and isolation, function of alkaloids in plant, general properties, nomenclature, and classification of alkaloids. Isolation, properties and structural elucidation of Quinine, Morphine: (structure, synthesis, molecular re-arrangement, stereo chemistry and bio-genesis). Steroids: Introduction, nomenclature of steroids, absolute configuration of steroid. Occurrence, isolation, Structure elucidation, and chemical properties of Cholesterol. Terpenoids: Introduction, isolation, and classification of terpenoids. General properties, structure determination of Citral and Camphor. Vitamins: Introduction, chemical properties and structure elucidation of vitamin A, Vitamin B, Ascorbic Acid and Vitamin D.

Essential Reading:

1. S. V. Bhat, B. A. Nagaramgagi, M. Srikumar, *Chemistry of Natural Products*, Alpha Science International Ltd, 2005.
2. O. P. Agarwal, *Chemistry of Natural Products*, Vol- 1 &Vol-2, Goel publishing House, 1989.

Supplementary Reading:

1. K. C. Nicolaou, T. Montagnon, *Molecules that changed world*, Wiley-VCH, 1st Ed., 2008.
2. J. R. Hanson, *Natural Products: the secondary metabolites*, Royal society of Chemistry, 2003.

CY 518 POLYMER CHEMISTRY

3 Credits [3-0-0]

Introductory concepts, definition, common system chemistry and classification of polymers, synthetic and natural polymers, types of polymerization, addition, condensation, co-ordination and ring opening polymerization, Preparation, properties and uses of some important thermoplastic (i.e. PE, PVC, Teflon, PS, PMMA) and thermosetting resins (i.e. Phenolic resin, Amino resin and Epoxy resin), natural and synthetic rubbers, Fibers (i.e. Nylons, PAN, Polyurethanes). Polymer Characterization: molecular weight studies and molecular weight distribution, polydispersive index, determination of molecular weight of polymers. Polymer behavior, crystalline and thermal behavior, Glass transition temperature, factor influencing glass transition. Polymerization techniques: bulk, solution, emulsion, and suspension polymerization, polymer colloids and polymer solution. Thermodynamics aspect of Polymerization, Stereo Chemistry and mechanism of polymerization: free radical, cationic and anionic polymerization. Relevant aspects of physical properties of polymer systems, rheological properties, polymer processing, processing techniques i.e. molding, casting, extrusion and, calendaring techniques. Polymer degradation and stabilization, biological degradation of polymers. Polymers & environments, environmental pollution by polymers.

Essential Reading:

1. J. W. Nicolson, *The chemistry of polymers*, RSC publishing, 3rd Ed., 2006
2. P. Bahadur and N.V. Sastry, *Principles of Polymer Science*, Norosa Publication, 2nd Edition, 2005.

Supplementary Reading:

1. F. W Billmeyer, *Text book of Polymer Science*, Johns Wiley and sons Publication, 3rd Edition, 1984

2. I. M. Cambell, *Introduction to synthetic polymer*, Oxford university press, 2nd Ed., 2000.

CY 519 METHODS OF ORGANIC SYNTHESIS

3 Credits [3-0-0]

The disconnection approach, chemoselective synthesis, C-C bond forming reactions, organometallic reagents in organic synthesis: Grignard reagents, organolithium reagents, organocadmium reagents, organocopper reagents, organosilicon compounds, organotin compounds, organoaluminum compounds, organoiron compounds, organochromium reagents, ylides of sulfur, phosphorous and nitrogen. Tebbe's reagent. Enolates, kinetic and thermodynamic enolates, enolate condensation reactions like Claisen, Dieckmann, Knoevenagel, Stobbe, Darzen glycidic ester. Umpolung reagents, definition of umpolung, acyl anion equivalent, equivalents of ketene, RCOCH_2^+ , $\text{RCOCH}_2\text{CH}_2\text{CH}_2^+$, $\text{RCOCH}_2\text{CH}_2\text{CH}_2^-$ etc. Protecting groups: protection of hydroxyl, carboxyl, carbonyl, amino groups. Protection of carbon-carbon multiple bonds. Illustration of protection and deprotection in synthesis.

Essential Reading:

1. S. Warren, *Organic Synthesis: The Disconnection Approach*, Wiley Student Ed. 2007
2. F. A. Carey and R. I. Sundberg, *Advanced Organic Chemistry, Part A and B*, 3rd edition, Plenum Press, 1990.
3. Michael B. Smith, *Organic Synthesis*, McGraw Hill, 2004.

Supplementary Reading:

1. S. Warren, *Designing Organic Synthesis*, John Wiley, 1978
2. S. G. Davies, *Organotransition Metal Chemistry, Application to Organic Synthesis*, Pergamon Press, 1982.
3. R. K. Mackie and D. M. Smith, *Guidebook to Organic Synthesis*, ELBS, 1982.

CY 521 PRINCIPLES OF INORGANIC CHEMISTRY

4 Credits [3-1-0]

Modern view of atomic structure, wave mechanical description of electron and orbital. Covalent Bond: The natures of covalent bond, resonance, formal charge, overlap of atomic orbital, partial ionic character of a covalent bond, electronegativity, electron affinity, polarization. VBT/VSEPR, inert pair effect, diagonal relationships. Molecular Orbital Treatment: Hydrogen molecule ion, molecular orbital of diatomic molecules like H_2 , N_2 , O_2 , F_2 , CO and NO . Hydrogen bond & Vander wall force bond. Acid-base theories: Bronsted, Lewis and Lux-Flood theories, HSAB model. Theories of Metal-Ligand bonding and stereochemistry: Valency bond theory, crystal field theory, tetrahedral, octahedral complexes, spinels. Chemistry of selected Inorganic Compounds: Acyclic & cyclic ring systems, boranes, carboranes, silicones, phosphazens etc.

Essential Reading:

1. M. Chanda, *Structure and Chemical bond*, Tata McGraw Hill Atomic Edition, 2000.
2. Cotton and Wilkinson, *Advanced Inorganic Chemistry*, Wiley Eastern, 1976.

Supplementary Reading:

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, *Inorganic Chemistry, Principles of structure and reactivity*, Harper Collins 1993.
2. D. F. Shriver, P. W. Atkins and C. H. Langford, *Inorganic Chemistry*, Oxford University Press, 1990.
3. N. N. Greenwood and E. A. Earnshaw, *Chemistry of Elements*, Pergaman Press, 1984.

**CY 522 CHEMISTRY OF TRANSITION AND NON- TRANSITION 4 Credits [3-1-0]
ELEMENTS**

d-block Elements : Introduction, chemistry of titanium group elements, technetium and Rhenium, Metal carbonyls : Preparation, properties and bonding of iron, cobalt and nickel carbonyls, general treatment of isopoly molybdates and vanadates. heteropoly acids. Cages & clusters of elements, structural variety, properties and implications of borides, carbides, silicides, nitrides, phosphides, oxides and sulphides of transition elements, multiple bonds and cluster variety of transition metals. Structure, synthesis and reactions of boranes, carboranes and metalloboranes. f-block Elements : Chemistry of lanthanides, position in the periodic table. Electronic configuration, oxidation states, color paramagnets, lanthanide contraction general methods of extraction. Actinides : Electronic structure, ionic radii, oxidation state, spectra and paramagnetic properties of actinides elements, Actinide hypothesis, chemistry of uranium and thorium, isolation of neptunium, plutonium and americium and their aqueous chemistry, introduction to transamericium elements.

Essential Reading:

1. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann ,*Advanced Inorganic Chemistry*, 6th Edition Wiley, Chichester, 1999.
2. D. F. Shriver, P. W. Atkins and C. H. Langford, *Inorganic Chemistry*, Oxford University press, 2002.

Supplementary Reading:

1. A. Kettle, *Physical Inorganic Chemistry*, Freeman, N.Y., 1996.
2. N. N. Greenwood and A. Earnshaw, *Chemistry of the Elements*, 2nd ed Butterworth-Heinman, London, 1997.
3. Cotton, *Lanthanide and Actinide Chemistry*, John Wiley & Sons, 2006.

CY 523 INDUSTRIAL INORGANIC CHEMISTRY 3 Credits [3-0-0]

Introduction to chemical industry, Industrial Gases: carbon dioxide, carbon monoxide, sulphur dioxide, hydrogen, oxygen, nitrogen, rare gases of the atmosphere, coal gas, water gas, manufacture of producer gas. Manufacture of ammonia, urea, nitric acid, calcium ammonium nitrate, cement, glasses, carbon black, abrasives, fertilizers, pulp and paper. Zeolites, Surface active agents, High purity electronic materials, explosives and propellants, extraction of iron, aluminium, copper, tin, lead from ores. Application of catalysis in industry.

Essential Reading:

1. H. L. White, *Introduction to Industrial Chemistry*, Wiley-Interscience, 1986.
2. P. J. Chenier, *Survey of Industrial Chemistry*, 3rd Ed. Springer, 2002.

Supplementary Reading:

C. A. Clausen and G. Mattson, *Principles of Industrial Chemistry*, Wiley-Interscience, 1978.

CY 524 GROUP THEORY AND MOLECULAR ORBITALS 3 Credits [3-0-0]

Groups, sub-groups, cosets, classes, symmetry elements and symmetry operations. Matrix formulation of group theory (Idea of matrix multiplication, inverse, trace, diagonalisation, eigen

values and eigen vectors should be given). Classification of point groups (and octahedral group are to be discussed). Molecular orbitals : Hydrogen like orbitals, Molecular orbital calculation Electronic energy levels. The LCAO method, Overlap and Coulomb Integrals. Solution of problems dealing with bicyclobutadiene, butadiene pentene and toluene. Bond order, free valance index, charge distribution, mobile bond order, self consistent field and length. Aromaticity rule, Application of group theory to simplification of M.O.determination.

Essential Reading:

1. A. Vincet, *Molecular symmetry and Group Theory*, John-Wiley & Sons, 1977.
2. F. A. Cotton, *Chemical Applications of Group Theory*, Wiley Eastern, 1991.
3. M. S. Gopinathan and V. Ramakrishnan, *Group Theory in Chemistry*, Vishal Publishers, 1988.

Supplementary Reading:

1. J. D. Roberts, *Notes on M.O.Calculation*, McGraw Hill, 1990.
2. A. Streitweiser, Jr *Molecular Orbital for Organic Chemistry*, John Wiley & Sons, 1991.
3. Raj and Jain, *Group Theory and Symmetry in Chemistry*, Wiley Estern, 1992.
4. David M. Bishop, *Group theory and Chemistry*, Dover, 1989.

CY 525 ADVANCED CO-ORDINATION CHEMISTRY

3 Credits [3-0-0]

Theories of metal-ligand bonding, Crystal field theory with respect to octahedral, tetrahedral and square planner, regular symmetry, distortion from regular system, John Teller effect. Ligand field theory. Spectral Properties : Selection rule, mechanism for breakdown of selection rule, absorption band width & shape, energy level diagrams, derivation of term symbols, nephelauxetic effect, Orgel and Tanabe-Sugano diagrams. Charge transfer spectra, Magnetic properties of complexes, Isomerism and stability of metal complexes. Mechanism of Inorganic Substitution Reactions : The nature of substitution reactions, Kinetic application of crystal field theory, Acid hydrolysis of octahedral cobalt Complexes, Effect of charge, chelation, steric crowding in determining the mechanism. Base hydrolysis of octahedral cobalt complexes: Conjugate base and ion pair mechanisms, tests for conjugate base mechanisms. Mechanism of redox reactions. Mixed valence complexes. Modern aspects of crystal field theory, molecular orbital theory and valence bond methods applied to chemical, optical and magnetic properties of coordination compounds.

Essential Reading:

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemsitry: Principles of Structure and Reactivity*, Pearson, 2006.
2. J. D. Lee, *Concise Inorganic Chemistry*, Blackwell Science, 1996

Supplementary Reading:

1. D. J. Newman, Betty, *Crystal Field*, Science, 2000
2. Emeleous & Sharpe, *Inorganic Chemistry*, Longman,1981.

CY 526 BIO- INORGANIC CHEMISTRY

3 Credits [3-0-0]

Metal ions in biology, their vital role in the active-site structure and function of metallo-proteins and enzymes especially those containing Mg, Ca, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Mo and W ions. Both heme and non-heme systems with one-, two- or multi-metal centers (e.g., Fe: Hb,

Mb, Hr, P-450, MMO, ferridoxins, Fe-S clusters: Cu: hemocyanin, SOD, Mn: vitamin B12; Zn: CPA, CA, Ni: urease will also be highlighted. Focus will be on the metal environment (ligand type, coordination, geometry), electronic, magnetic and redox properties; functions such as electron - transfer, O₂-binding, reduction to O₂⁻, O₂²⁻, and O₂⁻ species their utilization in hydroxylation and epoxidation; fixation of N₂, water-oxidation (Oxygen Evolving Complex) reactions.

Essential Reading:

1. G. N. Mukherjee and A. Das, *Elements of Bioinorganic Chemistry*, U.N. Dhar and Sons Pvt. Ltd., Kolkata, Revised Second Edition, 2002.
2. S. J. Lippard, and J. M. Berg, *Principles of Bioinorganic Chemistry*, Univ. Science Books, 1994.

Supplementary Reading:

1. D. E. Fenton, *Bio coordination Chemistry* (Chemistry Primer 26), Oxford Univ. Press, 1996.
2. L. Bertini, H. B. Gray, S. J. Lippard, and J. S. Valentine, *Bioinorganic Chemistry*, Univ. Science Books, 1994.

CY 527 SUPERMOLECULAR CHEMISTRY

3 Credits [3-0-0]

From molecular to supramolecular chemistry: factors leading to strong binding, hydrogen bonding and stacking interactions. Molecular models of biological receptors, biomimetic chemistry, design, synthesis and binding studies of synthetic receptors. Metal guided self assembly reactions, molecular knot with double helical complexes of Cu(I). Self assembly of polynuclear metal complexes. New molecular receptors: crown ethers, siderophores, cyclophanes, cyclodextrin and their application in specific recognition processes. Anion coordination chemistry and recognition. Supramolecular reactivity and catalysis, supramolecular devices.

Essential Reading:

1. J. W. Steed and J.L. Atwood, *Supramolecular Chemistry*, CRC Press, 2004.
2. H. W. Roesky, *Rings, Clusters & Polymers of the main group & Transition Elements*, Elsevier, 1989.

Supplementary Reading:

1. P. Beer, P. Gale and D. Smith, *Supramolecular Chemistry* (Oxford Chemistry Primers), 1999.
2. J. M. Lehn, *Supramolecular Chemistry*, VCH, 1995.

CY 531 THERMODYNAMICS AND CHEMICAL EQUILIBRIUM

4 Credits [3-1-0]

Thermodynamics : Concept of system, exact differentials. First law of thermodynamics : energy and heat changes, Reversible processes, heat capacities, relation between C_p and C_v, Isothermal and adiabatic process, Joule-Thomson coefficient of ideal and real gases. Thermo Chemistry: Hess Laws, Heat changes of chemical reactions. Kirchoff's equation and its application, Calculation of heat of reaction from bond energy. Second Law of Thermodynamics. Elementary concept of entropy and free energy, Entropy and its variation with temperature, pressure and volume, entropy of mixing, Thermodynamic equation of state. Entropy and heat capacities relationship, Boltzmann-Planck equation for entropy. Work function, Gibb's Helmholtz

equation and its application, Carnot cycle, Heat engine. Third Law of Thermodynamics and its application to solid liquids and gases, Partial Molar Properties, Chemical potential and its variation with temperature and pressure, Fugacity. Chemical Equilibrium: Free energy and entropy, partial molar quantities, Equilibrium constant, Temperature – dependence of equilibrium constant, phase diagram of one – and two – component systems, phase rule.

Essential Reading:

1. G. N. Barrow, *Physical Chemistry*, TATA MCGRAW-HILL, 2007.
2. T. Engel, P.Reid, *Physical Chemistry*, Pearson, 2006.

Supplementary Reading:

1. K. L. Kapoor, *Text Book of Physical Chemistry*, MACMILLAN, 2006.
2. A. W. Atkins, *Physical Chemistry*, W. H. Freeman and Company, 1997.

CY 532 CHEMICAL KINETICS

4 Credits [3-1-0]

Chemical Kinetics : Methods of determining rate laws; Dependence of rate on concentration; Determination of order and rate constant from experimental data; Integrated rate expressions; Collision theory of reaction rates; steric factor, treatment of unimolecular reactions; Modified collision theory; Transition state theory; Chain reactions; Characteristic experimental features of chain reactions; Identification of a chain reaction; Normal and branched chain reactions; Theory of absolute reaction rates, comparison of results with Eyring and Arrhenius equations, ionic reactions; Salt effect; Mechanisms of photochemical, chain and oscillatory reactions; Homogeneous catalysis and Michaelis – Menten kinetics; - Lineweaver-Burk and Eadie plots, Effect of temperature and pH, inhibition effect, transient-phase kinetics, heterogeneous catalysis. Kinetics in the excited electronic states : Jablonskii diagram, Laws of light absorption, kinetics of unimolecular photophysical and photochemical processes, photostationary states, photoisomerisation, bimolecular photophysical and photochemical processes: excimers, exciplexes and sensitisation. Mechanism of fluorescence quenching - Stern - Volmer equation, solar cells, photocatalysis, photosensitization, photo-initiated polymerization, epoxy polymers, photorefractive polymers supramolecules, dendrimers, photochromic compounds, Flash photolysis, Chemistry of vision.

Essential Reading:

1. M. R. Wright, *An Introduction to Chemical Kinetics*, John Wiley & Sons, 2005.
2. K. J. Laidler, *Chemical Kinetics*, Harper and Row, 3rd Edition, 1990.
3. J. Raja Ram, and J. C. Kuriacose, *Kinetics and Mechanism of Chemical Transformations*, MacMillan Indian Ltd., New Delhi, 1993.
4. C. Kalidas, *Chemical Kinetic Methods: Principles of Relaxation Techniques and applications*, New Age International (P), 1996.

Supplementary Reading:

1. Richard I. Masel, *Chemical Kinetics & Catalysis*, Wiley-Interscience; 1st Edition, 2001.
2. K. K. Rohatgi-Mukherjee, *Fundamentals of Photochemistry*, Wiley, New York, 3rd Edition, 2002.
3. M. J. Pilling and P. W. Seakins, *Reaction Kinetics*, Oxford Univ. Press, 2nd Edition, 1996.

CY 533 QUANTUM CHEMISTRY**4 Credits [3-1-0]**

Quantum Chemistry : Planck's quantum theory, wave – particle duality. Uncertainty Principle, operators and commutation relations; postulates of quantum mechanics and Schrodinger equation; free particle, particle in a box, degeneracy, harmonic oscillator, rigid rotator and the hydrogen atom. Angular momentum, eigenvalues of angular momentum operator, ladder operators, orbital and spin motion of electron, coupling of angular momenta including spin-orbit coupling, Time-independent perturbation theory, degenerate states, variational method, Hellmann-Feynman theorem. Spectra and structure of helium atom, term symbols for atoms, Hartree-Fock equations, self-consistent field method and coupling schemes. Born-Oppenheimer approximation, hydrogen molecule ion, hydrogen molecule: valence bond and molecular orbital methods, polyatomic molecules and hybridisation. The concept of groups, symmetry operations and symmetry elements in molecules, matrix representations of symmetry operations, point groups, irreducible representations and character tables.

Essential Reading:

1. R. K. Prasad, *Quantum Chemistry*, New Age International Publishers, 1996.
2. A. K. Chandra, *Introductory Quantum Chemistry*, Tata McGraw Hill, 1979.
3. P. W. Atkins, *Molecular Quantum Mechanics*, 2nd edition, Oxford University Press, 1983.

Supplementary Reading:

1. Eyring, Walter & Kimbel, *Quantum Chemistry*, John Willey, 1953.
2. Fitts, D. Donald, *Principle of Quantum Mechanics*, Cambridge University Press, 1999.
3. D. A. McQuarrie, *Quantum Chemistry*, University Science Books, 1983.
4. I. N. Levine, *Quantum Chemistry*, 3rd edition, Allyn and Bacon, 1983.

CY 534 PRINCIPLE OF HETEROGENEOUS CATALYSIS**3 Credits [3-0-0]**

Basic principles of catalysis, homogeneous and heterogeneous catalysis. Adsorptions: type of adsorption and their discrimination, adsorption isotherms, BDDT classification, surface area and pore size calculation, Enthalpy and entropy of adsorption, Langmuir, BET and other isotherms, Kelvin equation and capillary condensation. Kinetics: Kinetics of catalysed reaction, various types of reactions such as simple, parallel and consecutive reaction, order of reaction, energy of activation. Catalyst preparation: Selection, preparation and evaluation of a catalyst, Effect of promoter, carrier, stabilizer, poisoning effect. Catalyst site characterization: Types of catalyst based on active sites, acid-base and redox catalysts, methods of determination of active sites (titration, TPD, TPR, FTIR etc.). Mechanism of catalyst action: Mechanism of selected reactions on catalyst surfaces such as hydrogenation, dehydrogenation, dehydration, cracking etc. Applications to selected industrial processes- petrochemical industry-reforming and refining, environment protection, value added chemicals, autoexhaust catalysis, pharmaceuticals. Novel nanosize catalysts: Novel nanosize catalytic materials- clusters, zeolites, Mesoporous materials, clays, composite oxides etc.

Essential Reading:

1. M. Thomas and W. H. Thomas, *Introduction to the principles of heterogeneous catalysis*, Academic press, London 2007.
2. G. A. Somorjai, *Introduction to surface chemistry and catalysis*, John Wiley and Sons 2006.

Supplementary Reading:

1. L. Augustine, *Heterogeneous catalysis for the synthetic chemist*. Marcel Dekker Inc., New York, 1996

CY 535 ELECTROCHEMISTRY**3 Credits [3-0-0]**

Inter ionic attraction theory, Derivation of Debye Huckel Onsager's conductance equation, its verifications and modifications and its present trend. Determination of degree of dissociation of electrolyte. Theoretical calculation of activity coefficient from ionic strength by Debye-Huckel theory, Determination of activity coefficient from Freezing Point method, EMF method and solubility method. Ion association, determination of thermodynamic dissociation, constant of weak electrolytes by Shedlovsky method, Reversible cells, chemical and construction cells, Liquid junction potential, single electrode potential, oxidation – reduction electrodes. Determination of (i) dissociation constant of weak monobasic acid (ii) hydrolysis constant of salts (iii) ionic product of water and (iv) solubility product of sparingly spoilable salts by EMF measurements. Factors effecting the EMF of half cells, Determination of pH. Electrode concentration cells, Electrolyte concentration cell. Electrochemical series and its significance., Electrolytic polarization, over voltage.. Factors effecting the EMF of half cells, Determination of pH. Electrode concentration cells, Electrolyte concentration cell. Electrochemical series and its significance.

Essential Reading:

1. S. Glasstone, *Text Book of Physical Chemistry*, MACMILLAN 1974.
2. S. Glasstone, *Introduction to Electrochemistry*, Affiliated East West Press.
3. G.M. Barrow , *Physical Chemistry*, TATA MCGRAW-HILL ,2007

Supplementary Reading:

1. Books and Reddy, *Modern Electrochemistry*, Vol – I .Springer,2000.
2. W.J. Moore, *Physical Chemistry*, Prentice Hall,1993

CY 536 COLLOIDS AND SURFACE CHEMISTRY**3 Credits [3-0-0]**

The colloidal state: Introduction; Classification and colloidal systems; Properties of lyophilic and lyophobic colloidal solutions. Structural characteristics; Preparation and purification of colloidal systems. Kinetic properties: The motion of particles in liquid media; Brownian motion and translational diffusion; Osmotic pressure; Rotary Brownian motion. Optical properties: Optical and electron microscopy; Light scattering; Tyndall effect- turbidity. Liquid-gas and liquid-liquid interfaces; Surface and interfacial tensions; Adsorption and orientation at interfaces; Association colloids-micelle formation; spreading; Surface films and Langmuir-Blodgett films. Properties and aggregation of surfactants; The solid-gas interface: Adsorption of gases and vapours on solids; Capillary condensation; Langmuir adsorption isotherm; BET equation for multimolecular adsorption; Composition and structure of solid surfaces. The solid-liquid interface; Contact angles and wetting; Detergency; Adsorption from solution. Charged interfaces: The electric double layer; Electrokinetic phenomena; Electrokinetic theory. Colloid stability: Lyophobic sols; van der Waals forces between colloidal particles; Measurement systems containing lyophilic material; Stability control. Rheology: Introduction; Viscosity; Non-Newtonian flow; Viscoelasticity. Emulsions and foams: Oil-in-water and water-in-oil emulsions; Emulsifying agents and emulsion type; gels and Foams.

Essential Reading:

1. R. M. Pashley, and M. E. Karaman, *Applied Colloid and Surface Chemistry*, John Wiley & Sons Ltd., 2004.
2. D. Shaw, and B. Heinemann, *Introduction to Colloid and Surface Chemistry*, Butterworth Heinemann, 4th Edition, 1992.

Supplementary Reading:

1. E. D. Shchukin, A. V. Pertsov, E. A. Amelina, and A. S. Zelenev, *Colloid and Surface Chemistry*, Elsevier, 2001.
2. F. Caruso (Editor), *Colloids and Colloid Assemblies: Synthesis, Modification, Organisation and Utilization of Colloid Particles*, Wiley, 2004.

CY 537 ADVANCED SOLID STATE CHEMISTRY

3 Credits [3-0-0]

Introduction, Crystal structure, Crystalline solids, Crystal systems, Metallic structure-Unit cells, Crystallographic directions and planes, linear and planar densities, close-packed crystal structures, Types of close packing-hcp and ccp, packing efficiency, Ceramics structure- radius ratio, structure types-NaCl, ZnS, Na₂O, CdCl₂, wurtzite, nickel arsenide, CsCl, CdI₂, rutile, Perovskite ABO₃ and Spinel AB₂O₄. Material preparation-Solid state reactions, precipitation, sol-gel route, precursor method, Ion exchange reactions, Intercalation/deintercalation reactions, soft chemical reactions and thin film preparation, Method of characterization-Powder X-ray diffraction, electron and Neutron diffraction, Thermal analysis, microscopic and spectroscopic techniques as tools for material characterization, Phase diagram and microstructure analysis-simple binary isomorphous, eutectic and congruent phase diagrams, Electronic properties-Developments, free electron theory, Band Theory, metals and their properties, Semiconductors-intrinsic and extrinsic, Hall Effect, Insulators-dielectric, ferroelectric, pyroelectric and Piezoelectric properties, Magnetic properties-Dia, para, ferro, ferri, antiferro and antiferri materials, Defects and dislocations-Vacancies and interstitials, dislocations and grain boundaries colour centers and reactivity, Amorphous materials-glasses and refractories, Superconductivity-Theory, discovery, various high T_c materials, Novel materials-Zeolites, Heteropoly acids, Mesoporous materials (MCM-41, MCM-48, SBA, TS), fullerenes, carbon nanotubes etc

Essential Reading:

1. A. R. West, *Solid state Chemistry and its applications*, Wiley Student Edition (John Wiley & Sons), 1988
2. C. N. R. Rao and J. Gopal Krishnan, *New directions in solid state Chemistry*, Cambridge press, 1990

Supplementary Reading:

1. A. F. Wells, *Structural Inorganic Chemistry*, Oxford University Press, USA; 5 Edition, 1984.

CY 538 MOLECULAR SPECTROSCOPY

3 Credits [3-0-0]

Interaction of matter with radiation, time dependent perturbation theory, Einstein coefficients. Energy levels and transition probabilities for the rigid rotor - harmonic oscillator model, potential energy surfaces in the ground and excited electronic states, Franck-Condon principle, spectroscopy of diatomic molecules (rotational, vibrational and electronic). Anharmonicity and centrifugal effects, Dunham expansion and Morse oscillator. Rotational and vibrational

spectroscopy of polyatomic molecules, angular momentum operator matrix elements, energy levels and transition probabilities for symmetric and asymmetric top molecules, normal modes of vibration and their classification by group theory. Coupling between rotational and vibrational degrees of freedom : elementary introduction. Electronic spectra of polyatomic molecules : absorption and emission spectroscopy, charge transfer spectra, effect of solvent, Raman spectroscopy, Introduction to Mossbauer, photoelectron nuclear magnetic resonance spectroscopy. Electron Spin Resonance Spectroscopy: Electronic Zeeman and hyperfine interactions, hydrogen atom in a magnetic field, selection rules in ESR, anisotropy and hyperfine constants, hybridization, esr of organic free radicals in solution, McConnell's relations.

Essential Reading:

1. C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, Tata-McGraw-Hill, 1994.
2. P. S. Sindhu, *Fundamentals of Molecular Spectroscopy*, New Age International (p) Limited, 2008.

Supplementary Reading:

1. Peter F. Bernath, *Spectra of Atoms and Molecules*, Oxford University Press, 1995.
2. J. M. Hollas, *Modern Spectroscopy*, Wiley, 1992.
D. C. Harris and M. D. Bertolucci, *Symmetry and Spectroscopy*, Dover, 1989.

CY 539 BIOPHYSICAL CHEMISTRY

3 Credits [3-0-0]

Hydrophobic and hydrophilic interactions in biological systems, biological relevance of chemical potential, protein solvent interactions-binding, hydration and exclusion, protein structure, stability, folding, unfolding and their spectroscopic and calorimetric studies. Protein ligand binding, equilibria across membranes, structure-function relationships.

Essential Reading:

1. R. B. Gregory, *Protein solvent interactions*, Marcel Dekker, Inc. 1995.
2. B. T. Nall and K. A. Dill, *Conformations and forces in protein Folding*, American Association for the Advancement of science, 1991.

Supplementary Reading:

1. C. R. Cantor and P. R. Schimmel, *Biophysical Chemistry Part-III*, Freeman and Co. 1980.

CY 541 CHEMISTRY OF HETEROCYCLIC COMPOUNDS

3 Credits [3-0-0]

Introduction, Structure and uses of heterocycles, Synthesis and Reactivity of furan, thiophene, pyrrole, pyridine, quinoline, isoquinoline, indoles, azines, purines, pteridines, azoles, benzo-fused ring systems including isobenzofuran, heteroisobenzofurans, compounds with oxygen and sulfur hetero atoms and small-ring heterocycles. Role of heterocyclic compounds in biological systems.

Essential Reading:

1. T. L. Gilchrist, *Heterocyclic Chemistry*, Pearson Education, 3rd Ed. 2007.
2. J. A. Joule and G. F. Smith, *Heterocyclic Chemistry*, ELBS, 1978.

Supplementary Reading:

1. A. R. Katritzky and Pozharskii, *Handbook of Heterocyclic Chemistry* Academic Press; 2nd Ed. 2000.
2. J. A. Joule and K. Mills, *Heterocyclic Chemistry*, Wiley-blackwell; 4th Ed, 2000.

CY 542**PERICYCLIC REACTION AND PHOTOCHEMISTRY****3 Credits [3-0-0]**

Molecular orbitals and symmetry operations; Pericyclic reactions, Frontier orbital approach, Aromatic transition state approach (Huckel and Mobius systems) Woodward Hofmann rule for pericyclic reactions); Electrocyclic Reactions, correlation diagram; Cycloaddition reaction, [4+2]-cycloaddition reaction (Diels-Alder reaction), regioselectivity of Diels-Alder reaction, retroDiels-Alder reactions, heteroatom Diels-Alder reactions, Intramolecular Diels-Alder reactions [2+2]-cycloaddition reactions, 1,3 dipolar cycloaddition reactions; Sigmatropic reactions : Orbital description, [1,5], [2,3], [3,3] sigmatropic rearrangement, Claisen rearrangement, Cope rearrangement. Photochemistry: Introduction, Jablonski diagram, photochemical reactions including photochemical elimination reactions, Norrish type I process, Norrish type II process, photochemical reductions, photochemical oxidations, photochemical cyclization and photochemical isomerization and rearrangement, photosubstitution, photoaddition, Barton reaction, Paterno Buchi reaction, Nazarov cyclization,.

Essential Reading:

1. B. B. Woodward and Hoffman, *Conservation of Orbital Symmetry*, Verlag Chemie Academic Press, 1971.
2. M. Smith, *Organic Synthesis*, Mc Graw Hill, 2nd Ed. 2004.
3. J. M. Coxon, B. Halton, *Organic photochemistry*, Cambridge university press, 1974.

Supplementary Reading:

1. I. Fleming, *Frontier Orbitals and Organic Chemical Reactions*, Wiley, 1976.
2. W. Carruthers, *Some Modern Methods of Organic Synthesis*, Cambridge University, Press, 1993.
3. I. Ninomiya and T. Naito, *Photochemistry Synthesis*, Academic Press, 1989.

CY 543**MOLECULAR REARRANGEMENT****3 Credits [3-0-0]**

Aldol Condensation, Claisen condensation, Dieckmann condensation, Curtius, Schmidt, Lossen and Wolff Reaction, Cope Reaction, Chugaev Reaction, Perkin, Stobbs, Hofmann, Schmidt, Curtius, Reimer-Tiemann, Reformatsky, Diels-Alder reaction, Friedel-Craft reaction, Wittig reaction, Meerwein-Ponndorf-Verley reduction, Clemmenson reduction, Wolf-Kishner reduction, Birch reduction, Baylis-Hillman reaction, Barton reaction, Bamford-Stevens reaction, Shapiro reaction, Heck reaction, Demijanov, Pinacol-Pinacolone rearrangement, Favorski Rearrangement, Fries rearrangement, Wagner-Meerwein Rearrangement, Benzil-Benzilic Acid Rearrangement, Beckmann Rearrangement, Claisen rearrangement, Bamberger rearrangement, Suzuki coupling, Stille coupling, McMurry coupling, Sonogashira coupling.

Essential Reading:

1. E. L. Eliel, S. H. Wilen, L. N. Mander, *Stereochemistry of Carbon Compounds*, John Wiley & Sons, Inc, 2005.
2. D. Nasipuri, *Stereochemistry of Organic Compounds*, New age International, 2006.
3. Parikh, Parikh and Parikh, *Name reactions in Organic Synthesis*, Foundation Books, 2006

Supplementary Reading:

1. Robert and Cassenio, *Basic Principles of Organic Chemistry*, Addison-Wesley Pub 1977.
2. J. J. Li, *Name reactions in organic synthesis*, 3rd Edition, SPRINGER 2006.
3. M. Smith, *Organic Synthesis*, Mc Graw Hill, 2nd Ed. 2004.

CY 544 INSTRUMENTAL METHODS OF ANALYSIS**3 Credits [3-0-0]**

Basic principle, Instrumentation and application to chemist of the following instruments Atomic absorption spectroscopy, Flame emission spectroscopy, XRD, XRF. Polarography, Cyclic Voltametry, Basic principle and general analytical application of Thermal analysis, TGA and DTA, DSC Thermometric titration, Theory, instrumentation and complexation titrations dealing with EDTA., Principle, instrumentation and general application. Of Chromatography., Flow injection analysis, Recent development in the above technique.

Essential Reading:

1. A. S. Douglas, F. J Holler, S. R. Crouch, *Principles of Instrumental Analysis*, Thomson, 2007.
2. Willard, Merritt and Dean, *Instrumental Methods of Analysis*, AFFILIATED EAST-WEST, New Delhi, 2004

Supplementary Reading:

1. A. S. Douglas, F. J Holler, S R Crouch *Fundamentals of Analytical Chemistry*, Thomson, 2007.
2. R. S. Drago *Physical methods in inorganic chemistry*, AFFILIATED EAST-WEST, New Delhi, 1988.

CY 558 ORGANOMETALLIC CHEMISTRY**3 Credits [3-0-0]**

General introduction, Structure and bonding, 18-Electron rule, Wades rule, Survey of organometallic complexes Preparation, properties and bonding of metal carbonyl complexes, Bonding in carbonyls, nitrosyls, tertiary phosphines, hydrides, alkene, alkyne, cyclobutadiene, cyclopentadiene, arene compounds and their M.O. diagrams. Metal-carbon multiple bonds. Fluxional organometallic compounds including δ -allyl complexes and their characterization. Metallocycles, unsaturated nitrogen ligands including dinitrogen complexes. Preparation and applications of organomagnesium compounds, Organolithium compounds, organocopper reagents, organozinc compounds, organolead compounds, organoaluminum compounds, organosilanes and organoboranes towards organic transformations. Metal-Metal bond and transition metal cluster, Organometallic catalysis.

Essential Reading:

1. B. F.G. Johnson, *Transition metal cluster*, Wiley, 1980.
2. R. C. Mehrotra and A. Singh, *Organometallic Chemistry-A unified approach*, New age international(P)limited publisher, 2001.
3. C. Elschenbroich and A, Salzer, *Organometallic-A Concise introduction*, Weinheim, 1992.

Supplementary Reading:

1. R.H. Crabtree, *The organometallic chemistry of the transition metals*, Wiley-Interscience, 2005.
2. G. Wikinson, F.G.A. Stone, E. Abel, *Comprehensive Organometallic Chemistry*, Peramon, 1980.
3. P. Powell, *Principle of Organometallic Chemistry*, Kulwar, 1991.

CY 571 ORGANIC CHEMISTRY LABORATORY

6 Credits [0-0-9]

Elemental Analysis of Organic Compounds (C, H, N, O, S), Identification of organic compounds having at least two functional groups; Preparation of (a) P-Iodo toluene, (b) Benzaldehyde to Benzoin → Benzil → Bensilic acid, (c) Benzoic acid → o-Benzoyl Benzoic acid → Anthraquinone → Anthrone, (d) Ethylacetate → Ethylaceto acetate, (e) Anisole → Phenacetin; Synthesis of a simple dye and check, its purity by paper chromatography and extinction coefficient measurement; Estimation : (a) Methoxy group, (b) Acetyl group, (c) Nitrogen, (d) Carbon and hydrogen, (e) Spectrophotometric analysis of Keto group

Essential Reading:

1. V. K. Ahluwalia and R. Aggarwal, *Comprehensive practical organic chemistry*, University press. 2000
2. B. S. Furniss, *Vogel's Text Book of Practical Organic Chemistry*, ELBS Longman, 5th Edition, 1996.

Supplementary Reading:

1. D. S. Gupta , *Experimental Organic Chemistry, Qualitative and Quantitative*, TATA MCGRAW HILL 2004
2. A. Ault, *Techniques and Experiments for Organic Chemistry*, University Science Book.1998

CY 572 INORGANIC CHEMISTRY LABORATORY

6 Credits [0-0-9]

Qualitative Analysis of inorganic mixture containing not more than six radicals, any one of the following rare metal may be included, tungsten, molybdenum, titanium and vanadium. Organic radicals are excluded; Quantitative Analysis of major constituents of : Chrome iron ore, dolomite or Portland cement, Pyrolusite. Quantitative Analysis of major constituents of Bronze, Brass, solder, etc; Preparation and characterization of metal complexes

Essential Reading:

1. G. Svehla, *Vogel's qualitative inorganic analysis*, Harlow Longman, 2002.
2. A. I. Vogel, John Bassett, *Vogel's textbook of quantitative inorganic analysis: including elementary instrumental analysis*, Longman,2003

Supplementary Reading:

1. A. I. Vogel , *Qualitative Inorganic Analysis*, Orient Longman – 1979.

CY 573 PHYSICAL CHEMISTRY LABORATORY

6 Credits [0-0-9]

Conductometric titrations: Dissociation constant of weak acid, solubility product of sparingly soluble salt (PbSO₄, BaSO₄), Determination of strength of strong and weak acids in a given mixture conductometrically, Determination of ratio of Potassium Dichromate, chromate in a

supplied mixture. Potentiometric titration: Determination of Dissociation Constant of weak acid
Determination of pH of an electrolyte. Polarimetric determination of Concentration of unknown
sugar solution Inversion of cane sugar; Determination of Co-ordination number of copper in
cupramine complex by distribution method, determination of Equilibrium constant of the
reversible reaction $KI + I_2 = KI_3$, Kinetics of Ester Hydrolysis by acid and base; Determination
of Molecular mass of volatile liquids by Victor Meyer Method. Determination of Molecular mass
of inorganic solids by Rast's method, Determination of magnetic moment by Gouy's balance.

Essential Reading:

1. B. Behera , *Experimental Physical Chemistry* , Tata McGraw Hill 2000.

Supplementary Reading:

1. D. Alart, *Practical Physical Chemistry*, Longman, 1993.

CY 574

ENVIRONMENTAL CHEMISTRY LABORATORY

6 Credits [0-0-9]

1. Physico-chemical analysis of water and waste water analysis
2. Analysis of Soil parameters.
3. Analysis of air & Noise

Essential Reading:

1. N. Manivaskam, *Physico-Chemical Examination of Water, sewage and Industrial Effluences*, Pragatiprakashan, 2000.

Supplementary Reading:

1. *Standard Methods for the Examination of Water and Waste Water*, APHA, AWWA, 6th Edition, 2002.