DEPARTMENT OF CHEMISTRY

Four –Year Undergraduate Programme
Course Structure
&
Syllabi (up to 4th semester)

Girijananda Chowdhury University, Assam

Summary of Minimum Credit Framework for UG Programme

SEM	Core (Major)	Core (Minor)	Multi- Disciplinary Course (MDC)*	Ability Enhancement courses (AEC)*	Skill Enhancement courses (SEC)	Common Value-Added Courses (VAC)*	Internship	Diss./Project	Total Credit Offered	Exit option
I	**4**	**4+4**	**3**	**2**	**3**	**2**	**-**		**22**	Certificate**
II	**4**	**4+4**	**3**	**2**	**3**	**2**	**-**		**22**	
III	**4**	**4+4**	**3**	**2**	**3**	**-**	**-**		**20**	Diploma**
IV	**16**	-	-	**2**	**-**	**2**	**-**		**20**	
V	**16**	-		**-**	**-**	**-**	**4**		**20**	**Degree (with Single Major and/or Minor /Double Minor) in Discipline(s)**
VI	**20**		**-**	**-**	**-**	**-**	**-**		**20**	
						Total			**124**	
VII	**8**	**4+4**	-	-	-	-		Project /Dissertation I (4) /Core (4)***	**20**	**Degree Honours with Research/With out Research (With Single Major and Minor(s) /Double Major) in Discipline(s)**
VIII	**12**	**-**	-	-	-	-		Project/ Dissertation II (8) /Core (4+4) ***	**20**	
						Total			**164**	

*Students have to choose one course from the pool of courses offered under MDC, AEC, SEC, VAC.

** Students, opting to exit from the programme at the end of 1st /2nd year, need to undertake a compulsory Internship/ Vocational Programme carrying 4 credits.

*** Students not opting for Research Project I and II have to undertake 3 courses of 4 credit each.

GIRIJANANDA CHOWDHURY UNIVERSITY
Hathkhowapara, Azara, Guwahati 781017, Assam

Department of Chemistry
Course Structure For Four –Year Undergraduate Programme
Bachelor of Science in Chemistry

YEAR 1

First Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Fundamentals of Chemistry – I	Core	3-0-2	4
	MINOR – 1	Minor	3-0-2	4
	MINOR – 2	Minor	3-1-0	4
	MDC – 1	MDC	3-0-0	3
	AEC – 1	AEC	2-0-0	2
	SEC – 1	SEC	3-0-0	3
	VAC – 1	VAC	2-0-0	2
			TOTAL	22

Second Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Fundamentals of Chemistry – II	Core	3-0-2	4
	MINOR – 3	Minor	3-0-2	4
	MINOR – 4	Minor	3-1-0	4
	MDC – 2	MDC	3-0-0	3
	AEC – 2	AEC	2-0-0	2
	SEC – 2	SEC	3-0-0	3
	VAC – 2	VAC	2-0-0	2
			TOTAL	22

EXIT OPTION WITH CERTIFICATION. Students who desire to exit after 1 year of study need to undertake Vocational Training/Course of 8 weeks / 4 credits.

Third Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Inorganic Chemistry-I	Major/Core	3-0-2	4
	MINOR – 5	Minor	3-0-2	4
	MINOR – 6	Minor	3-0-2	4
	MDC – 3	MDC	3-0-0	3
	AEC – 3	AEC	2-0-0	2
	SEC – 3	SEC	3-0-0	3
			TOTAL	20

Fourth Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Organic Chemistry-I	Major/Core	3-0-2	4
	Physical Chemistry-I	Major/Core	3-0-2	4
	Inorganic Chemistry-II	Major/Core	3-0-2	4
	*Elective-I Analytical Chemistry / Polymer Chemistry	Elective	3-0-2	4
	AEC-4	AEC	2-0-0	2
	VAC-3	VAC	2-0-0	2
			TOTAL	20

EXIT OPTION WITH DIPLOMA. Students who desire to exit after 2 years of study and have not undertaken Vocational Training/Course of 8 weeks / 4 credits after 1 year, need to go for such training.

YEAR-3

Fifth Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Organic Chemistry-II	Major/Core	3-0-2	4
	Physical Chemistry-II	Major/Core	3-0-2	4
	Inorganic Chemistry-III	Major/Core	3-0-2	4
	*Elective -II Inorganic Materials of Industrial Importance / Instrumental Methods of Analysis	Elective	3-0-2	4
	Internship	Major/Core	0-0-8	4
			TOTAL	20

Sixth Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Organic Chemistry-III	Major/Core	3-0-2	4
	Physical Chemistry-III	Major/Core	3-0-2	4
	Inorganic Chemistry-IV	Major/Core	3-0-2	4
	Advanced Quantum Chemistry and Spectroscopy	Major/Core	3-0-2	4
	*Elective - III Food Chemistry / Green Chemistry	Elective	3-0-2	4
			TOTAL	20

EXIT OPTION WITH BACHELOR DEGREE IN CHEMISTRY

Students who want to undertake 3-year UG Programme will be awarded **UG Degree in the field of study** upon securing the **minimum credit requirements** prescribed by the university.

YEAR-4

Seventh Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Physical Chemistry-IV	Major/Core	3-0-2	4
	Research Methodology	Major/Core	4-0-0	4
	Minor Elective 1	Minor Elective	3-0-2	4
	Minor Elective 2	Minor Elective	3-0-2	4
	Research Project Part I	Project	0-0-8	4
	OR			
	*Elective - IV Medicinal Chemistry/ Applications of Computers in Chemistry	Elective	3-0-2	4
			TOTAL	20

Eighth Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Organic Chemistry-IV	Major/Core	3-0-2	4
	Inorganic Chemistry-V	Major/Core	3-0-2	4
	Physical Chemistry-V	Major/Core	3-0-2	4
	Chemistry of Advanced Materials	Major/Core	3-0-2	4
	OR			
	Research Project Part II	Project	0-0-16	8
	*Elective-V Industrial Chemicals and Environment / Nanoscale materials and their applications	Elective	3-0-2	4
			TOTAL	20

Students will be awarded UG Degree (Honours) in Chemistry OR UG Degree (Honours) with Research in Chemistry

***Elective-Students has to choose any one course from the two options.**

LIST OF MINOR AND ELECTIVE COURSES OFFERED BY CHEMISTRY DEPARTMENT FOR OTHER DISCIPLINES

Sl. No	SEMESTER	Course Type	Course Name	Hours per Week			Credits
				L	T	P	C
1	I	MINOR-1	Fundamentals of Chemistry – I	3	0	2	4
2	I	MINOR-2	Material Chemistry	3	1	0	4
3	II	MINOR-3	Fundamentals of Chemistry – II	3	0	2	4
4	II	MINOR-4	Fuel Chemistry	3	1	0	4
5	III	MINOR-5	Fundamentals of Chemistry – III	3	0	2	4
6	III	MINOR-6	Basic Analytical Chemistry	3	0	2	4
****Elective-Any one course out of the two options (a) and (b)**							
7	VII	**Elective 1	(a). Sustainable Chemistry (b). Chemistry of Polymers	3	0	2	4
8	VII	**Elective 2	(a) Industrial Chemicals and Environment (b) Chemistry of Food	3	0	2	4

LIST OF MULTIDICIPLINERY COURSES (MDC)

Sl. No	SEMESTER	Course Type	Course Name	Hours per Week			Credits
				L	T	P	C
1	I	MDC	Chemistry in everyday Life	3	0	0	3
2	II	MDC	Molecules of Life	3	0	0	3
3	III	MDC	Fuel Science	3	0	0	3

Detailed Syllabus:

SEMESTER -I(CORE/MINOR)

	FUNDAMENTALS OF CHEMISTRY – I	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2) level

Course Objectives:

1. To provide knowledge of atomic structure and their periodicity.
2. To provide an insight into the kinetic theory of gases and behavior of ideal and real gases.
3. To make students understand the structure and properties of liquid.
4. To provide knowledge about different types of organic compounds, their reactivity and reaction intermediates.
5. To make students understand the stereo chemical aspects of organic chemistry.
6. To make students aware of qualitative analysis of organic molecules.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To learn the concepts related to atomic structure and their periodicity.
CO2: To understand the fundamentals of kinetic theory of gases and relate the behavior of ideal and real gases.
CO3: To gain the knowledge of qualitative treatment of the structure of liquid along with the physical properties of liquid, viz, vapour pressure, surface tension and viscosity.
CO4: To identify different classes of organic compounds, relate their reactivity with different physical effects along with understanding of various types of reaction intermediates.
CO5: To explain the stereochemical aspects of organic compounds.
CO6: To detect the elements and functional groups present in organic molecules qualitatively.

Module 1: ATOMIC STRUCTURE — **8 hours**

Bohr's theory and its limitations, hydrogen atom spectra, dual behaviour of matter, de Broglie's relation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance, Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals, Aufbau's principle, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Rules for filling electrons in various orbitals, Electronic configurations of the atoms, stability of half – filled and completely filled orbitals, concept of exchange energy.

Module 2: PERIODICITY OF ELEMENTS — **8 hours**

The general idea of Modern periodic table, s, *p*, *d*, *f* block elements, Detailed discussion of the following properties of the elements, with reference to *s* & *p*-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(b) Atomic radii(van der Waals)
(c) Ionic and crystal radii.
(d) Covalent radii(octahedral and tetrahedral)
(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(f) Electron gain enthalpy, trends of electron gain enthalpy.
(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-

Jaffé's electronegativity scales.Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

Module 3: GASEOUS STATE	**10 hours**

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; collision number, mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η ; variation of viscosity with temperature and pressure.
Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, principle of equipartition of energy.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. Van der Waals equation of state, its derivation and application in explaining real gas behaviour, Boyle temperature. Continuity of states, critical phenomena, determination of critical temperature and pressure, relation between critical constants and Van der Waals constants, law of corresponding states.

Module 4: LIQUID STATE	**5 hours**

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity, surface energy. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Module 5: BASICS OF ORGANIC CHEMISTRY	**7 hours**

Physical effects, electronic displacements, inductive effect, electromeric effect, resonance and hyperconjugation, cleavage of bonds, homolysis and heterolysis.

Nomenclature, structure, shape and reactivity of organic molecules, nucleophiles and electrophiles. Reaction intermediates: Carbocations, carbanions and free radicals.
.
Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Module 6: STEREOCHEMISTRY	**7 hours**

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. **Optical Isomerism:** Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers,

Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixtureand resolution. Relative and absolute configuration: D/L and R/S designations.

Total Lecture hours	**45 hours**

Practical

List of Laboratory Experiments:

1. Laboratory hazards and safety precautions.
2. Calibration and use of apparatus.
3. Study of Bunsen flame.
4. Detection of elements (N, Cl, Br, I & S) and functional groups (-COOH, Ph-OH, Alc-OH, -CHO, =CO, $-NH_2$ & $-NO_2$) in an organic compound. (Minimum 4 samples).
5. Preparation of potassium tris oxalato iron(II) complex.

Text Book(s)

1.	Lee, J.D. Concise Inorganic Chemistry ELBS, 1991
2.	Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
3.	Peter Atkins & Julio De Paula, Physical Chemistry 10th Ed., Oxford University Press (2014)
4.	Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012
5.	Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6.	Finar, I. L. Organic Chemistry (Volume 1&2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7.	Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry.
8.	Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.

Reference Books

1.	Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2.	McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013
3.	Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4.	Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
5.	Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
6.	Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
7.	Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
8.	A Text Book of Practical Chemistry By Dr. Sudarshan Barua

SEMESTER –I (MINOR)

	MATERIAL CHEMISTRY	L	T	P	C
		3	1	0	4

Pre-requisite: Knowledge of Chemistry at (10+2) level

Course Objectives:

1. To make students aware of manufacturing processes and properties of cement and ceramics.
2. To provide knowledge of the properties and applications of different polymeric compounds.
3. To provide knowledge of different types of composites, lubricants and refractories along with their applications.
4. To give an insight into characteristics properties and manufacturing methods of nanomaterials with their applications.
5. To make students familiar with structural aspects and chemical properties of liquid crystal.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To gain knowledge of manufacturing processes and properties of cement and ceramics.
CO2: To learn the properties and applications of different polymeric compounds.
CO3: To know about different types of composites, lubricants and refractories along with their applications.
CO4: To become familiar with characteristics properties and manufacturing methods of nanomaterials with their applications in various fields.
CO5: To know the structural aspects and chemical properties of liquid crystal.

Module 1: CEMENT — **7 hours**

Cement and its classification, Portland cement, composition, manufacture and its setting and hardening, heat of hydration of cement.

Module 2: POLYMERS — **8 hours**

Classification of polymers, Types of polymerization, Molecular weight of polymers, Structure and properties of polymers, Important thermoplastic and thermosetting polymers, polyvinyl chloride (PVC), polystyrene (PS), Polymethyl methacrylate (PMMA), Polytetrafluoroethylene (PTFE), Polycarbonate polyamide and phenolic resins, Natural and Synthetic rubbers, Specialty polymers: Silicones, Conducting polymers and biodegradable polymers.

Module 3: CERAMICS — **4 hours**

Introduction, general properties, classification, applications.

Module 4: LUBRICANTS — **3 hours**

Lubricants: Mechanism of lubrication, classification of lubricants, their properties, grease, synthetic lubricants.

Module 5: REFRACTORIES — **6 hours**

Definition, classification, properties of refractories, manufacture of refractories, uses.

Module 6: COMPOSITES — **4 hours**

Composites and their constituents; Classification: particle reinforced composites, fiber reinforced composites and properties; Metal matrix, ceramic matrix and polymer matrix composites.	
Module 7: LIQUID CRYSTALS	**6 hours**
Introduction, structure of liquid crystal forming compounds, classification of liquid crystals, chemical properties of liquid crystals, applications of liquid crystals.	
Module 8: NANOMATERIALS	**7 hours**
Introduction, differences from bulk materials, Properties of nanomaterials, one, two and 3D nanomaterials, preparation of nanomaterials (top down and bottom-up approach), Fullerenes, Carbon nanotube, Nanowire, Application of Nanomaterial, Bio nanomaterials.	
Total Lecture hours	**45 hours**

Text Book(s)	
1.	Material Chemistry, Bradley D. Fahlman, Springer
2.	Introduction to Materials Chemistry, Harry R. Allcock, Wiley
3	Atkin P., Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010)
Reference Books	
1.	Polymer Science and Technology, J. R. Fired (Prentice Hall)
2.	Introduction to Polymers-R. J. Young.
3.	Polymer Science-V. R. Gowarikar (New Age International)
4.	Advance Inorganic Chemistry- Cotton et. Al. (John Willey)
5.	Poole, C. P., Ovens, F. J., Introduction to Nanotechnology, Wiley India, 2009.

Semester-II (CORE/MINOR)

	FUNDAMENTALS OF CHEMISTRY – II	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2) level

Course Objectives:

1. To understand different types of chemical bonding present in a molecule and its relation with the structure.
2. To make students familiar with the principles behind the acid base behaviour of different substances.
3. To explain the laws of thermodynamics and its applications.
4. To illustrate the preparation and different chemical reactions of aliphatic hydrocarbons.
5. To make students understand the properties and reactions of aromatic compounds.
6. To understand the concept of quantitative analysis and apply for different titrations.
7. To understand the properties of liquids by experimental methods.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To gain knowledge of different types of chemical bonding present in a molecule and its relation with the structure.
CO2: To understand the principles behind acid base behaviour of different substances.
CO3: To know about the laws of thermodynamics and its application to chemical processes.
CO4: To describe the preparation and different chemical reactions of aliphatic hydrocarbons.
CO5: To learn different aspects of aromatic compounds.
CO6: To conduct quantitative analysis of a given substance by using different types of volumetric titrations.
CO7: To learn the physical properties like surface tension and viscosity of liquids by conducting experiments.

Module 1: CHEMICAL BONDING — **10 hours**

Ionic bond: General characteristics, Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, Born – Haber cycle and its applications.

Covalent bond: Valence Bond Theory and its limitations, various types of hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Shapes of some inorganic molecules and ions on the basis of Valence Shell Electron Pair Repulsion Theory (VSEPR). MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics, MO treatment of homonuclear and heteronuclear diatomic molecules.

Covalent character in ionic compounds: Polarizing power and polarizability, Fajan's rules and effects of polarization

Metallic bond, Weak chemical forces – Vander Waal's forces, ion – dipole forces, dipole – dipole interactions, induced dipole interactions, Repulsive forces, Hydrogen bonding.

Module 2: ACIDS AND BASES — **5 hours**

Bronsted-Lowry concept of acid-base reactions, relative strength of acids, types of acid base reactions, levelling solvents, Lewis acid-base concept, classification of Lewis acids, Hard and Soft acids and Bases (HSAB), HSAB principle and its applications.

Module 3: LAWS OF THERMODYNAMICS	**14 hours**

Macroscopic properties, state variables, system, surroundings, intensive and extensive properties.

First Law of Thermodynamics-Statement, concept of internal energy, work, heat, heat capacity, relation between heat capacities. Calculation of Q, W, U, and H for reversible and irreversible work done under adiabatic and isothermal conditions, Joule-Thomson effect and Joule - Thomson coefficient, inversion temperature.

Second Law of Thermodynamics-
Second law of thermodynamics, Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T, Entropy change for reversible, irreversible condition. Entropy as criteria of spontaneity and equilibrium, Entropy change in ideal gases. Gibbs free energy and Helmholtz free energy. Variation of G and A with P, V and T, Gibbs-Helmholtz equation.

Module 4: ALIPHATIC HYDROCARBONS	**10 hours**

Alkanes : Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe'e synthesis, from Grignard's reagent. Reactions: Free radical substitution, halogenation – relative reactivity and selectivity

Alkenes: Preparation of alkenes by elimination reactions, Saytzeff and Hofmann eliminations. Reactions of alkenes: cis-addition (alk. $KMnO_4$) and trans addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, Oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: Preparation, Acidity, Reactions of alkynes : Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, Ozonolysis and oxidation with hot alkaline $KMnO_4$.

Module 5: AROMATIC HYDROCARBONS	**6 hours**

Aromaticity*:* Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Total Lecture hours	**45 hours**

Practical

List of Laboratory Experiments:

1. Preparation of solutions of different normality/molarity.
2. Estimation of iron (Fe^{2+}) by a standard solution of $KMnO_4$.
3. To determine the relative viscosity of a liquid at room temperature by Ostwald's viscometer. (Minimum three liquids)
4. To determine the surface tension of a liquid at room temperature by drop number method using a stalagmometer. (Minimum three liquids).
5. Conductometric titration between a strong acid and a strong alkali.

Textbook(s)	
1.	Lee, J.D. Concise Inorganic Chemistry ELBS, 1991
2.	Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
3.	Peter Atkins & Julio De Paula, Physical Chemistry 10th Ed., Oxford University Press (2014)
4.	Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012)
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6.	Finar, I. L. Organic Chemistry (Volume 1&2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7.	Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry.
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2.	McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3.	Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4.	Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
5.	Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
6.	Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
7.	Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
8.	Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
9.	Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
10	A Textbook of Practical Chemistry By Dr. Sudarshan Barua

Semester-II (MINOR)

	FUEL CHEMISTRY	L	T	P	C
		3	1	0	4

Pre-requisite: Knowledge of chemistry at (10+2)level

Course Objectives:

1. To provide basic idea of fuel and calorific value.
2. To make the students aware of solid fuel, emphasis on coal and coke.
3. To provide an insight into liquid fuel and some important properties.
4. To make students understand gaseous fuel and their analysis.
5. To make the students aware of different types of energy sources.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To understand fuel and its relation with calorific value.
CO 2: To explain important constituents of solid fuel and their impact on its calorific value.
CO 3: To know about liquid fuel, cracking, refining, reforming and their different properties.
CO 4: To know about different types of gaseous fuel.
CO 5: To know about different alternative sources of energy.

Module 1: INTRODUCTION OF FUEL	**10 hours**

Definition and classification of fuels, characteristics of a good fuel, calorific value, gross and net calorific value, Dulong's formula for theoretical calculation of calorific value, Determination of calorific value by Bomb calorimeter and Boy's gas calorimeter.

Module 2: SOLID FUELS	**8 hours**

Coal, classification of coal, proximate and ultimate Analysis of coal, carbonization of coal, caking and coking of coal, metallurgical coke and its manufacture.

Module 3: LIQUID FUEL	**10 hours**

Petroleum, origin of petroleum, composition, classification, Processing of crude petroleum, Refining of petroleum, cracking, Synthetic petrol, Refining of Gasoline, Knocking, octane rating, Diesel engine fuels, Reformimg, Benzol, power alcohol, kerosene.

Module 4: GASEOUS FUEL	**9 hours**

Natural gas, Producer gas, Water gas, Carburetted water gas, Coal gas, Oil gas, calculation of air required for combustion. Analysis of flue gases.

Module 5: ALTERNATIVE FUEL	**8 hours**

Non-conventional sources of energy-Solar Energy, CNG, LPG, P-series fuel, Ethanol, Biodiesel, Biomass, Biogas, nuclear fuel.

Total Lecture hours	**45 hours**

Text Book(s)

1. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
2. B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut

Reference Books

1. Fuel Chemistry by Dr. Biswajit Saikia
2. Fuel Chemistry by Debasis Mohanty

SEMESTER-III (MAJOR/CORE)

	INORGANIC CHEMISTRY-I	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2) level

Course Objectives:

1. To provide knowledge of redox chemistry in metallurgical processes.
2. To make students aware of stability of s – block elements in different oxidation states, diagonal relationship and complex forming abilities.
3. To give an insight into structure and bonding of compounds formed by p – block elements.
4. To give students knowledge of different chemical properties and bonding of noble gas compounds.
5. To provide basic idea of structures of some inorganic polymers along with their applications.
6. To make students aware of different volumetric titrations used for quantitative analysis of a given substance.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To apply theoretical principles of redox chemistry in the understanding of metallurgical. Processes.

CO2: To understand about the stability of different oxidation states, diagonal relationship and complex forming abilities of s – block elements.

CO3: To gain knowledge of structure and bonding of compounds formed by p – block elements.

CO4: To learn various chemical properties and bonding of noble gas compounds.

CO5: To understand the structural aspects and applications of inorganic polymers.

CO6: To conduct quantitative analysis of a given substance by using different types of volumetric titrations.

Module 1: GENERAL PRINCIPLES OF METALLURGY — **8 hours**

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

Module 2: CHEMISTRY OF s – BLOCK ELEMENTS — **10 hours**

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

Module 3: CHEMISTRY OF p – BLOCK ELEMENTS — **12 hours**

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

Module 4: NOBLE GASES — **8 hours**

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

Module 5: INORGANIC POLYMERS	**7 hours**
Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.	
Total Lecture hours	**45 hours**

List of Laboratory Experiments:

1. Estimation of hardness of water by a standard solution of EDTA.
2. Estimation of copper by a standard solution of $Na_2S_2O_3$.
3. Estimation of oxalic acid and sodium oxalate in a given mixture.
4. Estimation of sodium carbonate and sodium bicarbonate in their mixture.
5. Estimation of sodium carbonate and sodium hydroxide in their mixture.
6. Estimation of Fe(II) by $K_2Cr_2O_7$.
7. Estimation of free chlorine in bleaching powder.

Textbook(s)

1.	Lee J. D., Concise Inorganic Chemistry, ELBS, 1991
2.	Atkin P., Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010)

Reference Books

1.	Douglas B. E., Mc Daniel D. H., & Alexander J. J., Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
2.	Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3.	Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
4.	Greenwood, N.N. & Earnshaw, . Chemistry of the Elements, Butterworth Heinemann 1997.
5.	Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
6.	A Textbook of Practical Chemistry By Dr. Sudarshan Barua

SEMESTER-III (MINOR)

	FUNDAMENTALS OF CHEMISTRY-III	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2) level

Course Objectives:

1. To provide knowledge about patterns and trends exhibited by s- and p- block elements.
2. To make the students aware of kinetics of chemical reactions.
3. To provide an insight into different types of electrolytes and hydrolysis of salt.
4. To give better understanding of oxygen containing functional groups like alcohols and phenols.
5. To make students understand about different reaction pathways of carbonyl compounds.
6. To make students familiar with different quantitaive analysis.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To explain the patterns and trends exhibited by s- and p- block elements.
CO2: To have understanding of rate law and rate of reaction.
CO3: To Explain the ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt.
CO4: To explain the preparation and properties of oxygen containing functional groups like alcohols and phenols.
CO5: To explain plausible mechanistic pathways of carbonyl compounds.
CO6: To conduct quantitative analysis of a given substance by using different types of volumetric titrations.

Module 1: CHEMISTRY OF s-BLOCK ELEMENTS — **8 hours**

General characteristics: melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of the group. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, and water. Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.

Module 2: CHEMISTRY OF p-BLOCK ELEMENTS — **8 hours**

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Catenation, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si, trends in chemical reactivity of B and anomalous behaviour of first member of the group.

Module 3: CHEMICAL KINETICS — **7 hours**

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Module 4: IONIC EQUILIBRIA — **7 hours**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of

hydrolysis and pH for different salts. Buffer solutions.

Module 5: ALCOHOLS AND PHENOLS	**7 hours**

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouveault-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;
Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

Module 6: CARBONYL COMPOUNDS-ALDEHYDES AND KETONES	**8 hours**

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$).

Total Lecture hours	**45 hours**

Practical

List of Laboratory Experiments

1. Estimation of hardness of water by a standard solution of EDTA.
2. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
3. Estimation of oxalic acid and sodium oxalate in a given mixture.
4. Estimation of Sodium carbonate and Sodium bicarbonate from their mixture.
5. Estimation of Sodium carbonate and Sodium hydroxide from their mixture.
6. Estimation of Fe(II) with $K_2Cr_2O_7$.
7. Estimation of free chlorine in bleaching powder.

Text Book(s)

1.	Lee, J.D. Concise Inorganic Chemistry ELBS, 1991
2.	Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
3.	Peter Atkins & Julio De Paula, Physical Chemistry 10th Ed., Oxford University Press (2014)
4.	Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012)
5.	Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6.	Finar, I. L. Organic Chemistry (Volume 1&2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7.	Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry.
8.	Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.

Reference Books

1.	Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2.	McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3.	Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

4.	Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
5.	Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
6.	Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
7.	A Text Book of Practical Chemistry By Dr. Sudarshan Barua
8.	Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
9.	Marr, G. and Rockett, R.W. Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972.

SEMESTER-III (MINOR)

	BASIC ANALYTICAL CHEMISTRY	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2)level

Course Objectives:

1. To give the concept of accuracy and types of errors in a chemical analysis.
2. To make students aware of different separation techniques and chromatographic methods.
3. To make students aware of different titrimetric analysis used for quantitative determination of a substance.
4. To give students theoretical knowledge to carry out analysis of soil and water sample.
5. To provide hands on experience of different analytical methods.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To learn the concept of accuracy and types of errors in a chemical analysis.

CO2: To know about different separation techniques and chromatographic methods.

CO3: To apply titrimetric methods in quantitative analysis of a substance.

CO4: To gain theoretical knowledge to carry out analysis of soil and water samples.

CO5: To analyze different samples by paper chromatography, titrimetric methods and gravimetric methods.

Module 1: ERRORS IN CHEMICAL ANALYSIS	**7 hours**

Definition of Significant figures, accuracy and precision, mean, median, variance, deviation, relative mean deviation, standard deviation. Error-Determinate and indeterminate error, absolute errors, relative errors.

Module 2: SEPARATION AND PURIFICATION TECHNIQUES	**14 hours**

Introduction, instrumental separation, filtration, solvent extraction, crystallisation and precipitation, Basic principles of Thin Layer Chromatography, Paper Chromatography, Column Chromatography, Gas Chromatography, Ion exchange Chromatography.

Module 3: TITRIMETRIC METHODS OF ANALYSIS	**10 hours**

Introduction, standard solution- primary and secondary standard types of titrations – acid base titrations, theories of acid base indicators, redox titrations, iodometric titrations, precipitation titrations.

Module 4: ANALYSIS OF SOIL	**7 hours**

Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators, Determination of pH of soil samples, Estimation of Calcium and Magnesium ions by complexometric titration.

Module 5: ANALYSIS OF WATER	**7 hours**

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods, Determination of pH, acidity and alkalinity of a water sample, Determination of dissolved oxygen (DO) of a water sample.

Total Lecture hours	**45 hours**

Practical

List of Laboratory Experiments:

1. Separation of amino acids from their mixture by paper chromatography.
2. Separation of sugars from their mixture by paper chromatography.
3. Separation of Group IIIB cations from their mixture by paper chromatography.
4. Determination of the water of crystallization in hydrated salt by gravimetric method.
5. To determine the water crystallization in Mohr's salt (ferrous ammonium sulphate), by titration with potassium permanganate ($KMnO_4$).
6. Determine the total dissolved solids in water by gravimetric method.
7. Determination of Vitamin C Content in Fruit Juice by Redox Titration.

Textbook(s)	
1.	Vogel's Textbook of Quantitative Chemical Analysis, G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, John Wiley and Sons (1989)
2.	Fundamentals of Analytical Chemistry, S. P. J. Higson, Brooks/Cole (2003)
Reference Books	
1.	Analytical Chemistry, G. D. Christian, 6th Edition, John Wiley & Sons, New York (2004).
2.	Principles and Practice of Analytical Chemistry, Wiley (2000).
3.	Quantitative Analysis, R. A. Day, A. L. Underwood, Prentice Hall of India (1991).
4.	Mikes, O. and Chalmers, R. A. Ed. Laboratory Hand book of Chromatographic and Allied Methods, Elles Horwood Ltd. London.

SEMESTER -I(MDC)

	CHEMISTRY IN EVERYDAY LIFE	L	T	P	C
		3	0	0	3

Pre-requisite: Knowledge of Basic Science

Course Objectives:

1. To make students aware of different air pollutants and their effects on the environment.
2. To provide scientific knowledge of daily used cosmetics and perfumes.
3. To make students identify different food additives, adulterants and contaminants.
4. To provide an insight into different polymeric compounds.
5. To give knowledge about composition and applications of soap, detergents, dyes and fertilizers.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To learn about the sources and effects of different types of air pollutants.
CO2: To gain knowledge of science behind different cosmetics and perfumes.
CO3: To identify different food additives, adulterants and contaminants.
CO4: To know different types of polymers and their applications.
CO5: To understand the composition and uses of soap, detergents, dyes and fertilizers.

Module 1: AIR POLLUTION — **7 hours**

Air pollutants, sources and sinks of carbon monoxide pollution, sources and sinks of nitrogen. oxide pollution, photochemical smog, acid rain, ozone hole, CFCs, particulates – sources of particulates, inorganic particulate matter, organic particulate matter, fly ash, Bhopal disaster.

Module 2: COSMETICS & PERFUMES — **7 hours**

General study of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries.

Module 3: FODD ADDITIVES, ADULTERANTS AND CONTAMINANTS — **9 hours**

Food preservatives – benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose and sodium cyclamate. Flavours: Vanillin, alkyl esters (fruit flavours) and monosodium glutamate.
Introduction to adulteration, adulterants in some common food items like coffee powder, chilli powder, turmeric powder, coriander powder and pulses.
Artificial food colorants - Coal tar dyes and non-permitted colours and metallic salts.

Module 4: POLYMERS — **7 hours**

Classification of polymers, types of polymerization – addition and condensation polymerization, Some important polymers and their applications, polymers in medicines and surgery, Biodegradable polymers and their applications.

Module 5: SOAPS AND DETERGENTS — **5 hours**

Types of soaps, synthetic detergents, cleansing action of detergents, advantages and disadvantages of detergents over soaps.

Module 6: DYE	**5 hours**
Historical background, Classification, dyes and colours for Textiles, Synthetic dyes, General Study of Azo dyes, Mordant brown, Congo red and methyl orange.	
Module 7: FERTILIZERS	**5 hours**
Composition of fertilizers, uses of Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphate, superphosphate of lime.	
Total Lecture hours	**45 hours**

Text Book(s)	
1.	Organic Chemistry by I. L. Finar, Vol. 1 & 2.
2.	Polymer Science and Technology, J. R. Fired (Prentice Hall)
Reference Books	
1.	Analysis of foods, H. E. Cox
2.	Introduction to Industrial Chemistry, B. K. Sharma, Goel Publishing (1998)
3.	Foods: Facts and Principles, N. S. Many, S. Swamy, New Age International (1998)
4.	Environmental Chemistry, A. K. De, New Age International
5.	Handbook of Fertilizer Technology by Swaminathan and Goswamy, 6th Edition, 2001, FAI

Semester - II (MDC)

	MOLECULES OF LIFE	L	T	P	C
		3	0	0	3

Pre-requisite: Knowledge of basic science

Course Objectives:

1. To provide knowledge about biomolecule which is a source of energy for life.
2. To make students aware of amino acids and proteins.
3. To make students realize the importance of enzymes.
4. To provide an introduction on selected components of hormones and vitamins.
5. To make students understand the role of metal ions in biological system.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To understand the biological importance of carbohydrates.
CO 2: To know about amino acids and proteins.
CO 3: To explain the importance of enzymes.
CO 4: To explain the biological role of vitamins and hormones.
CO 5: To understand the value of metal ions.

Module 1: CARBOHYDRATES — **9 hours**

Carbohydrates and classification, Sugars, non-sugars, reducing and non-reducing sugars. Occurrence and general properties of glucose and fructose, Open chain and Haworth ring structures of glucose and fructose, Polysaccharides: Starch, cellulose – monomer units, glycosidic linkage, biological importance of carbohydrates.

Module 2: AMINO ACIDS, PEPTIDES AND PROTEINS — **11 hours**

Amino acids, Classification of amino acids as essential and non-essential- examples. Configuration of optically active α-amino acids (found in proteins), α- amino acids, general formula, zwitter ion form of α- amino acid, general formula, Isoelectric point, proteins, classification of proteins, denaturation of proteins.

Module 3: ENZYMES — **5 hours**

Definition, classification of enzymes, characteristics of enzymes, examples of some common enzymes, co-enzymes, applications of enzymes, enzyme deficiency diseases and their cure.

Module 4: NUCLEIC ACIDS — **7 hours**

Components of nucleic acids: Adenine, guanine, thymine and cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides, polynucleotides, Structure of DNA (Watson-Crick model) and RNA (types of RNA).

Module 5: HORMONES AND VITAMINS — **7 hours**

Hormones, classification of hormones with examples, deficiency diseases of hormones. Vitamins, classification of vitamins with examples, importance of Vitamin B1, Vitamin B2, Vitamin B6, Vitamin B12, Niacin, Vitamin H, Folic Acid (Vitamin M), Vitamin C, Vitamin A, Vitamin D, Vitamin E, Vitamin K.

Module 6: ROLE OF METAL IONS — **6 hours**

Introduction to the Role of metal ions in biological systems-Fe^{+2}, Copper and Zinc, Cobalt, Manganese, selenium, chromium. Brief introduction about toxicity of metal ions ($Hg^{2+}$and

Cd^{2+}).	
Total Lecture hours	**45 hours**
Text Book(s)	
1.	Chittaranjan Bhakta, Organic Chemistry vol 2: Chemistry of Polymers and Biomolecules.
2.	Morrison, R. T. & Boyd, R. N. Organic Chemistry, sixth edition, (Pearson Education).
3.	Finar, I. L. Organic Chemistry (Volume 1), (Pearson Education).
Reference Books	
1.	Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed.
2.	Finar, I. L. Organic Chemistry (Volume 2), (Pearson Education).

SEMESTER-III (MDC)

	FUEL SCIENCE	L	T	P	C
		3	0	0	3

Pre-requisite: Knowledge of Basic Science

Course Objectives:

1. To provide basic idea of a fuel and calorific value.
2. To make the students aware of solid fuel, emphasis on coal and coke.
3. To provide an insight into liquid fuel and some important properties.
4. To make students understand gaseous fuel and their analysis.
5. To make the students aware of production and applications of biofuel.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To understand fuel and its relation with caloric value.

CO2: To explain important constituents of solid fuel and their impact on its calorific value.

CO3: To know about liquid fuel, cracking, refining, reforming, and their properties.

CO4: To know about different types of gaseous fuel.

CO5: To know the importance of biofuel and its applications.

Module 1: INTRODUCTION TO FUEL — **9 hours**

Definition, classification based on physical state, classification based on occurrence, comparison of solid, liquid and gaseous fuel, characteristics of a good fuel, calorific value – gross and net calorific values, determination of calorific value, combustion.

Module 2: COAL — **10 hours**

Types of coal, uses of coal, Pulverized coal, Proximate and ultimate analysis of coal, coke, coke as metallurgical fuel, caking and coking coals, action of heat on different coal samples, different types of coal combustion techniques, coal tar distillation, coal liquefaction, direct liquefaction, indirect liquefaction, coal gasification.

Module 3: PETROLEUM AND LUBRICANTS — **17 hours**

Origin of petroleum, classification of petroleum, mining of petroleum, Exploration, of crude petroleum, composition of crude petroleum, Refining anddifferent types of petroleum products, cracking – Thermal cracking and catalytic cracking, synthetic petrol, reforming, knocking. Classification of lubricants – lubricating oils, semi solid lubricants or greases, solid lubricants, properties of lubricants – viscosity, flash and fire points, functions of lubricants, synthetic lubricants.

Module 4: GASES — **3 hours**

Natural gas and LPG, Producer gas, Water gas, Coal gas, Oil gas

Module 5: BIOFUEL — **6 hours**

Introduction and perspective of biofuels, environmental impact of biofuel, production and applications of biomass, biodiesel, biogas, bioethanol.

Total Lecture hours — **45 hours**

Textbook(s)

1. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
2. Industrial Chemistry-B. K. Sharma.

Reference Books	
1.	Fuel Chemistry by Dr. Biswajit Saikia
2.	Fuel Chemistry by Debasis Mohanty

Detailed Syllabus:

SEMESTER-IV (CORE)

	ORGANIC CHEMISTRY – I	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2) level

Course Objectives:

1. To provide knowledge about the structure and reactivity of carbonyl compounds.
2. To impart understanding of different conformations.
3. To make students familiar with different arrays of compounds containing nitrogen, their preparation and reactions.
4. To provide theoretical knowledge and hands on experience with different laboratory techniques.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To Recall carbonyl compounds, cycloalkanes and nitrogen containing functional groups.
CO2: To explain the differences between carbonyl compounds, cycloalkanes and nitrogen containing functional groups.
CO3: To identify the synthetic pathways of different types of compounds and conformations of cycloalkanes.
CO4: To inspect different types of organic compounds.

Module 1:Carbonyl Compounds — **14 hours**

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations, and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, PDC and PCC).
Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Module 2: Cycloalkanes and Conformational Analysis — **10 hours**

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms: Relative stability with energy diagrams.

Module 3:Nitrogen Containing Functional Groups — **21 hours**

Preparation and important reactions:
Nitro compounds- classification and general methods of preparation: from alkyl halides, alkanes, oxidation of amines and oximes and diazonium salts.
Nitriles- Preparation from the following reactions: Dehydration of amides and aldoximes, from Grignard reagents and from dehydrogenation of primary amines, Reaction with Grignard reagent, hydrolysis, addition reaction with HX, NH_3, reaction with aqueous ROH, Reduction reactions-catalytic reduction and Stephen's reaction, Condensation reactions-Thorpe Nitrile Condensation.

and sulphur, Grignard reaction, oxidation and rearrangement.
Amines: Effect of substituent and solvent on basicity: Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich Reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction: Distinction between 1°, 2°, and 3°, amines with Hinsberg reagent and nitrous acid.
Diazonium Salts: Preparation and their synthetic applications.

Total Lecture hours	**45 hours**

LABORATORY EXPEIMENTS

List of Laboratory Experiments:

1. Purification of organic compounds by crystallization using the following solvents:
a. Water
b. Alcohol
c. Alcohol-Water
2. Chromatography
a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.
b. Separation of a mixture of two sugars by ascending paper chromatography.
3. Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid).
4. Iodoform reaction of Acetone
5. Selective reduction of meta dinitrobenzene to m-nitroaniline.
6. Benzil-Benzilic acid rearrangement.
7. Preparation of Methyl Orange from Sulphanilic acid.

Text Book(s)

1.	Clayden, J., Greeves, N. & Warren, S. Organic Chemistry,Second edition, Oxford University Press, 2012.
2.	Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3.	Finar, I. L. Organic Chemistry (Volume 1&2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4.	Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
5.	Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
6.	Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.

Reference Books

1.	Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2.	McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013
3.	Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4.	Carey, F. A.; Sundberg, R. J. Advanced Organic Chemistry: Reactions and Synthesis (Part B), Springers.
5.	Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
6.	A Text Book of Practical Chemistry By Dr. Sudarshan Barua
7.	Dutta, S, B. Sc. Honours Practical Chemistry, Bharati Book Stall.

	PHYSICAL CHEMISTRY – I	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2) level

Course Objectives:

1. To provide knowledge of chemical equilibrium.
2. To provide a fundamental insight into the macromolecules.
3. To make students understand the electrochemistry laws, equations, and cells.
4. To provide knowledge about colloidal states and applications.
5. To make students understand the phase rule and its applications.
6. To provide students concepts and skills of physical chemistry experiments.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: Understand the concepts chemical equilibrium, electrochemistry and apply it to solve related mathematical problems and to predict feasibility of reactions.

CO2: Acquire the fundamental knowledge of macromolecules, polymerization reactions, molecular weight and apply the knowledge to evaluate the molecular weight of polymers.

CO3: Understand and apply the concept of the colloidal state and its application in different fields.

CO4: Acquire the fundamental knowledge of Phase rule and apply it.

CO5: Acquire the practical concepts, develop the competencies and skills of physical chemistry experiments, apply it in different fields, analyze and evaluate them.

Module 1:CHEMICAL EQUILIBRIUM — **10 hours**

Reversible reactions, Chemical equilibrium and its Characteristics, Law of mass action, Law of chemical equilibrium, Vant Hoff's reaction isotherm, chemical equilibrium of Homogeneous and Heterogeneous systems, Derivation of expression of equilibrium constants- temperature- pressure and concentration dependence of equilibrium constants (K_P, K_C, K_X)- Le Chatelier's principle of dynamic equilibrium. Temperature dependence of equilibrium constants, Vant Hoff's equation, Hydrogen-Iodine equilibrium, dissociation of PCl_5, dissociation of $CaCO_3$, Mathematical problems and solutions.

Module 2: ELECTROCHEMISTRY — **10 hours**

Molar conductance and Kohlraursh's law of ionic conductance-Application of Kohlraursh's law-Debye–Huchel theory of strong electrolyte- Activity co-efficient- mean activity co-efficient- Ionic strength- Salt effect–primary and secondary salt effect.

Galvanic cell and electrochemical series- Nernst equation- Concentration cell- liquid junction potential- reference electrode-standard Hydrogen electrode- calomel electrode- glass electrode-quinhydrone electrode and measurement of pH- Different types of electrochemical cells- Fuel cell-Potentiometric titrations- concept of polarography and Half wave potential.

Module 3: MACROMOLECULES — **10 hours**

Macromolecules, Historical background, Classification of polymers, Tacticity, Isotactic, Atactic and Syndiotactic polymers, Homopolymers and Copolymers, Random, Alternating, Block and Graft polymers; Rubbers, Plastics and Fibres; Linear, branched and cross-linked polymers; Molecular weight of polymer, Number average and Weight average molecular weight, Viscosity average

Viscometry, Osmometry,
Commodity and Engineering plastics, Synthesis and uses of some important Commodity and Engineering plastics, Thermosetting and Thermoplastics- Synthesis of Bakelite- Biodegradable Polymer.

Module 4: COLLOIDAL STATE	**10 hours**

Difference between true solution, colloidal solution and suspension, Phases of colloidal solutions, Classification of colloids, Lyphilic and Lyphobic colloids, Micelles, Preparation of colloids, Dialysis, Properties of colloidal solutions, Tyndall effect, Sedimentation, Electrophoresis, Origin of charge, Doble layer theory, protective colloids, Gold number, Emulsions, Determination of size of colloidal particles, Application of Colloids in different fields.

Module 5: Phase Rule	**5 hours**

Phase, Component and Degree of Freedom, The Phase rule and its applications, Derivation of Phase rule, Phase diagram, Overview of Application of phase rule to one and two component systems.

Total Lecture hours	**45 hours**

Physical Chemistry I Laboratory

List of Laboratory Experiments

1. Laboratory safety and precautions.
2. Calibration and use of apparatus and instruments.
3. Determination of surface tension of a given liquid by using a Stalagmometer.
4. Determination of viscosity of a liquid by using Ostwald viscometer.
5. Determination of rate constant and energy of activation of given ester catalyzed by acid. (first order / second order)
6. Study of a redox reaction: Standardization of potassium permanganate solution by standard oxalic acid solution
7. Standardization of sodium thiosulphate solution by standard potassium dichromate solution by Iodometric method.
8. Determination of Strength of HCl solution by titrating it against NaOH solution conductometrically.
9. Determination of the strength of an unknown acetic acid solution by conductometric titration against a strong base.
10. To determine the strength of mixture of strong acid and weak acid by conductometric method.
11. Spectrophotometric determination of concentration of $KMnO_4$ solution

Text Book(s)

1. B.R. Puri, L.R Sharma, M.S. Pathania, “Principles of Physical Chemistry” Vishal Publishing Co. India
2. P.W. Atkins, “Physical Chemistry”, 8th Edition, Oxford University Press, New York.
3. F.W. Billmeyer, Jr.”Text Book of Polymer Science” 3rd Edition, 1984, Willey – Interscience, New York.

Reference Books

1. J. O’M. Bockris& A.K.N. Reddy,” Modern Electrochemistry”, Vol. 2 A & B, 2nd Edition, Plenum Press, New York, 1998.
2. N.Karak., “Fundamentals of Polymers”, PHI Learning Private Limited, 2009.
6. Levine, I .N. “Physical Chemistry”, 6th Ed., Tata Mc Graw Hill (2010).
8. A Text Book of Practical Chemistry By Dr. Sudarshan Barua

	INORGANIC CHEMISTRY – II	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at H.S. level

Course Objectives:

The course is being offered with the following objectives:

1. To make students familiar with molecular symmetry.
2. To provide basic concepts of coordination compounds.
3. To discuss the basics and applications of acids and bases.
4. To provide knowledge of oxidation and reduction.
5. To provide knowledge of qualitative inorganic salt analysis.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To define molecular symmetry, coordination compounds, acids, bases, oxidation and reduction.

CO2: To explain the basics of molecular symmetry, coordination compounds, acids-bases and oxidation and reduction.

CO3: To identify symmetry elements, symmetry operations and acid-base strength.

CO4: To apply the acquired knowledge for solving problems of coordination compounds and oxidation -reduction.

CO5: To analyse inorganic salts qualitatively.

Module 1:INTRODUCTION TO MOLECULAR SYMMETRY — **8 hours**

Symmetry elements and operations, molecular point groups, symmetry elements present in C_{2v}, C_{3v}, T_d and O_h point group (pictorial representation), introductory idea of character tables, Mulliken symbols.

Module 2:COORDINATION CHEMISTRY-I — **12 hours**

Introduction to coordination complexes (Werner theory, types of ligands) IUPAC nomenclature, isomerism in coordination complexes, stereochemistry of complexes with coordination numbers 4, 5, and 6.

Module 3: CONCEPTS OF ACIDS AND BASES — **12hours**

Acid-base concepts, measure of acid and base strength, proton affinity, acidity and basicity of binary hydrogen compounds, inductive effect and strength of oxyacids, acidity of aqua ions, steric effect, proton sponge, solvation and acid base strength, non-aqueous solvents and acid base strength, superacids and superbases. Applications of hard and soft acid base (HSAB) principle, and symbiosis.

Module 4: OXIDATION AND REDUCTION — **13 hours**

Reduction potentials: Redox half-reactions, standard potentials and spontaneity, trends in standard potentials, the electrochemical series, Nernst equation (Influence of pH and concentration on electrode potential). Principles of redox titration and choice of redox indicators.

Total Lecture hours — **45 hours**

LABORATORY EXPERIMENTS

Inorganic qualitative analysis:

Qualitative analysis of mixtures containing four cations and anions. Emphasis should be given to the understanding of reactions. The following radicals are suggested: CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}

Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions such as CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and I^-.
Spot tests should be done whenever possible.

Text Book(s)

1.	General and Inorganic Chemistry, R.P. Sarkar (part 1), 3rd edition, NCBA.
2.	Concise Coordination Chemistry, R. Gopalan, V. Ramalingam, 1st edition, Vikash PublishingHouse.
3.	Inorganic Chemistry (Principles of Structure and Reactivity), J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 5thedition, Pearson Education.
4.	Principles of Inorganic Chemistry, 7th edition, Puri, Sharma, Kalia, Vishal Publishing Co.
5.	**Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.**
6.	**A Textbook of Practical Chemistry By Dr. Sudarshan Barua**

Reference Books

1.	Inorganic Chemistry, G.L. Meissler and D. A. Tarr, 5th edition, Pearson.
2.	Inorganic Chemistry, P. Atkins, Overtone Rourke, Weller and Armstrong 5th edition, Oxford.
3.	Inorganic Chemistry (Principles of Structure and Reactivity), J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 5th edition, Pearson Education.
4	Advanced Inorganic Chemistry, F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann, Wiley.

Elective-I

	ANALYTICAL CHEMISTRY	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2) level

Course Objectives:

1. To provide knowledge of different quantitative analysis.
2. To make students aware of the treatment of analytical data.
3. To give an insight into different separation techniques in chemical analysis.
4. To give students knowledge of different chromatographic techniques.

Course Outcome:

After successful completion of the course, the students will be able

CO1: To explain principles of quantitative and separation techniques in different chemical analysis.

CO2: To analyze various redox, complexometric, iodometric and precipitation reactions through titrations and chromatography along with treatment of data by different methods.

CO3: To estimate a compound using volumetric and gravimetric analysis.

CO4: To apply the methods of solvent extraction, ion exchange and chromatography in various processes.

Module 1:QUANTITATIVE ANALYSIS — **10 hours**

a) Importance in various fields of science, steps involved in chemical analysis. Principles of volumetric analysis: Theories of acid-base, redox, complexometric, iodometric and precipitation titrations - choice of indicators for these titrations.

b) Principles of gravimetric analysis: precipitation, coagulation, peptization, coprecipitation, post precipitation, digestion, filtration and washing of precipitate, drying and ignition

Module 2: TREATMENT OF ANALYTICAL DATA — **7 hours**

Types of errors, significant figures and its importance, accuracy - methods of expressing accuracy, error analysis and minimization of errors, precision - methods of expressing precision, standard deviation and confidence limit.

Module 3: SEPARATION TECHNIQUES IN CHEMICAL ANALYSIS — **8 hours**

SOLVENT EXTRACTION: Introduction, principle, techniques, factors affecting solvent extraction, Batch extraction, continuous extraction and counter current extraction. Synergism., Application - Determination of Iron (III)

ION EXCHANGE: Introduction, action of ion exchange resins, separation of inorganic mixtures, applications, Solvent extraction: Principle and process

Module 4:PURIFICATION TECHNIQUE 1 — **10 hours**

Chromatography: Classification of chromatography methods, principles of differential migration adsorption phenomenon, Nature of adsorbents, solvent systems, Rf values, factors affecting Rf values.

Paper Chromatography: Principles, Rf values, experimental procedures, choice of paper and solvent systems, developments of chromatogram - ascending, descending and radial. Two-dimensional chromatography, applications.

Module 5:PURIFICATION TECHNIQUE 2 — **10 hours**

Thin layer Chromatography (TLC): Advantages. Principles, factors affecting Rf values. Experimental procedures. Adsorbents and solvents. Preparation of plates. Development of the chromatogram. Detection of the spots. Applications.

HPLC: Basic principles and applications.	
Total Lecture hours	**45 hours**

LABOATORY EXPERIMENTS

List of Laboratory Experiments:

1. Determination of Rf value of amino acids using paper chromatography.
2.Separation and identification of monosaccharides present in a given mixture by paper chromatography.
3.Determination of equivalent conductance of a weak electrolyte (acetic acid) at different concentrations.

4. Analysis of soil
i) Determination of pH of soil.
ii) Determination of total soluble salts.
iii) Determination of carbonate and bicarbonate.
iv) Determination of calcium, magnesium and iron.

5. Determination of adulterant in some common food items
i) Chicory in coffee powder
ii) Foreign resin in asafetida
iii) Chilli powder
iv) Turmeric powder
v) Pulses

Text Book(s)

1.	Skoog, D.A.; West, D.M. & Holler, F.J. Analytical Chemistry: An Introduction 6th Ed., Saunders College Publishing, Fort Worth, Philadelphia (1994).
2.	Dean, J. A. Analytical Chemistry Handbook, McGraw Hill, 2004.
3.	Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

Reference Books

1.	Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
2.	Skoog, D.A., Holler, F.J. & Crouch, S. Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.
3.	Harris, D. C. Quantitative Chemical Analysis, 9th ed. Macmillan Education, 2016
4.	Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India, 1992.
5.	Freifelder, D.M. Physical Biochemistry 2nd Ed., W.H. Freeman & Co., N.Y. USA (1982).
6.	Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996.
7.	Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Elective -I

	POLYMER CHEMISTRY	L	T	P	C
		3	0	2	4

Pre-requisite: Knowledge of chemistry at (10+2) level

Course Objectives:

1. To provide knowledge of polymers, their unique properties, scope and challenges.
2. To provide an insight into the raw materials and methods in polymer synthesis.
3. To make students understand about structure, property and testing of polymers.
4. To provide knowledge about thermoplastic polymers.
5. To provide knowledge about natural rubber latex and resins.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: Understand the concepts of polymers, their unique properties, raw materials, fundamentals of synthesis of polymers and structure property relationships.

CO2: Apply the knowledge of synthesis and properties of polymers to predict structure-based property, testing and analyzing of polymers and investigate their properties to obtain desired applications.

CO3: Acquire the knowledge of thermoplastics, natural rubber latex and synthetic resins.

CO4: Acquire the laboratory skills of synthesis of polymers, analyzing, testing and applying the skills to utilize in solving real world problems related to polymers.

Module 1:INTRODUCTION TO POLYMERS — **10 hours**

Introduction to polymers, historical background, Uniqueness of polymers, Difference of polymers over other categories of materials, Difference between polymers and fine chemicals, Nomenclature, Classification depending on source, mode of formation, chemical linkage, structure, thermal response, type of repeating units and physical properties. Scopes and challenges of polymers.

Module 2: Materials and Methods in Polymer Synthesis — **10 hours**

Raw materials, monomers and starting materials, Initiators, Catalyst, Inhibitor, Retarder, Chain transfer agents, Polymer forming processes-Chain polymerization and Step growth polymerization, Techniques of polymerization- Mass or bulk technique, Solution technique, Suspension technique, Emulsion polymerization technique and other special techniques.

Additives for polymers-types of additives, Process aid, Antidegradant, Fillers, coupling agent, Curing agent, Flame retardant, Blowing agent, Thixotopic agent, etc.

Module 3: Structure, Property and Testing of Polymers — **10 hours**

Molecular weight of polymer, Number average and Weight average molecular weight, Viscosity average molecular weight, Poly disparsity index (PDI), Determination of molecular mass of polymers. Glass transition temperature and factors affecting glass transition temperature. Thermosetting and Thermoplastics.

Testing of Polymers- MFI, LOI, Processibility testing, rheological behavior testing by viscometer and rheometer, Physical testing, Durability testing, Mechanical testing, Flammability testing, Adhesion, Electrical testing.

Module 4: Thermoplastic Polymers — **10 hours**

Commodity, Engineering and Specialty plastics, Synthesis, properties, and applications of the following polymers-

Condensation Plastics- PET and Polyamides
Rearrangement Polymers- Polyurethane
Natural and Modified Plastics- Cellulose, Cellulose nitrate, Cellulose acetate, Carboxy methyl cellulose, regenerated cellulose, Chitin and Chitosan, Carrageenans.

Module 5: Elastomers and Resins	**5 hours**

Characteristic properties of elastomers or rubbers, Natural Rubber (NR), Isolation and collection of Latex, Processing of latex, The composition and functions of NR latex, Grades of NR, Structure and Property, Application. Overview of synthetic rubbers. Synthesis, properties and applications of Phenolic and Amino resins. Concept of thermosetting resins, biodegradable polymers, andGreen chemistry.

Total Lecture hours	**45 hours**

Polymer Chemistry Laboratory

List of Laboratory Experiments:

1. Preparation of Phenol – Formaldehyde resin.
2. Preparation of Urea – Formaldehyde resin.
3. Synthesis of Melamine- Formaldehyde
4. Determination of viscosity of a polymer solution by using Brookfield viscometer.
5. Measurement of MFI.
6. Determination of LOI.
7. Determination of hardness by using hardness tester.
5. Synthesis of Polystyrene by suspension polymerization method.
7. Synthesis of PMMA by emulsion polymerization method.
8. Plastic processing and moulding experiments.
9. Determination of Adhesive strength.
10. Study of Rheological behavior of polymers by viscometer and rheometer.

Text Book(s)

1.	P. Ghosh, Polymer Science and Technology: Plastics, Rubbers, Blends and Composites, Third Edition, McGraw Hill Education Private Limited (India), 2011
2.	N.Karak., “Fundamentals of Polymers”, PHI Learning Private Limited, 2009.
3.	F.W. Billmeyer, Jr.”Text Book of Polymer Science” 3rd Edition, 1984, Willey – Interscience, New York.

Reference Books

1.	J. A. Brydson, Plastics Materials, 4th edn., Butterworths, London, 1982
2.	Odian, G. Principles of Polymerization (Wiley, 2004).