DEPARTMENT OF CHEMISTRY

PROGRAM SPECIFIC OUTCOME

TDC Chemistry (B Sc Honours and General Course):

After the completion of TDC Honours Course and General Course in Chemistry, the students are expected to achieve the following programme specific outcomes (PSO):

PSO 1: The Students gathers knowledge on the basic concept of inorganic, organic, physical, Spectroscopy, quantum, Analytical chemistry and be acquainted with the different branches of chemistry like environmental, biochemistry, medicinal, nanomaterials etc.
PSO 2: The students develop capability to correlate aspects of chemistry to the other allied multidisciplinary subjects like mathematics, physics, Statistics, environmental science etc.

PSO 3: The Learners would have a strong foundation in chemistry relating to scientific reasoning and problem solving perception.

PSO 4: The Learners grow the skills of conducting qualitative and quantitative analysis of materials, chemicals, water analysis through the use of standard laboratory apparatus and sophisticated instruments to carry out experiments in laboratories as well as in industries.

PSO 5: The Students gather knowledge on the principles and guidelines of green chemistry to perform experiments in sustainable and eco friendly way.

COURSE OUTCOME

The Department of Chemistry follows the syllabus and adheres to the curriculum structure as directed by the affiliating Assam University. During the three years of the B. Sc. Chemistry Honours programme, spread over 6 semesters,17 theory papers, 17 practical papers and 1 project work are taught. The Semester wise distribution of the Papers and their Course Outcomes are as follows:-

SEMESTER 1	
Name of the paper: **Inorganic Chemistry –I**	On completion of this course, the students will attain knowledge of atom, atomic structure, and their periodic properties, Chemical bonding and redox properties. Students will learn and develop the concepts of:

Atomic Structure and Chemical Bonding Paper Code: **CHMHCC101T**	**CO1: Atomic Structure** Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation,. Quantum numbers and their significance. Pauli's Exclusion Principle, Hund's rule, Aufbau's principle and its limitations. **CO2: Periodicity of Elements** Long form of periodic table. Periodic properties of the elements, Effective nuclear charge, Atomic radii, Ionization enthalpy, Electron gain enthalpy, Electronegativity. **CO3: Chemical Bonding I** Ionic bond, Covalent bond, Molecular orbital theory. Valence shell electron pair repulsion theory (VSEPR), **CO4: Chemical Bonding II** (i) Ionic character in covalent compounds (ii) Covalent character in ionic compounds,. (iii) Metallic Bond: (iv) Weak Chemical **CO5: Oxidation-Reduction** Redox reactions, Standard Electrode Potential and its application to inorganic reactions, concept of formal Electrode Potential, Principles involved in volumetric analysis
Name of the paper: **Practical** **CHMHCC103L**	After the completion of the practical course the students will be able to perform : **1. CO1: Titrimetric Analysis** **7 marks** (i) Calibration and use of apparatus (ii) Preparation of solutions of different Molarity/Normality of titrants **CO2: Oxidation-Reduction Titrimetry** **14 marks** **(iii)** Estimation of Fe (II) and oxalic acid using standardized KMnO4 solution.

	(iv) Estimation of Fe (II) with K2Cr2O7solution
Name of the paper: **Physical Chemistry –I** States of Matter and Ionic Equilibrium Paper Code: **CHMHCC102T**	Once this course is completed, the students will be able to learn the concepts of **CO1: Gaseous State I :** Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases. **CO2: Gaseous State II:**Behaviour of real gases: van der Waals equation of state, its derivation and application in explaining real gas behaviour, virial equation of state. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states. **CO3: Liquid State** Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. **CO4: Solid State** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, X-ray diffraction, Bragg's law. Defects in crystals. Glasses and liquid crystals. **CO 5: Ionic Equilibria** Strong, moderate and weak electrolytes, degree of ionization, Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Theory of acid–base indicators; selection of indicators and their limitations.

Name of the paper: **Practical** Paper Code: **CHMHCC104L**	At the end of this course, the students will be able to perform the following experiments of their own. **CO1:** a) Determination of transition temperature of the given substance by thermometric method (e.g., $MgSO_4/MnCl_2/Na_2SO4.10H_2O$). b) To determine the surface tension of glycerol/acetic acid/aniline solutions at different Concentrations and construction of graph. **CO2:** a) Preparation of Sodium acetate-acetic acid buffer solutions of different pH b) Preparation of Ammonium chloride-ammonium hydroxide buffer solutions of different pH c) pH metric titration of strong acid/strong base, d) pH metric titration of weak acid/strong base.
SEMESTER 2	
Name of the paper: **Organic Chemistry –I** Hydrocarbons and Stereochemistry Paper Code: **CHMHCC201T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO1: To understand the Basics of Organic Chemistry** Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications **CO2: To develop the knowledge on Chemistry of Aliphatic Hydrocarbons** Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: **CO3: To gather knowledge on Aromatic and Polynuclear Hydrocarbons** Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and

Name of the paper:	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. **CO 4: Stereochemistry** Fischer Projection, Newmann and Sawhorse Projection formulae and their inter-conversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism:Relative and absolute configuration: D/L and R/S designations. **CO5: Cycloalkanes and Conformational Analysis** Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: At the end of this course, the students will be able to perform the following experiments of their own. **CO1: Purification:** **10 marks** (a) Phthalic acid / Benzoic acid from hot water (using fluted filter paper and stem-less funnel) (b) Acetanilide from boiling water (c) Naphthalene/m-Dinitrobenzene from ethanol (d) Naphthalene/ camphor/phthalic acid (by sublimation) **CO2: Chromatographic separation** **11 marks** (a) 2,4-Dinitrophenyl hydrazones of any two carbonyl compounds (e.g., benzophenone and benzyl; p-nitrobenzaldehyde and benzaldehyde) from their mixture and

Practical Paper Code: **CHMHCC203L**	determination of Rf values (By Thin layer chromatography) (b) Paper chromatographic separation and determination of R*f* values of mixture of any three amino acids from their mixture (alanine, glycine and leucine or any other set). Spray reagent: Ninhydrin.
Name of the paper: **Physical Chemistry –II** Chemical Thermodynamics and its Applications Paper Code: **CHMHCC202T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO 1: Chemical Thermodynamics I** Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. First law: Concept of heat (q), work (w), internal energy (U), and statement of first law; enthalpy (H), Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; **CO2: Chemical Thermodynamics II** Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics. Third Law: Statement of third law, concept of residual entropy, Free Energy Functions: Gibbs and Helmholtz energy; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state. **CO 3: Systems of Variable Composition** Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation **CO4: Chemical Equilibrium** Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic

	derivation of relation between Gibbs free energy of reaction and reaction quotient.. Le Chatelier's Principle. **CO 5: Solutions and Colligative Properties** Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.
Name of the paper: **Practical** Paper Code: **CHMHCC204L**	**They will have hands-on training on** **CO1: Physical Experiments:** i. To determine the viscosity of glycerol/acetic acid solutions at different concentrations and construction of the graph. ii. To determine the solubility of benzoic acid at different temperatures and to determine pH of the dissolution process. iii. To determine the refractive index of a given liquid by Abbe refractometer and to find the specific and molar refraction. iv. To determine the molecular mass by transition point method (Solvent: Naphthalene /*m*-dinitrobenzene and Solute: Glucose/Urea)
SEMESTER 3	
Name of the paper: **Inorganic Chemistry –II** s- & p-block Elements and Metallurgy	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO 1: Chemistry of s- and p- Block Elements** Inert pair effect, Relative stability of different oxidation states, diagonal relationship Hydrides, Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds

Paper Code: **CHMHCC301T**	**CO2:** Noble Gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory). **CO3: Acids and Bases** Brönsted-Lowry concept of acid-base reactions, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB), Application of HSAB principle. **CO4: Inorganic Polymers** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. borazines, silicates. **CO 5: General Principles of Metallurgy** 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 processes and Mond's process, Zone refining.
Name of the paper: **Practical** Paper Code: **CHMHCC304L**	They will have hands-on training on **CO I: Iodo- / Iodimetric Titrations** (*i*) Estimation of Cu (II) and K2Cr2O using sc (Iodometrically). 7 (*ii*) Estimation of (i) arsenite and (ii) antimony iodimetr (*iii*) Estimation of available chlorine in bleaching powde **CO2: Inorganic preparations** (*i*) Cuprous Chloride, Cu2Cl2

	(*ii*) Preparation of Manganese (III) phosphate, MnPO4.H (*iii*) Preparation of Aluminium potassium sulphate KAl(SO4)2.12H2O (Potash alum) or Chrome alum. (*iv*) Preparation of Chrome alum.
Name of the paper: **Organic Chemistry –II** Halogen & Oxygen Containing Functional Groups Paper Code: **CHMHCC302T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO 1: Chemistry of Halogenated Hydrocarbons** Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent **CO2: Alcohols, Phenols, Ethers and Epoxides** Alcohols: Phenols: Ethers and Epoxides: Preparation and reactions with acids. **CO 3: Carbonyl Compounds** Structure, reactivity and preparation; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α- substitution reactions, oxidations and reductions **CO 4: Carboxylic Acids and their Derivatives** Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation and Curtius rearrangement. **CO5: Other Organic compounds** Preparation and reactions of thiols, thioethers and sulphonic acids. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications

Name of the paper: **Practical** Paper Code: **CHMHCC305L**	of diethyl malonate and ethyl acetoacetate. At the end of this course, the students will be able to perform the following experiments of their own. **CO I: Tests for functional groups** **14marks** Alcohols, phenols, carbonyl and carboxylic acid group. **CO2: Organic preparations:** **7 marks** i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (*β*-naphthol, vanillin) by conventional/green approach method. ii. Benzoylation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the following phenols (*β*-naphthol, resorcinol, *p*- cresol) by Schotten-Baumann reaction. iii. Nitration of Acetanilide/nitrobenzene by conventional method iv. Nitration ofSalicylic acid (preferably by green approach using ceric ammonium nitrate).
Name of the paper: **Physical Chemistry –III** Phase Equilibria and Chemical Kinetics Paper Code: **CHMHCC303T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO 1: Phase Equilibria I** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. **CO2: Phase Equilibria II** Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional

Name of the paper: **Practical** Paper Code:	distillation of binary miscible liquids **CO 3: Chemical Kinetics** 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, kinetics of complex reactions rates. **CO4: Catalysis** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis. **CO5: Surface chemistry** Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state. Students will have the practical knowledge on : **CO 1: Study of the equilibrium of the following reactions by the distribution method:** (*i*) $I_2(aq) + I^- \rightarrow_3 I^-(aq)$ (*ii*) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$ **CO2: Study the kinetics of the following reactions marks** a) Initial rate method: Iodide-persulphate reaction b) Integrated rate method: Acid hydrolysis of methyl acetate with hydrochloric acid. c) Integrated rate method: Saponification of ethyl acetate. d) Comparison the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate. e) Adsorption: Verification of the Freundlich isotherms for adsorption of oxalic acid / acetic acid on activated charcoal.

CHMHCC306L	
SEMESTER 4	
Name of the paper: **Inorganic Chemistry –III** Coordination Chemistry and its Applications Paper Code: **CHMHCC401T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO1: Coordination Chemistry I** Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). **CO 2: Coordination Chemistry II** IUPAC (2005) nomenclature, Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, **CO 3: Transition Elements** General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties and ability to form complexes. **CO4: Lanthanoids and Actinoids** Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides **CO 5: Bioinorganic Chemistry** Metal ions present in biological systems, classification of elements according to their action in biological system,Toxicity of metal ions They will have Practical knowledge on
Name of the paper: **Practical** Paper Code: **CHMHCC404L**	**CO1: Gravimetric Analysis:** **14 marks** i. Estimation of nickel (II) using Dimethylglyoxime (DMG). ii. Estimation of copper as CuSCN iii. Estimation of iron as Fe2O3 by precipitating iron as Fe(OH)3.

	CO2: Inorganic Preparations: **7 marks** iv. Tetraamminecopper (II) sulphate, [Cu(NH3)4]SO4.H2O v. Sodium trioxalatochromate (III) vi. Tetraamminecarbonatocobalt (III) ion vii. Potassium tris(oxalate)ferrate (III)
Name of the paper: **Organic Chemistry –III** Heterocyclic Chemistry Paper Code: **CHMHCC402T** Name of the paper: **Practical**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO1: Nitrogen Containing Functional Groups** Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines:. Diazonium Salts: Preparation and their synthetic applications. **CO2: Heterocyclic Compounds - I** Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom **CO3: Heterocyclic Compounds - II** Pyrimidine, Structure elucidation of indole, Derivatives of furan: Furfural and furoic acid. **CO4: Alkaloids** Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. **CO5: Terpenes** isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and -terpineol. They will be able to get knowledge on : **CO1: Qualitative Organic analysis** **21 marks**

Paper Code: **CHMHCC405L**	Detection of elements (N, S and halogens) and functional groups, determination of melting points and preparation of suitable derivatives to identify the given organic compounds
Name of the paper: **Physical Chemistry –IV** Electrochemistry Paper Code: **CHMHCC403T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO1: Conductance I** Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. **CO2: Conductance II** Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers **CO3: Electrochemistry I** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. **CO4: Electrochemistry II** Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH valuesusing hydrogen/glass electrodes. **CO 5: Electrical & Magnetic Properties of Atoms and Molecules** Clausius-Mosotti equation Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements.
Name of the paper: **Practical** Paper Code: **CHMHCC406L**	**At the end of the course, they will have the Practical expertise on** **CO1: Physical experiments:** **10.5x2=21marks** 1. pH metric titration of HCl against standard NaOH 2. To determine the strength of the given acid conductometrically using standard

	alkali solution. 3. Determination of equivalent conductances of a strong electrolyte at various dilutions and verification of Onsagar equation. 4. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. 5. Conductometric titration of a mixture of strong and weak acid *vs* strong base. **6.** pH metric titration of a mixture of strong and weak acid *vs* strong base. **7.** Potentiometric titration of ferrous ammonium sulphate against standard K2Cr2O7/ KMnO4 and determination of redox potential of Fe(II)- Fe(III) system
SEMESTER 5	
Name of the paper: **Organic Chemistry –IV** Biomolecules Paper Code: **CHMHCC501T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO1: Nucleic Acids** Components of nucleic acids, Nucleosides and nucleotides; **CO2: Amino Acids, Peptides and Proteins** Amino acids, Peptides and their classification. determination of their primary structures-end group analysis, methods of peptide synthesis. **CO 3: Enzymes** Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. **CO 4: Lipids** Introduction to oils and fats; common fatty acids present in oils and fats,. **CO 5: Pharmaceutical Compounds: Structure and Importance** Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics:

Name of the paper: **Practical** Paper Code: **CHMHCC503L**	**At the end of the course, they acquire the Practical knowledge on:** **CO1: Organic synthesis:** **7 marks** (a) Acetylation of salicylic acid, aniline, and hydroquinone, benzoylation of aniline and phenol. (b) Aliphatic electrophilic substitution: preparation of iodoform from acetone/ethanol. (c) Aromatic electrophilic substitution: preparation of m-dinitrobenzene/preparation of methyl orange. **CO2: Organic quantitative analysis:** **14 marks** (i) Estimation of glucose/cholesterol/ urea/uric acid by colorimeteror by chemical methods. (ii) Determination of saponification equivalent of an ester
Name of the paper: **Physical Chemistry –V** Quantum Chemistry and Spectroscopy Paper Code: **CHMHCC502T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO1: Molecular Spectroscopy I** Born- Oppenheimer approximation. Rotation spectroscopy, Vibrational spectroscopy: **CO2: Molecular Spectroscopy II** Raman spectroscopy, Electronic spectroscopy: Nuclear Magnetic Resonance (NMR) spectroscopy: **CO3: Photochemistry** Lambert-Beer's law and its limitations, Laws, of photochemistry, quantum yield, Chemiluminescence.

Name of the paper: **Practical** Paper Code: **CHMHCC504L**	Students will gather the Practical knowledge on the following at the completion of course. **CO1:** Verification of Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration **CO2**:Determination of the concentrations of KMnO4 and K2Cr2O7 in a mixture. **CO3:** Study of the kinetics of iodination of propanone in acidic medium. **CO4:** Determination of the amount of iron present in a sample using 1,10-phenathroline. **CO5**:Determination of the dissociation constant of an indicator (phenolphthalein). **CO6:** Study of the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
SEMESTER 6	
Name of the paper: **Inorganic Chemistry –IV** Organometallic Chemistry Paper Code: **CHMHCC601T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO 1: Organometallic Compounds - I** Metal carbonyls: 18 electron rule, Ferrocene: Comparison of aromaticity and reactivity with that of benzene. **CO 2: Organometallic Compounds - II** Metal Alkyls, bonding in these compounds. Ziegler – Natta Catalyst. **CO 3: Reaction Kinetics and Mechanism** Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes. **CO4: Catalysis by Organometallic Compounds** 1. Alkene hydrogenation (Wilkinsons Catalyst)

	2. Hydroformylation (Co salts) 3. Synthetic gasoline (Fischer Tropsch reaction) 4. Synthesis gas by metal carbonyl complexes **CO5: Principles in Qualitative Analysis** Basic principles involved in analysis of cations and anions and solubility products, common ion effect..
Name of the paper: **Practical** Paper Code: **CHMHCC603L**	**Students will gather the Practical knowledge on the following at the completion of course.** **CO1: Qualitative Inorganic Analysis** **21 marks** Qualitative analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested: CO_3^{2-}, NO^-, 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+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+} Mixtures should preferably contain one interfering anion, or insoluble component e.g., $BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3 or combination of anions e.g. CO_3^{2-} and SO_4^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, $B_4O_7^-$ rand I^-, NO_3^- and Br^-, NO_3^- and I^-.
	Once this course is completed, the students will be able to learn, understand and develop the concepts of:

Name of the paper: **Organic Chemistry –V** Spectroscopy, Dyes and Polymers Paper Code: **CHMHCC602T**	**CO1: Organic Spectroscopy I** UV Spectroscopy: Types of electronic transitions, IR Spectroscopy: IR for identification of simple organic molecules. **CO 2: Organic Spectroscopy II** NMR Spectroscopy: Basic principles of Proton Magnetic Resonance **CO3: Carbohydrates** Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, Killiani Fischer synthesis **CO 4: Dyes** Classification, Colour and constitution **CO 5**: Polymers Polymerisation reactions- Fabrics – natural and synthetic fabrics (acrylic, polyester); Rubbers – natural and synthetic rubbers: Buna-S, Chloroprene and Neoprene; Vulcanization.
Name of the paper: **Practical** Paper Code: **CHMHCC604L**	Students will gather the Practical knowledge on the following at the completion of course. **CO1:The students were able to perform the following experiments after the completion of Course** **10.5x2-21 marks** i. Extraction of caffeine from tea leaves. ii. Preparation of sodium polyacrylate. iii. Preparation of urea formaldehyde. iv. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars. v. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).

	vi. Preparation of methyl orange.
Name of the paper: **Analytical Methods in Chemistry** Paper Code: **CHMDSE501T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO1: Qualitative and quantitative aspects of analysis** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression **CO2: UV-Visible and IR Spectrometry** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. *UV-Visible Spectrometry*, *Infrared Spectrometry* **CO3: Flame Atomic Absorption and Emission Spectrometry** Basic principles of instrumentation **CO 4: Thermal and electro-analytical methods of analysis** Theory of thermo-gravimetry (TG), basic principle of pH metric, potentiometric and conductometric titrations. **CO5: Separation techniques** *Solvent extraction*: *Chromatography*: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange.: TLC and HPLC.
Name of the paper: **Practical** Paper Code: **CHMDSE503L**	Students will gather the Practical knowledge on the following at the completion of course. **CO1: The Experimental aspects of :** **10.5x2=21 marks** i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}. ii) Separation and identification of the

	monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values. iii) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values. iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC v) Determine the pH of the given aerated drinks fruit juices, shampoos and soaps. vi) Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques. vii) Analysis of soil: determination of pH of soil, total soluble salt, estimation of calcium, magnesium, phosphate, nitrate viii) Separation of metal ions from their binary mixture. ix) Separation of amino acids from organic acids by ion exchange chromatography. x) Determination of dissolved oxygen in water. xi) Determination of chemical oxygen demand (COD).
Name of the paper: **Green Chemistry** Paper Code: **CHMDSE502T**	Be aware of the principles and guidelines of green chemistry to perform experiments without disturbing the equilibrium of nature **CO1: Introduction to Green Chemistry** What is Green Chemistry, Green Chemistry in sustainable development. **CO2: Principles of Green Chemistry and Designing a Chemical synthesis** Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles

Name of the paper: **Practical** Paper Code: **CHMDSE504L**	**CO 3: Designing a Chemical synthesis** Designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances, to prevent and minimize the generation of hazardous substances in chemical processes. **CO4: Examples of Green Synthesis/ Reactions I** Green Synthesis of adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines **CO 5: Examples of Green Synthesis/ Reactions II** Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction. Students will gather the Practical knowledge on the following at the completion of course. **CO1:** Safer Stating Materials The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch – study of effect of concentration on clock reaction **CO2: Using Renewable Resources** Preparation of biodiesel from vegetable oil. **CO3:Green Reactions** **11 marks** a) Reaction between furan and maleic acid in water and at room temperature rather than inbenzene and reflux. b) Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice. c) Mechanochemical solvent free synthesis of azomethines d) Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II). **CO4:** Photoreduction of benzophenone to benzopinacol in the presence of sunlight

Name of the paper: **Inorganic Materials of Industrial Importance** Paper Code: **CHMDSE601T**	Once this course is completed, the students will be able to learn, understand and develop the concepts of: **CO1: Silicate Industries** Glass, Ceramics, Cements **CO2: Fertilizers** Different types of fertilizers. Manufacture of the fertilizers **CO 3: Surface Coatings** Objectives of coatings surfaces, Paints and pigments-formulation, composition and related properties. **CO4: Batteries** Primary and secondary batteries, battery components and their role **Unit 5: Alloys** Classification of alloys, ferrous and non-ferrous alloys, Composition and properties of different types of steels.
Name of the paper: **Practical** Paper Code: **CHMDSE603L**	Students will gather the Practical knowledge on the following at the completion of course. **CO1: Experimental aspects of 21 marks** a. Determination of free acidity in ammonium sulphate fertilizer. b. Estimation of Calcium in Calcium ammonium nitrate fertilizer. c. Estimation of phosphoric acid in superphosphate fertilizer. d. Electroless metallic coatings on ceramic and plastic material. e. Determination of composition of dolomite (by complexometric titration).

	f. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples. g. Analysis of Cement.
Name of the paper: ***Dissertation* (*Project Work*)** Paper Code: **CHMDSE602P**	Students will gather the Practical knowledge on the *Dissertation* (*Project Work*) at the completion of course. **CO1:** Project work on inorganic / physical / analytical / biochemical / environmental / agricultural or others related interface areas may be undertaken. Project work can be experimental, theoretical or both. The following activities have been outlined as guidelines (not exhaustive): (a) Physiochemical studies (pH, conductivity, turbidity, etc.) of different wetlands (ponds, lakes, river etc.) (b) Analysis of iron in pond / tube well / river water. (c) Analysis of Ca^{2+} / Mg^{2+} / As^{3+} / As^{5+} in soil / water samples. (d) Adulteration detection activities. (e) Extraction and preliminary characterization of useful chemicals (as far as possible) from plants. (f) Solubility, surface tension, and viscosity measurements of some solution of practical relevance, (cough syrup, soap solution, pesticides, fertilizers,... etc.) (g) Pollution related activities. (h) Nutrition related activities, (essential metal detection in food, cereals, pulses, fruits etc.) (i) Heavy metal uptake / sequestering activities, (from nature and laboratory based experiments.
