REVISED
M. Sc. (CHEMISTRY)
SYLLABUS
BASED ON
CBCS SYSTEM

महात्मा ज्योतिबा फुले
रुहेलखण्ड विश्वविद्यालय, बरेली

DEPARTMENT OF APPLIED CHEMISTRY
FACULTY OF ENGINEERING& TECHNOLOGY
M.J.P. ROHILKHAND UNIVERSITY
BAREILLY-243 006

COURSE STRUCTURE FOR M. Sc. (CHEMISTRY) PROGRAM

1st Year: Semester-I

S. No.	Paper	Course Name	Paper Code	Contact Hours/week (L-T-P-C)	Max Marks		Total
					Sessional	End Semester	
1.	I	Physical Chemistry-I	CY-511	3-1-0-4	30	70	100
2.	II	Physical Chemistry-II	CY-513	3-1-0-4	30	70	100
3.	III	Inorganic Chemistry-I	CY-515	3-1-0-4	30	70	100
4.	IV	Environmental Chemistry	CY-517	3-1-0-4	30	70	100
5.	V	Organic Chemistry-I	CY-519	3-1-0-4	30	70	100
6.	VI	Organic Natural Products-I	CY-521	3-1-0-4	30	70	100
7.	Lab Work*	Inorganic & Physical Chemistry Laboratory	CY-523P	0-0-18-6	90	210	300

1st Year: Semester-II

S. No.	Paper	Course Name	Paper Code	Contact Hours/week (L-T-P-C)	Max Marks		Total
					Sessional	End Semester	
1.	I	Physical Chemistry-III	CY-512	3-1-0-4	30	70	100
2.	II	Analytical Chemistry	CY-514	3-1-0-4	30	70	100
3.	III	Inorganic Chemistry-II	CY-516	3-1-0-4	30	70	100
4.	IV	Bioinorganic Chemistry	CY-518	3-1-0-4	30	70	100
5.	V	Organic Chemistry-II	CY-520	3-1-0-4	30	70	100
6.	VI	Organic Natural Products-II	CY-522	3-1-0-4	30	70	100
7.	Lab Work*	Organic & Analytical Chemistry Laboratory	CY-524P	0-0-18-6	90	210	300

2nd Year: Semester-III

S. No.	Paper	Course Name	Paper Code	Contact Hours/week (L-T-P-C)	Max Marks		Total
					Sessional	End Semester	
1.	I	Applied Organic Chemistry-I	CY-611	3-1-0-4	30	70	100
2.	II	Advanced Organic Chemistry-I	CY-613	3-1-0-4	30	70	100
3.	III	Spectroscopic Analysis-I	CY-615	3-1-0-4	30	70	100
4.	IV	Pharmaceutical Chemistry	CY-617	3-1-0-4	30	70	100
5.	V	Medicinal Chemistry-I	CY-619	3-1-0-4	30	70	100
6.	VI	Elective	-	3-1-0-4	30	70	100
7.	Lab Work*	Organic Identification, Separation & Analysis Laboratory	CY-631P	0-0-18-6	90	210	300

*** Experiments in lab work will be based on the theory.**

List of Elective Courses

S. No.	Course Name	Paper Code	Contact Hours/week (L-T-P-C)	Max Marks		Total
				Sessional	End Semester	
1.	Chemistry of Natural Products	CY-621	3-1-0-4	30	70	100
2.	Chemistry of Bioactive Compounds	CY-623	3-1-0-4	30	70	100
3.	Organometallic Chemistry	CY-625	3-1-0-4	30	70	100
4.	Chemistry of Electronic Material, Solar Cells and Nanotechnology	CY-627	3-1-0-4	30	70	100
5.	Role of Catalysis in Chemical Synthesis	CY-629	3-1-0-4	30	70	100

2nd Year: Semester-IV

S. No.	Paper	Course Name	Paper Code	Contact Hours/week (L-T-P-C)	Max Marks		Total
					Sessional	End Semester	
1.	I	Advanced Organic Chemistry-II	CY-612	3-1-0-4	30	70	100
2.	II	Spectroscopic Analysis-II	CY-614	3-1-0-4	30	70	100
3.	III	Bio-Organic Chemistry	CY-616	3-1-0-4	30	70	100
4.	IV	Medicinal Chemistry-II	CY-618	3-1-0-4	30	70	100
5.	V	Elective	-	3-1-0-4	30	70	100
6.	Project Work		CY-630P	0-0-18-6	90	210	300

List of Elective Courses

S. No.	Course Name	Paper Code	Contact Hours/week (L-T-P-C)	Max Marks		Total
				Sessional	End Semester	
1.	Applied Organic Chemistry-II	CY-620	3-1-0-4	30	70	100
2.	Chemistry of Life Processes	CY-622	3-1-0-4	30	70	100
3.	Chemistry of Nano-Structured Materials	CY-624	3-1-0-4	30	70	100
4.	Industrial Chemistry	CY-626	3-1-0-4	30	70	100
5.	Polymer Structure and Properties	CY-628	3-1-0-4	30	70	100

CY-511:	PHYSICAL CHEMISTRY-I	4 (3-1-0)

Course Outcomes: To provide knowledge about various aspects of the principle of spectroscopy, electrochemistry and quantum mechanical view of chemistry.

Course Learning Outcomes: The students will acquire knowledge about spectroscopic principle and understand the application of spectroscopy, electrochemistry and Quantum Chemistry.

Course Contents:

Unifying Principles: Electromagnetic radiation, interaction of electromagnetic radiation with matter; absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering, uncertainty relation and natural line width and natural line broadening, transition probability, result of the time-dependent perturbation theory, transition moment, selection rule for intensity of spectral line, Born Oppenheimer approximation, rotational, vibrational and electronic energy levels.

Quantum Chemistry: Wave-particle duality, Schrodinger equation and the postulates of quantum mechanics, discussion of solution of Schrodinger equation to some model system *viz.*, particle in a box, the harmonic oscillator, the rigid rotor and the hydrogen atom.

Electronic Structure of Atom: Electronic configuration, the Russell-Saunders terms and coupling schemes, Slater-Condon parameters, terms separation energy of the p^n configuration, term separation energy for the d^n configurations, magnetic effect: spin-orbital coupling and Zeeman splitting.

Electrochemistry: Metal/electrolyte interface; OHP and IHP, potential profile across double layer region, potential difference across electrified interface, structure of the double layer, Helmholtz-Perrin, Gouy- Chapmann, and stern models, Butler-Volmer equation under near equilibrium and non-equilibrium condition, exchange-current density, Tafel plot, polarizable and non-polarizable interface, conductometry, Ostwald dilution law, Debye-Huckle limiting law, Onsagar equation.

Texts/References:

1. P. W. Atkins, Physical Chemistry, Oxford University press, New York.
2. S. Glasston, Physical Cemistry, Nostrand.
3. K. L. Kapoor, Advance Physical Chemistry (vol.1,2,3& 4), Macmillan India.
4. Puri Sharma & Pathania: Physical Chemistry.
5. J.O’M. Bockris and A.K. N. Reddy, Modern Electrochemistry, Vol. 2, Plenum Press, New York.

CY-513:	PHYSICAL CHEMISTRY-II	4 (3-1-0)

Course Outcomes: To learn about the fundamentals of chemical kinetics, macromolecular chemistry, symmetry of molecules and basic of computer science. The course is sufficient for various competitive examinations with knowledge of:

- fundamental of chemical kinetics and its various applied fields,
- primary learning about giant molecules (synthetic as well as natural),
- structure and symmetry in the various molecular shapes.
- introductory information of computer sciences.

Course Learning Outcomes: The course content embedded with the basic knowledge of topics assimilated with the applied approach of learning for the students. The topics cited enable the students to ascertain about logical dealing to the problems of topics within it.

Course Contents:

Chemical Kinetics: Kinetics of III order reaction, kinetics of parallel, opposing, consecutive and chain reactions, kinetics of unimolecular reactions, Lindeman theory, collision and activated complex theory, comparison of results with Eyring and Arrhenius equation, Hinshelwood theory, RRKL theory, kinetics of homogeneous catalyst, kinetics of enzyme catalyzed reaction.

Macromolecules: Definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization, molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, calculation of average dimensions of various chain structures.

Computational Chemistry: Basic concepts of computer science, language, programming and its application for chemical sciences.

Symmetry and Group Theory: Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup, conjugacy relation and classes, point symmetry group, Schonflies symbols, representations of groups by matrices.

Texts/References:

1. P. W. Atkins, Physical Chemistry, Oxford University Press, New York.
2. K. J. Laidler, Chemical Kinetics, Harper & Row, New York.
3. F. W. Billmayer, Jr., Text Book of Polymer Science, Wiley-Interscience, New York.
4. Puri, Sharma, Pathania, Advance Physical Chemistry.
5. K. L. Kapoor, Advance Physical Chemistry (vol.1,2,3&4), Mac millan India.
6. P. K. Bhattacharya, Group Theory & Its Chemical Applications.
7. Ramkrishnan et. al., Group Theory in Chemistry.
8. P. K. Sinha, Computer Fundamentals.
9. P. Kumar, A text book of Chemical Thermodynamics and Chemical Kinetics, SRS, Pub.

CY-515: INORGANIC CHEMISTRY-I 4 (3-1-0)

Course Outcomes: To impart basic knowledge of chemistry of some representative compounds of main-group elements. Also familiarize the students with the chemistry of transition elements and inner-transition elements.

Course Learning Outcomes: After successful completion of this course, the learners should be able to:

- have a good overview of the structure, bonding and properties of some representative compounds of main-group elements.
- able to understand the characteristics of transition elements and inner transition elements, and their applications in various fields.
- interpret the magnetic properties and spectroscopic properties of the transition and inner transition elements.
- able to understand the organometallic chemistry of lanthanides and actinides.
- able to investigate the lanthanide complexes using various physical techniques.

Course Contents:

Representative Chemistry of Main-Group Elements: Boranes, carboranes, metalloboranes, styx notation and Wade's rule, electron count in polyhedral boranes, borazines, silicates, silicones, phophazenes, interhalogen and xenon compounds.

Chemistry of Transition Elements: General characteristics: variable oxidation states, complex formation, color, magnetic and catalytic properties, comparative study of 4d & 5d transition elements with 3d analogues with respect to their ionic radii, oxidation states and magnetic properties.

Lanthanide and Actinide Chemistry: separation, oxidation states and electronic configurations, magnetic and spectroscopic properties, lanthanide luminescence spectra, physical methods for investigating lanthanide complexes, applications of lanthanides and actinides, lanthanide contraction, organometallic compounds of lanthanides and actinides.

Texts/References:

1. J. E. Huheey, E. A. Keiter and R. L.Keiter, Inorganic Chemistry, 4th ed., Pearson, 2001.
2. G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 3th ed., Pearson, 2004.
3. D. F. Shriver, P. W. Atkins, T. L. Overton, J. P. Rourke, M. T. Weller and F. A. Armstrong, Inorganic Chemistry, 4th ed., Oxford University Press, 2006.
5. J. D. Lee, Concise Inorganic chemistry, 5th ed., Wiley, 2010.
6. S. Cotton, Lanthanide and Actinide Chemistry, Wiley & Sons Ltd, 2006.
7. W. U. Malik, G. D. Tuli and R. D. Madan, Selected Topics in Inorganic Chemistry, S. Chand, 2019.

CY 517: ENVIRONMENTAL CHEMISTRY 4 (3-1-0)

Course Outcomes:

- The student will learn about the environment in general and various types of pollutions and pollutants.
- The student will learn about the ways to keep our environment clean.
- The student will learn to address energy crisis and sustainability.
- The student will learn to address different global issues related to environment.

Course Learning Outcomes: Upon successful completion of the course the student will be able to:

- Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
- Recognize different types of toxic substances & responses and analyze toxicological information.
- Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil).
- Describe water purification and waste treatment processes and the practical chemistry involved.
- Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies.
- Explain energy crisis and different aspects of sustainability.
- Discuss local and global environmental issues based on the knowledge gained throughout the course.

Course Contents:

General Aspects of Environmental Chemistry: atmosphere and its interaction with hydrosphere, lithosphere and biosphere, composition of air, water, soil, atmospheric layers, vertical temperature profile, heat radiation budget of the earth atmosphere system, properties of troposphere, thermodynamic derivation of lapse rate, temperature inversion, pressure variation in atmosphere and scale height, biogeochemical cycles of nitrogen and Sulphur, earth's carbon cycle, carbon emitters, carbon sequestration, carbon footprint and carbon trading.

Chemical and Photochemical Reactions in Atmosphere: Formation and reactions of O_3, O_2, NOx, SO_2, hydroxyl radical, hydroperoxyl radical, organic radicals, etc., photochemical smog, global warming, green-house effect, ozone depletion and acid rain, effects and control of air pollutants-gaseous, particulates.

Chemistry of Hydrosphere: Chemical reactions in aquatic environment, concept of oxygen demand; DO, BOD, COD, TDS, pH, conductivity, colloids, and salinity, aquatic pollution; sources (inorganic and organic pollutants, pesticides, industrial effluents, sewage, detergents and oil spills), effect of pollutants on aquatic life (flora and fauna), purification and treatment of water.

Environmental Toxicology: Toxicology, threshold limiting value (TLV), LD50, toxicity and control of toxicants, non-metallic compounds, asbestos, organic compounds (POP's, phthalate, dioxins, PCB's), pesticides,VOCs, endocrine disrupters.

Renewable Energy: Introduction, applications, merits and demerits: Solar energy, biomass energy, hydrogen fuel cells, hydrothermal energy, wind energy and geothermal energy.

Metals, Soil Sediments and Waste Disposal: Toxic heavy metals, waste, soils and sediments.

Texts/References:

1. S. E. Manahan, Environmental Chemistry, 10th Ed., CRC Press; 2017
2. C. Baird and W.H. Freeman, Environmental Chemistry, 5th Ed., 2012.
3. A. K. De, Environmental Chemistry, 9th Ed; New Age International, 2018.
4. T. G. Spiro & W. M. Stigliani, Chemistry of the Environment, Revised 3rd Ed., University Science Book, 2011.

CY 519:	ORGANIC CHEMISTRY-I	4 (3-1-0)

Course Outcomes: At the end of the course the students will Know and recall the fundamental principles of organic chemistry that include chemical bonding, nomenclature, structural isomerism, stereochemistry, chemical reactions and mechanism.

Course Learning Outcomes:

- To interpret the concept of aromaticity and the main properties of aromatic compounds.
- To understand the stereochemical aspects and understand different conformations and conformational analysis
- To understand nucleophile and electrophile groups and their properties and to interpret inductive and resonance effects on aromatic compounds.
- To derive the mechanism of different reactions.

Course Contents:

Nature of Bonding in Organic Molecules: Delocalized chemical bonding; conjugation, cross conjugation, resonance, hyperconjugation, aromaticity in benzenoids and non-benzenoid compounds, Huckel rule, homoaromatic and antiaromatic systems, charge transfer complexes.

Stereochemistry: Conformational analysis of acyclic systems and cycloalkanes (6-8 membered), optical isomerism, chirality, chiral synthesis, geometrical isomerism in acyclic and cyclic, condensed and bridged systems, methods of interconversion E to Z and vice-versa.

Substitution and Elimination Reactions: SN2, SN1& SNi change, solvent effect, competition between SN2 & SN1 mechanism, elimination reactions, E1, E2 and E1CB mechanism, Hofmann elimination, cyclic elimination, competition between elimination and substitution reactions.

Reactive Intermediates: Classical and non-classical carbocation, carbanions, radicals, radical anions, radical cations, carbenes, arynes and nitrenes, general methods of generation, detection and reactivity of these intermediates, singlet oxygen, its generation and its reaction with organic compounds.

Named Reactions: Claisen condensation, Hofmann bromide degradation, Beckmann's rearrangement, Pinacole-Pinacolone rearrangement, Perkin, stobbe, Dieckmann condensation, Schmidt, Lossen, Curtius, Fries rearrangement, Reimer-Tiemann reaction, Reformatsky and Grignard reaction, Diels-alder reaction, Friedal Craft reaction, Witting reaction, Hydroboration, Clemmenson, Wolf-Kishner, Meerwein, Pondorf-Varely and Birch reductions.

Texts/References:

1. O. P. Agarwal, Reactions and Reagent in Organic Synthesis, Goel Publishing House.
2. Eliel, Stereochemistry of Carbon Compounds, TMH Publishing Co. Ltd.
3. O. P. Agarwal, Synthetic Organic Chemistry, Goel Publishing.
4. P. Sykes, Mechanism in Organic Chemistry.
5. J. March, Advanced Organic Chemistry, Wiley.
6. House, Synthetic Reactions.

CY-521	ORGANIC NATURAL PRODUCTS-I	4 (3-1-0)

Course Outcomes: To provide knowledge about Natural Products Chemistry.

Course Learning Outcomes: After completion of course the students will understand about:

- knowledge about natural products- alkaloids isolated from plants.
- natural products-terpenoids which have specific smell and containing aldehyde, OH and ketone functional goups in their structure.
- natural occurring- purine bases with their synthetic procedure.

Course Contents:

Alkaloids: General methods for determining structure of alkaloid including Hofmann's exhaustive methylation method, Emde degradation,Von Braun's method for secondary and tertiary cyclic amines: structure determination of following: pyridine or piperidine group: conine, piperine, ricinine, pyrrolidine group-hygrine, pyrrolidine and pyridine group-nicotine, isoquinoline group-papaverine.

Terpenoids: General methods of extraction, isoprene rule, general methods of structure determination with particular emphasis on acyclic monoterpenoids: myrcene, and citral; monocyclic monoterpenoids: α-terpineol, carvone; bicyclic monoterpenoids: camphor, diterpenoid-phytol.

Purines: Structure and synthesis of uric acid, synthesis of adenine, guanine and xanthine derivatives caffeine, threobromine, theophylline.

Texts/References:

1. R. T. Morrison & R. N. Boyd, Organic Chemistry, P.H. Ltd.
2. Fieser & Fieser, Topics in Organic Chemistry, Reinhold.
3. I. L. Finar, Organic Chemistry (vol. 1 & 2), Elbs & Longmann.

CY-512 PHYSICAL CHEMISTRY-III 4 (3-1-0)

Course Outcomes: The objective of this paper is to acquire the knowledge of physical changes during the photochemical reactions, surface chemistry and thermodynamics of chemical processes. The thrust is specifically towards the physical aspects of the following topics. The students will have brief knowledge of:

- basic of photochemistry and various processes involved in it.
- the physical aspects of the surface of the sorbents in terms of energy changes.
- the feasibility of the chemical as well as physical processes.
- the concept of the thermodynamics in respect to the chemical changes at macro level.

Course Learning Outcomes: Photochemistry, surface chemistry and chemical thermodynamics are very important topics at undergraduate, postgraduate and research students. The students will be enabling to have the conceptual knowledge of the internal process involved in the chemical and physical processes. The energy change (free energy/spontaneity/enthalpy etc) during the various processes will be the part of this paper.

Course Contents

Photochemistry: Introduction of photochemical phenomenon, laws of photochemistry, quantum yield and its experimental determination, Jablonski diagram, photosensitization and quenching, photochemical rate law, kinetics of photochemical reactions (formation of hydrogen chloride, hydrogen bromide, decomposition of acetaldehyde etc.), photochemistry of stratospheric ozone, lasers in photochemical reactions.

Surface Chemistry: Physisorption and chemisorptions, adsorption isotherms, Langmuir and BET equation and its significance in surface area determination, study of adsorption kinetics (Lagergren equation, pseudo- second-order equation and Elovich model), Gibbs adsorption isotherm and its derivation, surface compositions, adsorption catalysis, surface activity, surface active agents and their classification, micellisation, critical micelle concentration (CMC) thermodynamics of micellisation, factors affecting CMC.

Chemical Thermodynamics: Brief resume of concept of laws of thermodynamics, entropy and entropy change, concept of free energy, Carnot cycle, partial molar properties and their significance, Gibbs-Duhem equation, Fugacity: its concept and determination, properties of ideal solutions; non-ideal systems-deviations (negative and positive) from ideal behaviour, excess functions for non-ideal solutions, calculations of partial molar quantities, determination of partial molar volume and partial molar enthalpy, colligative properties.

Texts/References:

1. P. Kumar, A text book of Chemical Thermodynamics and Chemical Kinetics, SRS, Pub.
2. P. W. Atkins, Physical Chemistry, Oxford University Press, New York.
3. K. L. Kapoor, Advance Physical Chemistry (Vol.1, 2, 3 & 4), Mac Millan India.
4. S. M. Mukherjee & S.P. Singh, Chemical Thermodynamics, Vikas Publication, India.
5. R. C. Srivatsava, S. Saha & A. K. Jain, Themodynamics, Prentice-hall, India.
6. Puri, Sharma, Pathania, Advance Physical Chemistry.
7. G. Raj, Advance Physical Chemistry, Pragati Pakashan, Meerut.

CY-514 ANALYTICAL CHEMISTRY 4 (3-1-0)

Course Outcomes: To acquire the knowledge about the analytical methods used in chemistry.

Course Learning Outcomes: The knowledge of different analytical methods is very essential for study of chemistry of any substance. This course will provide a systematic guidance for the chemical analysis of the materials

Course Contents:

Errors in Chemical Analysis and Statistical Evaluation of Data: Systematic and random errors, accuracy and precision, methods of expressing accuracy and precision, normal error curve and it's equation, propagation of error, useful statistical test; test of significance, the F test, the student 't' test, the chi-square test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures.

Polarography: Origin of polarography, current-voltage relationship, theory of polarographic waves (DC and sampled DC or test polarograms), instrumentation, Ilkovic equation, qualitative and quantitative applications, cyclic voltammetry; cell design, instrumentation, current-potential relation for linear sweep voltammetry (LSV), cyclic voltammetry, interpretation of voltammograms.

Separation Methods: Principle of chromatography, classifications of chromatography, techniques of planar and column chromatography, gas chromatography, high-performance liquid chromatography.

Thermal Analysis: Theory, methodology and applications of thermo-gravimetric analysis (TGA), differential thermal analysis (DTA) and differential scanning calorimetry (DSC), principles, techniques and applications of thermometric titration methods.

Texts/References:

1. S. M. Khopkar, Basic Concept of Analytical Chemistry, Wiley Eastern Ltd.
2. H. H. Willard, L.L. Mirrit, J.A. Dean, Instrumental Methods of Analysis, (CBS) publ.
3. Skoog and West, Principles of Instrumental Analysis, Saunders College Publishing, Philadelphia, London.
4. J.O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Plenum Press, New York.
5. H. Kaur, Instrumentation Methods of Chemical Analysis, Pragati Prakashan.

CY-516 INORGANIC CHEMISTRY-II 4 (3-1-0)

Course Outcomes: To impart basic concepts of coordination chemistry.

Course Learning Outcomes: After successful completion of this course, the learners should be able to:

- have a good overview of the fundamental principles of coordination chemistry.
- interpret the magnetic properties and electronic spectra of the complexes.
- predict stability and reactivity of simple complexes.
- understand fundamental reaction types and their mechanisms.

Course Contents:

Bonding in Coordination Compounds: Introduction, crystal field theory, crystal field splitting of d-orbitals in octhahedral, tetrahedral and square planar complexes, effects of crystal field splitting, calculation of stabilizations energies (CFSE) for d^1 to d^9 in weak and strong fields, spectrochemical series, tetragonal distortion and limitation of crystal field theory, molecular orbital theory, σ- and π-bonding in octahedral complexes, tetrahedral and square planar complexes, high and low spin complexes.

Electronic Spectra: Electronic spectra of octahedral and tetrahedral complexes, selection rules, splitting of electronic energy levels and spectroscopic states, Orgel diagrams, nephelauxetic effect, Racah parameter, Tanabe-sugano diagrams.

Magnetism: Magnetic susceptibility and spin-only formula, spin and orbital contributions to magnetic moment, spin-orbital coupling, quenching of orbital angular moment, variation of magnetic susceptibility with temperature, Curie law and its limitation, Curie-Weiss law, Curie and Neel temperatures, spin crossover, ferromagnetism, antiferromagnetism and ferrimagnetism, superexhange, magnetically dilute and concentrated substances.

Reaction Mechanisms of Coordination Compounds: Inert and labile complexes, kinetics and mechanism of substitution reactions, octahedral substitution reactions, dissociative & associative mechanisms, experimental tests of mechanisms, acid and base hydrolysis, conjugate base mechanism and experimental evidences, anation reactions, substitution without breaking the metal-ligand bond, trans effect and its applications, sigma-bonding & pi-bonding effects, inner and outer sphere reactions.

Texts/References:

1. B. Douglas, D. McDaniel, J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd ed., Wiley, 2018.
2. J. E. Huheey, E. A. Keiter and R. L.Keiter, Inorganic Chemistry, 4th ed., Pearson, 2001.
2. G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 3th ed., Pearson, 2004.
3. D. F. Shriver, P. W. Atkins, T. L. Overton, J. P. Rourke, M. T. Weller and F. A. Armstrong, Inorganic Chemistry, 4th ed., Oxford University Press, 2006.
4. C. E. Housecroft and A. G. Sharpe, Inorganic chemistry, 4th ed., Pearson, 2012.
5. J. D. Lee, Concise Inorganic chemistry, 5th ed., Wiley, 2010.
6. W. U. Malik, G. D. Tuli and R. D. Madan, Selected Topics in Inorganic Chemistry, S. Chand, 2019.

CY-518 BIOINORGANIC CHEMISTRY 4 (3-1-0)

Course Outcomes: To provide knowledge of bioinorganic chemistry and their importance.

Course Learning Outcomes: The students will acquire knowledge about the importance and applications of bioinorganic chemistry in biological systems and their environmental as well as medicinal aspects.

Course Contents:

Metal ions in Biological Systems: Essential and trace metals, Na+/K+ pump, heme proteins and oxygen uptake, structure and function of haemoglobin, haemocyanin and haemerythrin, model synthetic complexes of iron, cobalt and copper.

Electron Transfer in Biology: Structure and function of metalloenzymes and metalloproteins in electron transport process-cytochromes and iron-sulphur proteins, synthetic models, photosystems and porphyrin.

Nitrogenase: Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenase model systems

Metal Complexes as Medicine: Structure and mechanism of action of metal complexes as medicine, nuclear medicinal applications, use of Tc-99 as imaging agent.

Texts/References:

1. Cotton and Wilkinson, Inorganic Chemistry.
2. J. D. Lee, Advanced Inorganic Chemistry.
3. Gurdeep Raj, Advanced Inorganic Chemistry (Vol. 1&2).
4. L. Bertini, H.B. Gray S. J. Lippard and S.J. Valentine, Bio-inorganic Chemistry, University Science Books.
5. S. J. Lippard, J.M. Berg, Principles of Bioinorganic Chemistry, University of Science Books.
6. Cotton& Wilkinson, Advanced Inorganic Chemistry, Wiley.

CY 520	ORGANIC CHEMISTRY-II	4 (3-1-0)

Course Outcomes: At the end of the course the students will Know and recall the fundamental principles of organic chemistry that include chemical bonding, chemical reactions and mechanism.

Course Learning Outcomes:

- To interpret the concept of electrophilic and nucleophilic substitution reactions in aromatic compounds.
- To understand the mechanistic aspects of free radical reactions.
- To understand the chemistry of addition reactions and their applications in organic chemistry.
- To derive the mechanism of different reactions

Course Contents:

Aromatic Electrophilic Substitution: The arenium ion mechanism, Orientation and reactivity, energy profile diagram. The ortho/para ratio, ipso attack, orientation in other ring system, quantitative treatment of reactivity in substrates and electrophiles, Diazonium coupling, Vilsmeir reaction, Gatterman- Koch reaction.

Aromatic Nucleophilic Substitution: Aromatic nucleophilic substitution, rearrangements involving nucleophilic aromatic substitution, Bombarger rearrangements, Bucherer reaction, Smiles rearrangements and Sommlett-Hauser rearrangements.

Free Radical Reactions: Alicyclic halogenation (NBS), oxidation of aldehyde to carboxylic acid, auto- oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salt, Sandmeyer reaction, Free radical rearrangement, Huns-diecker reaction.

Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity, orientation and reactivity, addition to cyclopropane ring, hydrogenation of double and triple bonds, hydrogenation of aromatic ring, Michael reaction, Sharpless asymmetric epoxidation.

Named Reactions: Arndt-Eistert Synthesis, Bayer-Villiger reaction, Favoraskii rearrangement, Claisen rearrangement, Baylis-Hillmann reaction, Mitsunobu reaction.

Texts/References:

1. O. P. Agarwal, Reactions and Reagent in Organic Synthesis, Goel Publishing House.
2. Eliel, Stereochemistry of Carbon Compounds, TMH Publishing Co. Ltd.
3. O. P. Agarwal, Synthetic Organic Chemistry, Goel Publishing.
4. P. Sykes, Mechanism in Organic Chemistry:
5. J. March, Advanced Organic Chemistry, Wiley
6. House, Synthetic Reactions.

CY-522 ORGANIC NATURAL PRODUCTS-II 4 (3-1-0)

Course Outcomes: To provide the knowledge of natural occurring carbohydrates, heterocyclic chemistry, protein, structure of peptides and knowledge of biocatalysts in green chemistry.

Course Learning Outcomes: After completion of course the students will understand about:

- naturally occurring basic knowledge of carbohydrates and structure establishment of disaccharides *viz.*, maltose, lactose and sucrose and polysaccharides *viz.*, starch and cellulose.
- heterocyclic containing one and two hetro atoms and some thiazole group examples.
- amino acids and peptides structure with structure establishment of oxytocin and insulin.
- efficiency, specificity-stereospecificity and reaction specificity, substrate specificity with mechanics of enzyme action, coenzymes with structure elucidation of coenzyme I.

Course Contents:

Carbohydrates: General reactions of monosaccharides, epimerization, action of alkali, interconversion including Kiliani synthesis, Wohl's, Ruff's method, ring structure of aldose, determination of the size of ring by methylation method and peroxiodate oxidation method, mutarotation, structure establishment of diasaccharides; sucrose, maltose, lactose and polysaccharides; starch and cellulose.

Heterocyclic Compounds: Introduction, nomenclature, synthesis, reactions and structure of hetero cyclics having one heteroatom e.g. pyrole, furan, quinoline; synthesis and reaction of hetrocyclic containing two different hetro atom *viz.*, thiazole group: examples thiazole, thiazolines, thiazolidines, benzothiazoles and isothiazoles; hetrocyclics containing three hetro atoms triazole group: triazole, benzotriazole and oxadiazole.

Proteins: Amino acids, classification of amino acids, synthesis of amino acids, properties of amino acids, classification of proteins, peptide linkage, primary structure of peptides, synthesis of peptides, structure of oxytocin and insulin.

Biocatalysts in Green Chemistry: Advantages, nomenclature, classification, efficiency, specificity-stereospecificity and reaction specificity, substrate specificity, mechanics of enzyme action, coenzymes with structure elucidation of coenzyme I or Co-Zymase DPN, biochemical oxidations, biochemical reductions.

Texts/References:

1. R. T. Morrison & R.N. Boyd, Organic Chemistry, P.H. Ltd.
2. Fieser & Fieser, Topics in Organic Chemistry, Reinhold.
3. I. L. Finar, Organic Chemistry (vol. 1 & 2), Elbs & Longmann.

CY-611	APPLIED ORGANIC CHEMISTRY-I	4 (3-1-0)

Course Outcomes: To acquire knowledge about general organic chemistry.

Course Learning Outcomes: The students will get the knowledge about the:

- Organic Reagent
- Heterocyclic Chemistry
- Polymer Chemistry

Course Contents:

Heterocyclic Chemistry: Heterocyclic ring systems *viz*., azoles, oxazole, isoxazoles, pyrazoles, imidazole and thiazole, pyrimidines and pteridines, condensed ring System; acridine, quinazoline, phenothiazine, purines (uric acid, adenine, guanine, caffeine etc.).

Organic Reagents: Preparation, properties and uses of diisopropyl amide, diazomethane, lithium aluminium hydride, ozone, osmium tetraoxide, potassium permagnate, lead tetra acetate, raney nickel, sodium borohydride, N-bromo succinimide(NBS), dicyclohexyl carbo diimide, lithium tri-tert-butoxy aluminium hydride.

Macromolecules: Illustration of principles with polymeric materials, polymer structure and physical properties, thermoplastic and thermosetting resins, polysaccharides, fibers, rubbers (Natural and synthetic), DNA, RNA, engineering polymers, liquid crystalline polymers and conducting polymer.

Texts/References:

1. O. P. Agarwal, Reaction and reagents in Organic synthesis, goel publishing house
2. O. P Agarwal, Synthetic Organic chemistry, goel publishing house.
3. P. Skyes, Mechanism in Organic Chemistry.
4. J. March, Advance Organic Chemistry, Wiley
5. House, Synthetic Reactions.
6. R.T. Morrison and R. N Boyd, Organic Chemistry, P.H Ltd.
7. Fiesser&Fiesser, Topic in organic chemistry, Reinold
8. I. L. Finar, Organic Chemistry (Vol. 1& 2), Elbs with Longmann Pub.
9. V. R. Gowariker, N.V. Vishwanathan and J. Shreedhar, Polymer Science, New age international Pvt. Ltd.
10. F. W. BIllimayer, Text book of Polymer Science, John Wiley & Sons.

CY-613	ADVANCED ORGANIC CHEMISTRY-I	4 (3-1-0)

Course Outcomes: To understand the special topics such as pericyclic reaction, organic photochemistry as these are very important and useful for competitive examinations also.

Course Learning Outcomes: The students will have brief knowledge of:

- pericyclic reaction and various fundamentals to explain the concerted reaction.
- organic photochemistry.
- different processes of photo induced transitions.
- various molecular rearrangement.

Course Learning Outcomes: The course is very useful to learn about the chemistry of reactions which complete in single step and without any ionic or free radical intermediates. The subject is very important in aspects of competitive exams. The topics are also very useful for research point of view (experimental as well astheoretical research both).

Course Contents

Pericyclic Reactions: Molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene, allyl system, classification of pericyclic reactions, FMO approach, electrocyclic reactions: conrotatory and disotatory motions (4n) and (4n+2), allyl systems and secondary effects, cycloadditions: antarafacial and suprafacial additions, notation of cycloadditions, (4n) and (4n+2) systems with a greater emphasis on (2+2) and (4+4) cycloadditions, (2+2) additions of ketones secondary effects of substitutes on the rates of cycloadditions and chelotropic reactions. FMO approach for explanation of sigma tropic rearrgements under thermal and photochemical conditions, suprafacial and antarafacial shifts of H, sigmatropic shift involving carbon moieties, retention and inversion of configurations, (3-3) and (5-5) sigmatropic rearrangements, detailed treatment of Claisen and Cope rearrangement, fluxional tautomerism, aza-cope rearrangement and Barton reaction.

Organic Photochemistry: Introduction and principles of photochemistry, Jablonski diagram singlet and triplet states, dissipation of photochemical energy, photosensitization, quenching, quantum efficiency and quantum yield, photochemistry of carbonyl compounds; photochemistry of carbonyl compounds $n \rightarrow \pi^*$, $\pi \rightarrow \pi^*$ transitions, Norrish type I and II cleavages, Paterno-Buchi reaction, photochemistry of unsaturated systems; olefins, cis-trans isomerisation and dimerization hydrogen abstractions, photochemistry of butadiene, di-pi methane rearrangement, DeMayo rearrangement.

Rearrangements: Favorksii rearrangement, Naber rearrangement, Arndt-Eistrt synthesis, Shapiro reaction, Benzil-benzilic acid rearrangement.

Texts/References:

1. R T Morrison & R.N. Boyd, Organic Chemistry, Prentice Hall Ltd.
2. J. March, Advanced Organic Chemistry, Wiley.
3. I. L. Finar, Organic Chemistry (Vol. 1 & 2), Elbs & Longmann.
4. K. K. Rohtagi & Mukherjee, Fundaments of Photochemistry, Wiley Eastern Ltd.
5. G. Raj, Photochemistry, Goel Publication.
6. P. Sykes, Organic Chemistry Mechanism.
7. J. Singh, & L. D. S. Yadav, Organic Chemistry (vol. 1 & 2), Pragati Prakashan.
8. O. P. Agarwal, Synthetic Organic Chemistry, Goel Pub.

CY-615 SPECTROSCOPIC ANALYSIS-I 4 (3-1-0)

Course Outcomes: To impart the basic knowledge of ESR, UV, IR and Raman spectroscopic techniques required for the identification and structure elucidation of simple inorganic and organic molecules.

Course Learning Outcomes: After the completion of the course, the learners should be able to:

- apply these spectroscopic techniques in the identification and the elucidation of the structure of simple inorganic and organic molecules.
- interpret the spectral data of unknown inorganic and organic compounds.
- use these spectroscopic techniques in their research.

Course Contents:

Electron Spin Resonance Spectroscopy: Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensor, application of transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH_4, F^{2-} and $[BH_3]^-$.

Ultraviolet Spectroscopy: Nature of electronic excitations, types of electronic transitions in organic compounds, Beer-Lambert Law, instrumentation, sampling and presentation of spectra, choice of solvent, solvent effects, chromophores and auxochromes, effect of extended conjugation on electronic transitions, Woodward-Fieser rules, ultraviolet spectra of conjugated systems (dienes, polyenes, and enones), aromatic and heterocyclic compounds, Stereochemical factors and electronic absorption, Applications of UV spectroscopy.

Infrared Spectroscopy: Basic concepts, molecular vibrations, Hooke's Law, modes of vibration and quantum restrictions, factors influencing vibrational frequencies (vibrational coupling, hydrogen bonding, electronic effects, bond angles and field effects), combination bands, overtones and fermi resonance, instrumentation and sampling techniques, interpretation of spectra, fingerprint region and group frequencies, characteristics infrared absorptions of hydrocarbons, aromatic rings, alcohols and phenols, ethers and amines, detailed study of vibrational frequencies of carbonyl compounds (aldehydes, ketones, carboxylic acids, esters, amides, acid chlorides, anhydrides, lactones, lactams and conjugated carbonyl compounds).

Raman Spectroscopy: Basic principle, Raman effect, instrumentation and sampling procedure, selection rules, depolarization ratio, quantitative analysis, vibrational Raman spectra, rotational Raman spectroscopy, symmetric top molecules, vibration-rotation Raman spectroscopy, application of Raman spectroscopy, resonance Raman effect, surface-enhanced Raman scattering, non-linear Raman effects.

Texts/References:

1. W. Kemp, Organic Spectroscopy, 3rd ed., Palgrave, 2012.
2. D. L. Pavia, G.M. Lampman, G. S. Kriz and J.R. Vyvyan, Introduction to Spectroscopy, 5th ed., Cengage Learning, 2015.
3. R. M. Silverstein and F. X. Webster, Spectrometric Identification of Organic Compounds, 6th ed., Wiley, 2010.
4. D. H. Williams and I. Flemming, Spectroscopic Methods in Organic Chemistry, 6th ed., McGraw-Hill, 2011.
5. D. N. Sathyanarayana, Handbook of Molecular Spectroscopy: from radio waves to gamma rays, 2nd ed., Wiley, 2019.
6. C. N. Banwell & E. M. McCash, Fundamental of Molecular Spectroscopy, 4th ed., McGraw-Hill, 2017.

CY-617	PHARMACEUTICAL CHEMISTRY	4 (3-1-0)

Course Outcomes: To provide the basic Knowledge in Pharmaceutical Chemistry.

Course Learning Outcomes: After completion of course the students will understand about:

- basic principles of drug design and detailed knowledge of physiological properties of drugs.
- synthesis of drugs which stimulate central nervous system.
- synthesis of drugs used as anthelmintics.
- the drugs used as antisapasmodics and antiulcer drugs. This is very important because many patients aresuffering from gastric diseases and ulcer problems.

Course Contents:

Basic Principles of Medicinal Chemistry: Introduction, characteristic of drugs therapeutic index, mechanism of chemotherapeutic action metabolic antagonism with examples.

Principles of Drug Design: Introduction, relationship between molecular structure & biological activity, physiological properties of drugs *viz*., acid base properties relative acid strength(pKa), degree of ionization, water solubility of drug, hydrogen bond, stereochemistry, & drug action, optical isomerism & biological activity, geometrical isomerism & biological activity, bioisosterism and isosteric modification in drug design, classical & non classical isosteric modifications.

CNS Stimulating Agents: Nikethiamide, ethamivan, benigride, doxiprarr, biphenyl ethylanmine derivatives, e.g. amphetamine, fenfluramine hydrochloride, chlorophentermine hydrochloride, phenmetrazinehydrochloride, caffeine, theophyline.

Antihelmintics: Phenolic compounds *viz*., 4-N hexyl resorcinal, bithional, piperazine derivatives, heterazan, antepar, thiiabenidazole *viz.*, mintezole.

Antispasmodic & Antiulcer: Dicycloamine, piperidolate (dactil), propantheline, mepiperphenidol, H2 receptor antagonist e.g. cimetidine & ranitidine.

Texts/References:

1. D. A.Williams & T. L. Lemke, Foye's Principles of Medicinal Chemistry.
2. Wilson & Gisvold's Text Book of Organic, Medicinal & Pharmaceutical Chemistry.
3. Burger, Medicinal Chemistry (all volumes):
4. A. Kar, Medicinal Chemistry.
5. S. N. Pandeya, Medicinal Chemistry.

CY 619	MEDICINAL CHEMISTRY-I	4 (3-1-0)

Course Outcomes:

- To expose students towards different chemical classes of drugs and their pharmacological activity.
- To develop the linkage between organic molecules and their transformation to the drug molecule
- To explain the mechanisms of action for representative drug classes.
- To explain the relationship between drug's chemical structure and it's therapeutic properties.
- To discuss the metabolic pathways, adverse effect and therapeutic indications of drug molecules.

Course Learning Outcomes:

- Students will be able to name and classify drugs according to their chemical nature and pharmacological action.
- Students will be able to predict the reactivity of organic compounds and their possible transformation in to drug molecules.
- Students will be able to recognize and explain the types of molecular interaction between drugs and their biological target.
- Students will be able to explain the relationship between drug's chemical structure and it's therapeutic properties.
- Students will be able to know the metabolic pathways, adverse effect and therapeutic indication of drugs.

Course Contents:

Synthetic procedure for selected drugs, mode of action, structure activity relationship (SAR), physicochemical and steric aspect etc.

General Anesthetics and Local Anesthetics: General anesthetics; ether, ethyl chloride, cyclopropane, vinyl ether, fluoroxene , halothane, nitrous oxide, chloroform, thiopental sodium, thiomylal sodium, hydoxy dione sodium succinate, fantanyl citrate, tribromo ethanol, paraldehyde, local anaesthetics; amino ethyl benzoate, butamben, orthocain, procain hydrochloride, tetracaine, aminoethyl benzoate, butamben, orthocaine, procaine hydrochloride, tetracaine hydrochloride, butacaine sulphate, cyclomethycaine sulphate, lignocaine hydrochloride, prilocaine hydrochloride, mapivacaine hydrochloride, bupivacane hydrochloride, pyrrocaine hydrochloride, dibucaine hydrochloride, dimethoisoquin hydrochloride.

Opoid Analgesics: Morphene sulphate, codeine, dihydro codeine phosphate, levorphenol tartarate, dextromethorphan hydro bromide, metazocene, cycloazocine, pentazocine, fentyl citrate, pethidine hydrochloride, methadone hydrochloride, tramadol hydrochloride, naloxone hydrochloride.

Antitussives: Benzonatate, levopropoxyphene napsylate.

Anticonvulsants: Phenobarbital, phenytoin, ethotoin, methytoin, trimethadione, paramethadione, phensuximide, mesusuxinimide, ethosuximide, pyrimidone, phenacemide, carbamazepine.

Insulin and Oral Hypoglycemic Agents: Insulin, chlorpropamide, tol butamide, phenformin, metformin.

Texts/References:

1. Foye, Medicinal Chemistry.
2. Wilsons & Gisvold's Text Book of Organic, Medicinal& Pharmaceutical Chemistry.
3. Burger, Medicinal Chemistry (All volumes).
4. Ashutosh Kar, Medicinal Chemistry.
5. S. N. Singh, Medicinal Chemistry.

CY 621	CHEMISTRY OF NATURAL PRODUCTS	4 (3-1-0)

Course Outcomes: The course is aimed to provide the students a comprehensive knowledge of essential bioactive molecules which are required in day to day life and to understand their chemistry and biological aspects for the benefit of mankind.

Course Learning Outcomes:

- The students will know about the chemistry of vitamins and their role in humans
- To give knowledge about chemistry of steroids and their role in humans
- To let the students learn the chemistry of lipids and their role in humans.
- To let the students know the importance and precautions about the antibiotics

Course Contents:

Vitamins: Introduction, classification and chemistry of vitamin A, B1, B2, B6, folic acid, vitamin C, D, E, and K.

Steroids: Introduction, classification and chemistry of cholesterol, oesterone, testosterone, androgens & progesterone.

Antibiotics: Introduction, structure of important antibiotics e.g. penicillin, cephalosporins, tetracyclines, choramphenicol, streptomycin and quinolone antibiotics (ciprofloxacin and norfloxacin)

Lipids: Fats, oils and waxes, fatty acids, characterization and their physic-chemical properties, introduction to phospholipids; lecithins, cephalins, sphingomaleins & glycolipids.

Texts/References:

1. R. T. Morrison and R.N. Boyd, Organic Chemistry, P.H. Ltd.
2. Fieser and Fieser, Topics in Organic Chemistry, Reinhold.
3. I. L. Finar, Organic Chemistry (vol. I & II), Elbs & Longmann Pub.
4. O. P. Agarwal, Natural Products, Goel Publishing House.

CY-623 CHEMISTRY OF BIOACTIVE COMPOUNDS 4 (3-1-0)

Course Outcomes: To acquire knowledge of the chemistry of bioactive compounds. The students will acquire knowledge of:

- Role of vitamins, its biosynthesis, advantage and disadvantages in a living organism.
- Bioactive molecules in maintaining a healthy life.

Course Learning Outcomes: Vitamins are essential part of human life. This course gives an idea of role of vitamins, its biosynthesis, advantage and disadvantages in living organism. The course will also give information of other bioactive molecules like hormones which are very crucial in maintaining healthy life.

Course Contents:

Vitamins: Classification, occurrence, chemistry of vitamins A, C and E, structure elucidation and synthesis, deficiency syndromes, etc.

Insect Hormones: Introduction to BH, JH and MH, chemistry of JH, structure elucidation and synthesis, structural analogs, biosynthesis; JH mimics-some structures; chemistry of Juvabione.

Antifeedants: Different classes of antifeedants; role of azadirachtin in IPM.

Pyrethroids: Introduction; structure elucidation and synthesis of pyrethroids, namely pyrethrins, cinerins and jasmoline; Synthetic pyrethroids: structure-activity relationships; synthesis of various synthetic pyrethroids.

Insect Pheromones: Semiochemicals, pheromones, primers and releasers, different classes of pheromones, synthesis of different pheromones; advantages of pheromones over conventional pesticides.

Hormones: General study of hormones including classification, mechanism of action of water soluble and fat soluble hormones, secondary messengers, negative feedback mechanism; antifertility agents.

Texts/References:

1. L. Stryer, Biochemistry, 4th Ed., W. H. Freeman & Co., 1995.
2. S. Zubay, Biochemistry, Addison-Wesley, 1983.
3. G. Litwak, Vitamins and Hormones, Academic Press, 2005.
4. H. Dugas & C. Penney, Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Springer-Verlag, 1989.

CY-625 ORGANOMETALLIC CHEMISTRY 4 (3-1-0)

Course Outcomes: To impart basic concepts of organometallic chemistry in general, and their applications in industry.

Course Learning Outcomes: After successful completion of this course, the learners should be able to:

- have a good overview of the fundamental principles of organometallic chemistry.
- predict stability and reactivity of simple organometallic complexes.
- understand fundamental reaction types and their mechanisms, and how to combine them to understand efficient catalytic process.
- know important organic synthetic and industrial applications of organometallic catalysts.

Course Contents:

Structure and Bonding in Organometallics: Definition, hapticity, nomenclature,the18-valence-electron rule, electron counting and oxidation states; nature of the M-L bonding between metals and σ donor and π acceptor ligands, and organic pi systems with hapticity from 1 to 5; metal carbonyls, metallocenes (sandwich compounds), carbene (Fischer- and Schrock-type) and carbyne complexes, and metal cluster compounds; fluxionality, the isolobal analogy, and spectral analysis and characterization of organometallic complexes.

Organometallic Reactions: Ligand dissociation and substitution, Tolman cone angles, oxidative addition and reductive elimination, cyclometallations, Pd-catalyzed coupling reactions, sigma-bond metathesis,1,1- and 1,2-insertion and β-hydride elimination reactions,α- and β-abstraction reactions, nucleophilic and electrophilic attack of coordinated ligands, and carbonylate anions as nucleophiles.

Organometallic Catalysis: Hydrogenation by Wilkinson's Catalyst, Methanol carbonylation (Monsanto and Cativaacetic acid process), Hydroformylation (Oxo-process), Catalytic deuteration, Wacker (Smidt) process, Olefin metathesis, and Ziegler-Natta polymerizations.

Texts/References:

1. J. E. Huheey, E. A. Keiter and R. L.Keiter, Inorganic Chemistry, 4th ed., Pearson, 2001.
2. G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 3th ed., Pearson, 2004.
3. D. F. Shriver, P. W. Atkins, T. L. Overton, J. P. Rourke, M. T. Weller and F. A. Armstrong, Inorganic Chemistry, 4th ed., Oxford University Press, 2006.
4. C. E. Housecroft and A. G. Sharpe, Inorganic chemistry, 4th ed., Pearson, 2012.
5. B. D. Gupta and A. J. Elias, Basic Organometallic Chemistry, 2th ed., University Press, 2013.

CY-627 CHEMISTRY OF ELECTRONIC MATERIALS, SOLAR CELLS AND NANOTECHNOLOGY 4 (3-1-0)

Course Outcomes: To provide the knowledge about the electronic devices, solar technology, and nanotechnology.

Course Learning Outcomes: The students will get the knowledge about the conducting, super conducting materials, electronic devices, solar cells and nanotechnology.

Course Contents:

Electronic Materials: Different types of electronic materials, semiconducting and superconducting materials, electronic devices; LCD, LED, non-linear optical materials and their chemistry.

Solar Technology: Silicon based solar cells, dye sensitized solar cells (DSSC), organic and inorganic chromophoric materials, perovskite and quantum dot solar cells.

Use of Nanotechnology: Basics of nanotechnology, biological and medicinal applications, nanostructured innovations and their use in material science.

Texts/References:

1. S. O. Kasap, Principles of Electronic Materials and Devices, 4th Ed., Mc Graw Hill.
2. A.R. Jha, Solar Cell Technology and Applications, 1st ed., CRC press.
3. S. S. Siddiquee, G. H. Melvin, M.M. Rahman, Nanotechnology Applications in Energy Drug and Food, Springer.

CY-629 ROLE OF CATALYSIS IN CHEMICAL SYNTHESIS 4 (3-1-0)

Course Outcome: To acquire knowledge of various catalytic methods available for organic synthesis

Course Learning Outcome: The students will acquire knowledge of:

- Physico-chemical properties and molecular architecture of biopolymers.
- Folding, stability, and dynamics of protein.
- Dynamics by using fast kinetic methods (Stopped flow and laser flash photolysis)
- Catalyst, its use in various types of chemical reactions for synthesis of various products.

The course is applied in nature and very useful for students in understanding of polymer chemistry. The students learn basic concept, various techniques involves polymer synthesis, its use in daily life. Strong back ground in polymer technology will help to fetch job in industry. Second part of the course provides basic knowledge of catalyst, its use in various types of chemical reactions for the synthesis of various products.

Course Contents:

Unit-1: The art of catalysis, thermodynamic data and catalyst designing, metal catalyzed organic reactions, characteristics of transition metals which make them suitable as catalysts; homogeneous and heterogeneous catalysts and their characterization.

Unit-2: Catalyst and molecular activation, catalytic reaction and the 16 electron rule, catalysts for fine chemical synthesis, transition metal ion catalysts for organic transformations and their applications in epoxidation of alkenes, isomerization of unsaturated molecules, alkene metathesis, oligomerisation and polymerization (Zeigler Natta polymerization), olefin oxidation (Wacker Process), hydroformylation (oxoreaction) , Fischer-Tropsch Reaction, The water-gas shift reaction, Monsanto acetic acid process, Reppe carbonylation, hydrocyanation, activation of C-H bond, green chemistry and catalysis, computer applications in catalysis research.

Texts/References:

1. P. Hodge & D.C. Sherrington, Polymer Supported Reactions in Organic Synthesis, John Wiley & Sons, 1980.
2. J. P. Collman & L. S. Hegedus, Principles and Application of Organotransition Metal Chemistry, University Science Books, 1980.
3. C. Elschenbroich & A. Salzer, Organometallics: A Concise Introduction, VCH, 1989.
4. S. M. Roberts & G. Poignant, Catalysis for Fine Chemical Synthesis (vol. 1-5), John Wiley & Sons, 2002.
5. R. A. Sheldon, A. Isabel & U. Hanefeld, Green Chemistry and Catalysis, Wiley-VCH, 2007.

CY-612	ADVANCED ORGANIC CHEMISTRY-II	4 (3-1-0)

Course Outcomes: To understand the special topics Green Chemistry and disconnection approach towards the synthetic chemistry. The paper is for understanding and continued existence of chemistry with the environment. The students will have brief knowledge of:

- basic of green chemistry, methodology to do green chemistry.
- green chemistry in sustainable development.
- different protocols to do chemistry through green protocols.
- theoretical organic synthesis with a central idea of designing of synthesis.

Course Learning Outcomes: Green chemistry and retrosynthetic chemistry are most important topics for academics and research in current scenario. Both topics have scientific importance with socio-economic impact; meanwhile this paper also has the brief idea for sustainability of chemistry in future. The theoretical aspect of chemistry will have great importance for learners.

Course Contents

Green Chemistry: Introduction, tools and basic principles of green chemistry, education and need of green chemistry, evolution of the environmental movement, prevention or minimization of hazardous products, choice of solvents, supercritical solvents, evaluation of methods to design safer chemicals, sonochemistry, microwave induced reactions, polymer supported photo-sensitizes, polymer supported PTC, green chemistry and sustainable development, green plastics.

Disconnection Approach: Grounding of organic chemistry for understanding retrosynthesis, disconnection approach, basic principles, FGI, synthons and synthetic reagents of organic compounds, importance of order of events in organic synthesis, guidelines for choosing disconnection, C-X disconnection, two C-X disconnection, one and two group C-C disconnection, Diel's Alder reaction.

Commercial Polymers: Organic commercial polymers; synthesis, properties and application of polyethylene, polyvinyl chlorides, polyamides, phenolic resins and epoxy resins, natural and synthetic rubbers, fire retarding polymers and conducting polymers.

Texts/References:

1. V. K. Ahluwalia, M. Kidwai, New Trends in Green Chemistry, Anmaya Pub.
2. A. Matlack, Introduction of Green Chemistry, CRC.
3. S. Warren, Organic Chemistry: Disconnection Approach, Wiley.
4. J. Clayden, Organic Chemistry, Oxford University Press.
6. S. Warren,Workbook for Organic Synthesis: The Disconnection Approach, Wiley.
8. F. W.Billmayer, A Text book of Polymer Science, Wiley.
9. V. R. Gowarikar, Polymer Science, New Age Pub.

CY-614	SPECTROSCOPIC ANALYSIS-II	4 (3-1-0)

Course Outcomes: To provide the basic concepts of ^{1}H & ^{13}C and mass spectroscopic techniques required for the identification and structure elucidation of simple organic molecules.

Course Learning Outcomes: After the completion of the course, the learners should be able to:

- apply these spectroscopic techniques in the identification and the elucidation of the structure of simple organic molecules.
- analyze the spectral data of unknown organic compounds.
- use these techniques in their research.

Course Contents:

Nuclear Magnetic Resonance Spectroscopy: Magnetic properties of nuclei, precessional frequency, chemical shifts and its measurement, shielding mechanisms, anisotropic effects, chemical shift values and correlations to protons bound to carbon (aliphatic, olefinic, aldehydic and aromatic) and to other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercapto), spin-spin coupling and coupling constants, complex spin-spin interaction between two, three, four and five nuclei (first order spectra), chemical and magnetic equivalence, vicinal, geminal and long-range coupling, Karplus relationship of vicinal coupling constant with dihedral angle, proton exchange reactions, deuteration exchange, hindered rotation, stereochemistry, simplification of complex ^{1}H NMR spectra; nuclear magnetic double resonance, NMR shift reagents.

Carbon-13 Spectroscopy: General considerations, chemical shifts (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), heteronuclear coupling, off-resonance decoupling, NOE signal enhancement, DEPT and structural applications of ^{13}C NMR.

Mass Spectroscopy: Basic principles, instrumentation; sample introduction, ionization techniques (EI, CI, and FAB), magnetic sector and double-focusing mass analyzers, molecular ions and metastable ions, base peak, nitrogen rule, high resolution mass spectroscopy, isotope abundances, fragmentation and rearrangements, Stevenson's rule, even-electron rule and McLafferty rearrangement, structural analysis of organic molecules.

Texts/References:

1. W. Kemp, Organic Spectroscopy, 3rd ed., Palgrave, 2012.
2. D. L. Pavia, G.M. Lampman, G. S. Kriz and J.R. Vyvyan, Introduction to Spectroscopy, 5th ed., Cengage Learning, 2015.
3. R. M. Silverstein and F. X. Webster, Spectrometric Identification of Organic Compounds, 6th ed., Wiley, 2010.
4. D. H. Williams and I. Flemming, Spectroscopic Methods in Organic Chemistry, 6th ed., McGraw-Hill, 2011.

CY-616 BIO-ORGANIC CHEMISTRY 4 (3-1-0)

Course Outcomes: To provide the knowledge about the important concept of pharmacokinetics of drugs and about non-steroidal anti-inflammatory drugs, adrenergic hormones and diuretic agents

Course Learning Outcomes: After completion of course the students will understand about:

- pharmacokinetics of drug in which students will understands about quantitative study of drug movement inside the body and all factors related with this.
- about nonsteroidal Drugs .This drug is prescribed when body is inflamed due to various reasons.
- will gain knowledge about adrenomimetics and adrenergic stimulants.
- about diuretic agents which promote the output of urine from body or increase in urine flow.
- students will acquire knowledge about anti-infective drugs specially sulphonamide which acts against infections by bacteria and knowledge about important antimalarial drugs.

Course Contents:

Pharmacokinetics: Introduction, process of movement of drugs-passive diffusion, filtration specific transport; drug absorption factors, routes of administration; oral route, subcutaneous and intramuscular, topical sites administration, distribution and deposition of drugs, excretion and elimination, pharmacokinetics of elimination by clearance and bioavailability.

Nonsteroidal Anti-inflammatory Drugs: Hetero aryl acetic analogues *viz.*, indomethacin, tolmetin, aryl acetic acid analogues e.g. ibuprofen, naphthalene acetic acid analogues *viz.*, naproxan, anthranilic acids analogues e.g. mefenamic acid & flufenamic acid, pyraziles e.g. phenyl butazones & oxyphenbutazones, salicylic acid analogues e.g. aspirin, *p*-amino phenol analogues e.g. paracetamol.

Adrenergic Harmones & Drugs: Adrenoreceptor agonist and SAR of adrenomimetics, main clinical use of adrenoreceptor-bronchodialators *viz.*, salbutamol, isoprenatine, ephedrine and adrenaline.

Diuretic Agent: Thiazide, chlorothiazide, benzthiazide, cyclothiazide, hydrochlorthiazide, methyclothiazide, trichlor methiazide and bendriflumothiazide.

Local Anti-infective Drugs: Sulphonamides *viz.*, sulphanilamide, sulphathiazole or cibazole, sulphadiazine, sulphamethazine, sulphaquinoxaline,

Antimalarials Drugs: Chloroquine and primaquine.

Texts/References:

1. P. Parmioo, A text book of Medicinal Chemistry.
2. D. A.Williams & T. L. Lemke, Foye's Principles of Medicinal Chemistry.
3. Wilson & Gisvold's Text Book of Organic, Medicinal & Pharmaceutical Chemistry.
4. A. Kar, Medicinal Chemistry.
5. S. N. Pandeya, Medicinal Chemistry.

CY 618	MEDICINAL CHEMISTRY-II	4 (3-1-0)

Course Outcomes:

- To expose students towards different chemical classes of drugs and their pharmacological activity.
- To develop the linkage between organic molecules and their transformation to the drug molecule
- To explain the mechanisms of action for representative drug classes.
- To explain the relationship between drug's chemical structure and its therapeutic properties.
- To discuss the metabolic pathways, adverse effect and therapeutic indications of drug molecules.

Course Learning Outcomes:

- Students will be able to name and classify drugs according to their chemical nature and pharmacological action.
- Students will be able to predict the reactivity of organic compounds and their possible transformation in to drug molecules.
- Students will be able to recognize and explain the types of molecular interaction between drugs and their biological target.
- Students will be able to explain the relationship between drug's chemical structure and its therapeutic properties.
- Students will be able to know the metabolic pathways, adverse effect and therapeutic indication of drugs.

Course Contents:

Anti Perkinsonism Drugs: Biperiden hydrochloride, Cycrimine hydrochloride, Tri-hexy Phenidyl hydrochloride, Procyclidine hydrochloride, Benztropine Napsylate, Ethopropazine hydrochloride, L-Dopa.

Cardiovascular Drugs: Hydralzine hydrochloride, Methyl dopa, Captopril, Diazoxide, Quinidine Sulfate, Diisopyramide, Lorcainide, Procainamide, Propanol, Bretylium Tosylate

Antineoplastic Agents: Mechlorethamine hydrochloride, Mephalan, Chlorambucil, Busulfan, Triethyene melamine, Carmustin, Lomustin, Methotrexate, Mercaptopurin, Cytrabine, Vinblastine and, Vincrirstin (Only activity), Pipobroman, Testolactone

Thyroid and Antithyroid Drugs: Thyroxine Thioimidazoles, Methylthiouracil & Propyl thiouracil.

Diagnostic Agents: Iopanoic acid, indigotin, Disulphonate Sodium, Evans blue, Fluorescein Sodium.

Texts/References:

1. Foye, Medicinal Chemistry.
2. Wilsons & Gisvold's Text Book of Organic, Medicinal& Pharmaceutical Chemistry.
3. Burger, Medicinal Chemistry (All volumes).
4. Ashutosh Kar, Medicinal Chemistry.
5. S. N. Singh, Medicinal Chemistry.

CY-620	APPLIED ORGANIC CHEMISTRY-II	4 (3-1-0)

Course Outcomes: To acquire knowledge about the chemistry of some organic and organometallic compounds.

Course Learning Outcomes: Students will acquire knowledge of the following:

- Organometallic chemistry and application of their compounds in different fields.
- Knowledge about the pyrone compounds like anthocyanins, flavones etc.
- Deep insight into the structure and chemistry of poly nuclear aromatic compounds with special knowledge about their carcinogenic behavior.

Course Contents:

Organometallics: Principles, preparation, properties and applications of following in organic synthesis with mechanistic details; Li. Mg, Hg, Cd and Zn compounds.

Pyrones: Chemistry and structural aspects of pyrones; anthocyanins, flavones, isoflavones, flavanones, depsides, coumarins and quinones.

Polyaromatic Hydrocarbons: Introduction, isolated systems or poly phenyl compounds diphenyl, diphenic acid, diphenyl methane, tri-phenyl methane, tri-phenyl carbinol, tri-phenyl methyl chloride and hexa phenyl ethane), condensed ring systems (naphthalene, anthracene, phenanthrene), the chemistry of carcinogenic hydrocarbons.

Texts/References:

1. O. P. Agarwal, Reactions and Reagents in Organic Synthesis, Goel Publishing house.
2. O. P. Agarwal, Synthetic Organic Chemistry, Goel Publishing house.
3. P. Syke, Mechanism in Organic Chemistry.
3. J. March, Advanced Organic Chemistry, Wiley.
4. House, Synthetic Reactions.
5. R. T. Morrison and R.N. Boyd, Organic Chemistry, P.H. Ltd.
6. Fieser & Fieser,Topics in Organic Chemistry, Reinhold.
7. I. L. Finar, Organic Chemistry (vol. 1 & 2). Elbs & Longmann.
8. V. R. Gowariker, N.V. Vishwanathan & J. Shreedhar, Polymer Science, New Age.

CY-622	CHEMISTRY OF LIFE PROCESSES	4 (3-1-0)

Course Outcomes: To acquire knowledge of the chemistry of life processes. The students will acquire knowledge of:

- Metabolic process in all living organism.
- Various pathways like ATP, role of various enzymes, role of amino acids, and proteins.
- DNA structure, transfer of genetic information from one generation to another generation.
- Understanding the complexity of biological reactions in a living organism.

Course Learning Outcomes: This course provides basic knowledge of metabolic process in all living organism. The students will understand various pathways like ATP, role of various enzymes, role of amino acids, and proteins. This course will also explain DNA structure, transfer of genetic information from one generation to another generation, disorders etc. It is very useful for understanding the complexity of biological reactions in living organism.

Course Contents:

Introduction to Metabolic Processes: Catabolism and anabolism, ATP-currency of biological energy, energy rich and energy poor phosphates, role of NADH, NADPH, FADH2, TPP, coenzyme A, lipoic acid and biotin.

Carbohydrate Metabolism: Glycolysis, fate of pyruvate under anaerobic conditions, citric acid cycle, oxidative phosphorylation (electron transport system), gluconeogenesis, C4 pathway, pentose phosphate pathway and photosynthesis, fatty acid metabolism; even chain and odd chain (saturated and unsaturated) fatty acids, ketone bodies, fatty acid anabolism, calorific values of food.

Protein Metabolism and Disorders: Degradation of amino acids (C3, C4, C5 family), urea cycle, uric acid and ammonia formation, enzymes; enzyme active sites, allosteric sites and mechanisms of their actions, e.g. chymotrypsin, carboxypeptidase, lipases, etc.

Nucleic Acids: Chemical and enzymatic hydrolysis, purine metabolism, structure and functions of DNA, RNA (m-RNA, t-RNA, r-RNA), genetic code (origin, Wobble hypothesis and other important features), geneticerrors.

Texts/References:

1. L. Stryer, Biochemistry, 4th Ed., W. H. Freeman & Co., 1995.
2. S. Zubay, Biochemistry, Addison-Wesley, 1983.
3. G. Litwak, Vitamins and Hormones, Academic Press, 2005.
4. H. Dugas & C. Penney, Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Springer-Verlag, 1989.

CY-624 CHEMISTRY OF NANO-STRUCTURAL MATERIALS 4 (3-1-0)

Course Outcomes: Nanoscience and nanotechnology have a great scope for master degree as well as research students. Nanochemistry is the combination of nano science and chemistry.

Course Learning Outcomes: The course content will give basic platform about:

- the introduction of nano scale science
- the different approaches of classification of nanomaterials and to do nanoscale science
- different methods of synthesis of nanomaterials and their use in drug delivery
- the toxicity due to nano scale materials

Course Contents

Introduction: Background, nanotechnology and types, classifications and types of nanomaterials as nano-particles; 1D, 2D, 3D nanomaterials, concept of bulk versus nanomaterials and dependence of properties on size, introduction to 'Top down' *vs.* 'Bottom up' approach of synthesis with suitable examples.

Nano Material Synthesis: Nano scale synthesis, techniques based on liquid and vapor phase as the starting material, study of wet chemical method like sol-gel method, hydrothermal, micro emulsion technique, and chemical reduction, decomposition of organometallic precursors and chemical vapor deposition, metallo-organic chemical vapor deposition.

Polymer Based Drug Nanocarriers: Classification and types of polymeric nanocarriers, different methods of polymeric nanocarrier preparation: precipitation, emulsion diffusion/solvent evaporation, salting out etc.

Nano Toxicity: Epidemiological evidences, entry routes for nanoparticles in human body: lungs, intestinal tract and skin, deposition and translocation in the body, attributes contribute to nanomaterials toxicity.

Texts/References:

1. C. N. Rao, A. Muller and A. K. Cheetham, Nanomaterials Chemistry, Wiley VCH, 2007.
2. C. Brechignac, P. Houdy, M. Lahmani, Nanomaterials and Nanochemistry, Springer, 2007.
3. K. J. Klabunde, Nanoscale Materials in Chemistry, Wiley Interscience, 2001.
4. G. B. Sergeev Nanochemistry, Elseiver, 2006.
5. G. Cao, Nanostructures and Nanomaterials, Synthesis, Properties and Applications, Imperial College Press, 2004.
6. A. D. Sezer, Application of Nanotechnology in Drug Delivery, ISBN 978- 953-51-1628-8, 552.
7. N. K. Jain, Introduction to Novel Drug Delivery Systems.
8. S. C. Sahu, D. A. Casciano, Handbook of Nanotoxicology, Nanomedicine and Stem Cell Use in Toxicology.
9. Y. Zhao and H. S. Nalwa, Nanotoxicology-Interactions of Nanomaterials with Biological Systems.

CY-626	INDUSTRIAL CHEMISTRY	4 (3-1-0)

Course Outcomes: To provide the basic Knowledge of techniques and equipment used in chemical technology. It will also provide the knowledge of fuel chemistry *viz.*, coal and petrochemical industry; lubricants; explosive and fertilizers.

Course Learning Outcomes: After completion of course the students will gain:

- good knowledge of techniques and about equipment used in chemical industry.
- detail knowledge in chemistry of fuels including coal and petroleum.
- detail knowledge of lubricants, lubricating oils, solid and semisolid lubricants, synthetic lubricants, properties of lubricants.
- knowledge of origin properties and preparation of explosives.
- knowledge of manufacturing of different fertilizers used in agriculture.

Course Contents:

Chemical Technology: Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid- liquid extraction, separation by absorption and adsorption, an introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators, scaling up operations in chemical industry, introduction to clean technology.

Fuel Chemistry: Review of energy sources (renewable and non-renewable), classification of fuels and their calorific value; coal: uses of coal (fuel and non-fuel) in various industries, its composition, carbonization of coal, coal gas, producer gas and water gas-composition and uses, fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, coal gasification (hydro gasification and catalytic gasification), coal liquefaction and solvent refining; petroleum and petrochemical industry: composition of crude petroleum, refining and different types of petroleum products and their applications, fractional distillation (principle and process), cracking (thermal and catalytic cracking), reforming petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels, petrochemicals; vinyl acetate, propylene oxide, isoprene, butadiene, toluene and its derivatives xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting), solid and semisolid lubricants, synthetic lubricants, properties of lubricants and their determination, tribology.

Chemical Explosive: Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX), introduction of rocket propellant, high energy materials.

Fertilizers: Fertilizers; different types of fertilizers, manufacture of the following fertilizers; urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, super phosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate, nano fertilizer.

Texts/References:

1. N. Board, The Complete Technology Book on Chemical Industries.
2. G. T. Austin, Shreve's Chemical process Industries.
3. K. J. Rosa Phillo & J. Jacob, Industrial Chemicals and Environment.
4. J. Akhava, The Chemistry of Explosives, 4^{th} Ed.
5. D. R. Biswas, A text Book of Fertilizers.

CY-628: POLYMER STRUCTURE AND PROPERITES 4 (3-1-0)

Course Outcomes: To understand the nature and properties of polymeric materials. The structure and properties are very useful to predict the characteristics of any polymer. The students will have brief knowledge of:

- structures of polymeric materials.
- various thermal transitions and their analysis.
- dependence of properties of polymeric materials on various parameters.
- about to plasticity and elasticity of plastic and elastic materials.

Course Learning Outcomes: The course is very useful to learn about the processiblity of polymeric substances. It will be helpful to the students to understand the fundamentals of engineering in the properties of the plastic as well as elastic polymers. The structure and properties are very important parameters of any polymeric substance to prepare the finished goods. The course is very applied and useful to serve in the plastic industries.

Course Contents

Molecular Weight and Its Determination: Various average molecular weights of polymers, significance methods of determination, molecular weight distribution, significance, fractionation and determination of molecular weight distribution.

Thermal Analysis of Polymers: Thermo-gravimetric analysis, differential thermal analysis, differential scanning calorimetry, glass transition temperature (T_g), softening temperature, melting temperature and various other thermal transitions.

Polymer Crystallinity: Unit cells, chain packing, estimation of degree of crystallinity, kinetics of crystallization of polymers, isomerism in polymers.

Plasticity and Elasticity of Polymers: Theories of elasticity, measurement of plastic and elastic properties, mechanical models of viscoelastic fluids, retardation and relaxation spectrum, experimental characterization of viscoelastic materials, polymer rheology.

Processing of Polymeric Materials: Brief introduction of molding, fiber formation, formation of films, fillers, plasticizers and cross linking agents.

Texts/References:

1. P. Ghosh, Polymer Science and Technology, Tata McGraw Hill.
2. J. A. Brysdson, Plastic Materials, B & H Publishing House.
3. Wunderilich, Thermal Analysis of Polymeric Materials, Springer.
4. Young & Lovell, Introduction of Polymers, Nelson Throns.
5. Mishra & Ahluwalia, Polymer Science, CRC press.