

DEPARTMENT OF CHEMISTRY



SYLLABI OF COURSES

FOR

BACHELOR IN INDUSTRIAL CHEMISTRY PROGRAMME

UNIVERSITY OF ENGINEERING & TECHNOLOGY, KARACHI-75270 PAKISTAN

Bachelor of Science in Industrial Chemistry

FIRST YEAR

Fall Semester					Spring Semester				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		Th	Pr.	Total			Th	Pr.	Total
CY-113	Inorganic Chemistry I	3	0	3	CY-120	Analytical Chemistry I	3	0	3
CY-114	Organic Chemistry I	3	0	3	CY-117	Physical Chemistry I	3	0	3
CY-118	Industrial Chemistry Lab-I	0	1	1	CY-119	Industrial Chemistry Lab-II	0	1	1
HS-104	Functional English	3	0	3	HS-105/ HS-127	Pakistan Studies/ Pakistan Studies (for Foreigners)	2	0	2
PH-123	General Physics-I	2	1	3	EE-119	Fundamental of Electrical Engineering	3	1	4
MT-173	Calculus	3	0	3	CT-158	Fundamental of Information Technology	2	0	2
					PH-124	General Physics-II	2	1	3

SECOND YEAR

Fall Semester					Spring Semester				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		Th	Pr.	Total			Th	Pr.	Total
CY-205	Inorganic Chemistry II	3	0	3	CY-209	Analytical Chemistry II	3	0	3
CY-208	Organic Chemistry II	3	0	3	CY-210	Physical Chemistry II	3	0	3
CY-206	Industrial Chemistry Lab-III	0	1	1	CY- 207	Industrial Chemistry Lab-IV	0	1	1
HS-205/ HS-209	Islamic Studies/ Ethical Behavior (for Non-Muslims)	2	0	2	HS-201	Oral Communication	2	1	3
MT-223	Ordinary Differential Equations & Fourier Series	3	0	3	CH-202	Fluid Mechanics-I	3	1	4
MT-331	Probability & Statistics	3	0	3	EL-102	Basic Electronics	3	1	4
CT-153	Programming Languages	2	1	3					

THIRD YEAR

Fall Semester					Spring Semester				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		Th	Pr.	Total			Th	Pr.	Total
CY-313	Polymer Science	3	0	3	CY-404	Separation Techniques	3	0	3
CY-305	Industrial Stoichiometry	3	0	3	CY-303	Reaction Kinetics Unit	3	0	3
CY-310	Industrial Chemistry Lab V	0	1	1	CY-308	Processes Industrial	3	0	3
HS-301	Business & Organizational Commination	3	0	3	CY-311	Industrial Chemistry Lab -VI	0	1	1
CH-206	Thermodynamics	3	1	4	CY-314	Natural Products	3	0	3
CY-312	Spectroscopy	3	0	3	CY-315	Nuclear & Radiation Chemistry	3	0	3
					CH-203	Chemical Process Industries	3	0	3

FOURTH YEAR

Fall Semester					Spring Semester				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		Th	Pr.	Total			Th	Pr.	Total
CY-402	Environmental Chemistry	3	0	3	CY-416	Nanotechnology	3	0	3
CH-405	Industrial Safety & Maintenance Management	2	1	3	##-##	Elective-III	-	-	-

##-##	Elective-I	-	-	-	##-##	Elective-IV	-	-	-
##-##	Elective-II	-	-	-	CY-415	Industrial Chemistry Project	0	6	6
CY-415	Industrial Chemistry Project*	0	6	6					

Elective Courses

Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		T	P	Total			T	P	Total
CY-403	Beverage Technology	3	0	3	CY-411	Surface Coatings	3	0	3
CY-406	Fat & Oil Processing	3	0	3	CY-413	Surfactants and Cosmetics	3	0	3
CY-414	Pharmaceutical Chemistry	3	0	3	CH-406	Petroleum Refining & Petrochemicals	3	0	3
					CY-408	Polymer Technology	3	0	3
					CH-407	Industrial Organization & Management	2	1	3

CY-113 INORGANIC CHEMISTRY I

Atomic Structure: Development of theories for atomic structure, Discovery of fundamental subatomic particles, Bohr's model for Hydrogen, Line spectrum, Introduction to quantum mechanics, Quantum numbers and their significance, Wave Mechanics, Wave properties of the matter, the Schrödinger equation.

Periodic Table: Electronic configuration and periodic table, Periodicity, Group trends in atomic and ionic radii, Ionization energies, Electro negativity, Ionization potential, Electron affinity, Oxidation potentials, Electrode potential, Magnetic properties, Para and diamagnetisms.

Chemical Bonding in s and p Block Elements: Effective atomic number and shielding constant, Types of chemical bonds, Ionic bond, covalent bond, The concept of hybridization and its applications, Writing wave equations of hybrid orbitals, Lattice energy and Born Haber cycle of Ionic compounds, Related numerical.

s- and p- Block Elements Periodicity in s- and p- block elements, Allotropy in C, S, and P. Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Compounds of s- and p- Block Elements Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements. Concept of multicentre bonding (diborane). Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry. Hydrides of nitrogen (NH₃, N₂H₄, N₃H, NH₂OH) Oxoacids of P, S and Cl. Halides and oxohalides: PCl₃, PCl₅, SOCl₂ and SO₂Cl₂

Industrial Gases and Inorganic Chemicals

(a) **Industrial Gases:** Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

(b) **Inorganic Chemicals:** Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

CY-114 ORGANIC CHEMISTRY I

Basic Concepts: Bonding, Reactivity of organic compounds, Oxidation states of carbon, Structure and stability of reactive intermediates, Electrophiles and Nucleophiles, Types of reactions, Factors effecting reactions (reaction mechanism

Isomerism: Structural, Stereo, Geometrical and Optical isomerism

Chemistry Of Alkanes And Cycloalkanes: Nomenclature, Natural occurrence and Physical properties, Preparation and Reactions of alkane and cycloalkane.

Chemistry of Alkenes And Alkyne: Nomenclature, Natural occurrence, Physical properties, acidity, Preparations and reactions of alkenes and alkynes.

Aromatic Hydrocarbons and Heterocyclic Compounds: Nomenclature, Aromaticity, Preparation and Reactions of aromatic compounds, Electrophilic substitution reactions of benzene, Heterocyclic aromatic compounds (5 and 6 membered), Importance in pharmaceutical industry.

Alkyl Halides: Nomenclature, Classification and physical properties, Preparation of alkyl halides.

Important Industrial Organic Chemicals:

Large scale production and derived products of the following important industrial chemicals: Ethene, Butanes, Butadiene, BTX Chemistry (Benzene, Toluene, Xylene).

CY-120 ANALYTICAL CHEMISTRY I

Introduction: Introduction and scope of analytical chemistry, Major steps in total chemical analysis, a general survey of all analytical methods.

Errors in Chemical Analysis: Evaluation of reliability of analytical data, Significant figures, Selection of central best value from a set of data, Precision and accuracy, Methods to measure precision, Classification of errors, Distribution of data from replicate measurements, Comparison of results, Student 't' test, Modern trends in quality control.

Gravimetric Methods of Analysis: combustion analysis, Precipitation process: solubility, filterability, purity, composition of the product, scope of gravimetric analysis, calculation of gravimetric analysis.

Acid Bases and Buffers: Acid Base strength, pH and pOH, buffer solution and buffer capacity.

Volumetric Methods of Analysis: Titration calculations, precipitation titration, acid base titration, acid base indicators, Primary standards for acids and bases, acid base titrations in non-aqueous solutions, redox titration, end point location in acid base titrations, oxidation-reduction titrants, non-aqueous redox titrations, complexation titrations, titrations for complexation titrations, complexation titration curves, end point location in complexation titrations.

Spectroscopic Methods of Analysis: Overview of spectroscopy, basic components of spectroscopic instrumentation, Absorbance of electromagnetic Radiation, Transmittance and absorbance, Beer's Law, Limitations to Beer's Law, Ultraviolet-Visible Spectrophotometry: instrumentation, Quantitative and qualitative applications. Atomic Absorption spectrophotometry: instrumentation, Quantitative and qualitative applications.

Calibrations and Standardizations: Reagents used as standards, Single point vs multiple point standardizations, External standards, Standard Additions, Internal Standards, Linear regressions and calibration curves.

Analysis of Real Samples: Sampling, Digestion of samples by dry and wet ashing with special reference to Kjeldahl's method for nitrogen determination, Fluxes.

CY-117 PHYSICAL CHEMISTRY I

Introduction to Phase Equilibria: Phase, component and degree of freedom, Phase rule and its applications, One component system (water, carbon dioxide), Polymorphism, Enantiotropy, Two component systems (sulphur, Pb, Ag system), Vapour pressure diagram, Temperature composition diagrams, Azeotropes, Liquid-liquid phase, Liquid-solid phase.

Chemical Dynamics in Gases: The Postulates of kinetic theory of Gases, Translational K.E. of molecules, kinetic theory of temperature, Energy units for PV and RT, Mean Square velocity & Root mean square velocity, Graham's law of effusion, Distribution of molecular velocities, Vander Waal's equation.

Kinetic Theory of Matter: Theories pertaining to distribution of energies into different groups, Maxwell Boltzmann distribution law for energies of molecular systems, Method for the determination of Avogadro's number.

Solution: The properties of mixtures/solutions, Concentration terms, Thermodynamic description of mixtures, Partial molar quantities, Chemical potential of liquids, Ideal solutions, Raoult's Law, The properties of solutions: liquid mixtures, Colligative properties, Common features of colligative properties, Elevation of boiling point,

Depression of freezing point, Solubility, Osmosis and Osmotic pressure, Solvent and solute activity, Vant Hoff's theory of dilute solutions.

Conductance: Theory of electrolytes, Electrolytic conduction, Conductance, Specific, Equivalent and molar conductance, Circuit of conductivity meter, Measurements of cell constant, Arrhenius theory of ionization, Debye Hackle theory, Asymmetry or relaxation effect, Solvent effect, Electrophoretic effect, Debye Huckel Onsagar equation, Ion pair, Ion triplet formation, Transport numbers, Ion motilities and their calculations, Types of conductometric titrations, Applications of conductance in relation to A_a & K_a for weak and strong electrolyte, Determination of absolute ionic motilities, Solubility of sparingly soluble salts, K_w , Basicity of an organic acid, Speed ratio by transport number, Advantages of conductometric titration over volumetric titration.

Electrochemistry: Introduction to electrochemical processes: Redox Reactions, Electrode potential of a cell, Nernst theory of electrode potential, Laws of electrolysis, Characteristics of working cell, Corrosion, Rate of corrosion, Inhibition of corrosion, Electrical currents in ionic solutions:

CY-205 INORGANIC CHEMISTRY II

Transition Elements (3d series) General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanides and actinides: Electronic configurations, Oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ionexchange method only).

Coordination Chemistry Valency Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of Nomenclature.

Crystal Field Theory Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Molecular Orbital Theory: Molecular Orbital Energy diagrams of octahedral, tetrahedral and square planar complexes, Writing molecular orbital configuration of octahedral, tetrahedral and square planar complexes, π -bonding in complexes and its effect on Crystal Field Splitting Energy.

Magnetic Properties of Complex ions: Paramagnetic and diamagnetic complexes, Calculation of μ_s , μ_{s+L} , μ_{eff} and the relationship between the three.

Electronic Absorption Spectrum of Transition metal Complexes: Octahedral and tetrahedral complexes, d_2-d_8 ions Energy level diagram, Charge transfer spectra.

Chemistry of 3d metals: Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation, industrial application and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

CY-208 ORGANIC CHEMISTRY II

Alcohols And Phenols: Classification, Nomenclature, Physical properties, Preparation and reactions of Alcohols and phenols.

Ethers: Nomenclature and physical properties, Preparation and reactions.

Carbonyl Compounds (Aldehydes and Ketones): Nomenclature, Natural occurrence, Physical properties, Reactions of aldehydes and ketones.

Carboxylic Acids And Their Derivatives: Nomenclature, Natural occurrence, Physical properties and preparation of carboxylic acids

Amines: Nomenclature, Classification and physical properties of amines, Preparation and reaction of amines.

Important	Industrial	Organic	Chemicals:
Large scale production and derived products of the following important industrial chemicals acetophenone, Formaldehyde, Ester and simple amines.			

Green Synthesis/Reactions:

Green Synthesis of the following compounds Adipic acid, Catechol, Urethane, Benzyl bromide, Acetaldehyde, Aromatic amines (4-aminodiphenylamine), ibuprofen, paracetamol, Microwave assisted reactions.

CY-209 ANALYTICAL CHEMISTRY II

Fundamentals of Electrochemistry: Electrical measurements, Galvanic cells, standard potentials, Nernst Equation, Relationship between E° and equilibrium constant, Nernst Equation for half reactions, classification of electrochemical methods.

Potentiometric Methods of Analysis: potentiometric measurements, Reference Electrodes(NHE, SCE, Ag/AgCl), metallic Indicator Electrodes, membrane electrodes, Quantitative and Qualitative applications.

Coulometric Methods of Analysis: controlled-potential coulometry, controlled-current coulometry, Quantitative and Qualitative applications.

Voltammetric Methods of Analysis: Voltammetric measurements, current in voltammetry, shapes of voltammograms, voltammetric techniques: polarography, Amperometry, Quantitative and Qualitative applications.

Chromatographic Methods of Analysis: Principles of chromatography, classification, techniques of chromatography, General Theory of column chromatography (chromatographic resolution, capacity factor, column selectivity, column efficiency, peak capacity, non-ideal behavior)

Gas Chromatography: Mobile phase, chromatographic columns, stationary phases, temperature control, sample introduction, detectors for gas chromatography, Quantitative and Qualitative applications.

High-Performance Liquid Chromatography:

HPLC columns, stationary phases, mobile phases, HPLC plumbing, sample introduction, Detectors for HPLC, Qualitative and quantitative applications.

CY-210 PHYSICAL CHEMISTRY II

Chemical Equilibrium: Spontaneous chemical reactions and equilibrium, Properties of equilibrium state, Le Chatelier's Principle, the reaction quotient, Response of equilibria to the conditions such as concentration, pressure, temperature, Relationship between K_c and K_p , Heterogeneous equilibria, Nature of solubility equilibria, Distribution law and its validity, Application of the distribution law to the selected systems like solvent extraction, Extraction of metals from their ore, Investigation of complex ions,

Thermochemistry: Enthalpy, Entropy, Standard states, Hess's Law. Bond energies

The Properties Of Surfaces: Properties of liquid surfaces, Surfactants, Experimental study of surface films, physical properties of monolayer, Langmuir-Blodgett film, Adsorption of liquid on surface, physisorption, chemisorption, Adsorption isotherm: The Langmuir isotherm, The BET isotherm, Freundlich isotherm.

Colloidal systems: Introduction, properties of colloids, Classification, Preparation and purification of colloids, Emulsion, Emulsifiers

Macromolecules: Natural and synthetic polymers, conducting and non-conducting polymers, Their applications and reactivity.

CY-313 POLYMER SCIENCE

Monomers, polymers, nomenclature; molecular forces and chemical bonding (primary and secondary atomic and molecular bonding) in polymers; different functional groups and their properties; classification of polymers (thermoplastics and thermosets); polymer structure: skeletal structure, copolymers, tacticity, and geometrical isomerism; molar mass and its distribution.

Principles of polymerization: Classification of polymerization reaction, step-growth polymerization; kinetics, chain length regulation, Carothers equation.

Addition / chain growth polymerization, mechanism and kinetics of chain growth polymerization, ionic polymerization, chain transfer, inhibition and retardation, control of molecular weight.

Co polymerization: Principle and Industrial practice

Polymerization techniques: bulk polymerization, solution polymerization, suspension polymerization, and emulsion polymerization.

1. Thermoplastics, thermosets, and elastomers.

Properties and applications of :Commodity thermoplastics: polyolefins, vinyl polymers, polymethyl methacrylate.

Engineering thermoplastics — acrylonitrile butadiene styrene ABS, polyamides, polycarbonate, thermoplastic polyester (PET), acetal, modified poly (phenylene-oxide), polysulfones, poly (phenylene-sulphide), fluoropolymers. Engineering thermosets: phenol formaldehyde, epoxies, formaldehyde resins, unsaturated polyesters, and polyurethane.

Elastomer: natural rubber, styrene butadiene rubber (SBR), nitrile rubber, polychloroprene, ethylene propylene diene monomer (EPDM), silicone, thermoplastic elastomer

Compounding, vulcanization, and role of different additives in elastomer.

Specialty Polymers: Polyimides, Ionic polymers, polyaryetherketones, specialty polyolefins, inorganic polymers, liquid crystal polymers, conductive polymers, high performance fibers, and dendritic polymers.

2. Polymer additives: Fillers and reinforcements, plasticizers, and other important additives.

CY-305 INDUSTRIAL STOICHIOMETRY

Units and Dimension, conversion of units dimension analysis, stoichiometric and composition, concepts of ideal gases, vapor pressure saturation and humidity as applied material balance calculation Introduction to material & energy balance computation.

Material balancing involving consecutive reactions, recycling and purging of streams, energy computation and conservation in respect of selected unit process and unit operation combined material and energy balance calculation over process with particular reference to petroleum refining.

CY-312 SPECTROSCOPY

Infrared Spectrophotometry: Interaction of IR radiation with molecules, Types of molecular vibration, Selection rules, Instrumentation, Optical materials, Sources, Detectors used in IR spectroscopy, Interferometric (Fourier Transform), Spectrophotometers, Calibration and standardization, Preparation of samples for the analysis of solids, Liquids and gases.

Nuclear Magnetic Resonance Spectroscopy: Introduction, Chemical shift, Spin-spin splitting (spin coupling), Relaxation times

NMR Instrumentation: Magnets, Sample probes, Radiofrequency sources, Detectors, Techniques in instrumentation, Sample handling, NMR solvents, Purity, Reference compounds (TMS).

Quantitative Aspects: $^1\text{H-NMR}$ Interpretation, Structure elucidation, $^{13}\text{C-NMR}$ Interpretation, Structure elucidation.

Mass Spectrometry: Introduction to mass spectrometry, EI, CI, FAB, MALDI MS. Instrument components, Behavior and interpretation of various classes of compounds in mass spectrometry, Applications in chemical analysis.

Luminescence Spectrometry: Introduction, Types of luminescence, Energy level, Luminescent molecules, Process involving excited states i. e. Absorption, Vibrational relaxation, Internal conversion, Florescence, Intersystem crossing, and Phosphorescence. Instrumentation for fluorescence measurements and phosphorescence measurements.

Atomic Absorption Spectroscopy: Flame and Electro thermal Atomization Method; Sample Atomization, Types and sources of atomic spectra, Radiation sources, Burner and nebulizer, Atomization cells, Atomic absorption spectroscopy, Flame emission spectroscopy, Interferences and their control.

Atomic Emission Spectroscopy: Use of Gotrian diagram. Phenomenon of flame emission and interferences encountered in flame emission

CY-404 SEPARATION TECHNIQUES

Evaporation: Types of evaporator, jacketed, horizontal and vertical tube evaporators, force circulation evaporation, entrainment separators, multiple effect evaporator.

Distillation: Boiling and distillation, vapor liquid equilibria, azeotropic mixture, multicomponent systems, flash distillation, steam distillation, vacuum distillation, extractive distillation, batch and continuous distillation, fractional distillation, equipment and working rectifiers, use of packed column

Extraction: Liquid equilibria, reflux and agitation, extraction equipment, continuous contact equipment, packed spray extractors, leaching, continuous leaching, counter current extraction

Filtration: Theory of filtration, pressure and vacuum filtration, filter aids, principles of cake filtration, cake filtration parameters, washing filter cake, centrifugal filtration, Nutsch and continuous filters

Crystallization: Crystallization from aqueous, non-aqueous solutions and melts, factors accelerating growth, separation of crystals, contaminants and their removal, crystal hydrates and solvates, decomposition of crystals, deliquescence and hygroscopicity, efflorescence, dehydration, crystallization equipment

CY-303 REACTION KINETICS

Introduction and Scope of Chemical Kinetics: Experimental techniques for the determination of reaction rate, real time analysis, quenching method, flow method, stopped flow technique, flash photolysis, and electrochemical analysis, Factors affecting the rate of chemical reaction, Order and molecularity, Kinetics' of Zero order reaction, first order reaction, second reaction order (with same initial and different initial concentration), and pseudo order reactions, Half -life for various order reactions, Methods for the determination of order of reactions, The collision Theory, The Transition State Theory, The Arrhenius Theory, Activation parameters. The kinetics and mechanism of complex reactions: chain reaction, polymerization, catalysis and oscillation.

Third and higher order reactions: Deduction of third order reactions with same and different initial concentrations of the reactants, Rate expression of $2A+B \longrightarrow$ Products, Relation between rate equations for the forward and backward reactions, Reversible first order reactions, Consecutive first order reaction, Effect of temperature on rate constant and equilibrium constant, frequency factor, Concept of steric and energy factor, Arrhenius parameters for bimolecular reactions. Metathesis reactions not involving atoms, Association reactions of radicals, Hinshelwood theory of unimolecular reaction, Bimolecular collision theory, Trimolecular reactions, Branched and unbranched chain reactions.

Influence of ionic strength on the reaction rate. Reactions in solutions, Effect of dielectric constant of the medium on the rate of the reaction. Single sphere activated complex model. Double sphere activated complex model, Complex reactions, Chain reactions, Single chain carrier with second order breaking, One chain carrier with first order breaking. Two chain carrier with second order breaking, Experimental techniques for fast reactions.

CY-308 UNIT PROCESS

Catalysts: Characteristics and mechanisms of catalyzed reactions – Homogeneous catalysis – Acid base catalysis – Heterogeneous catalysis – Chemisorption physisorption – Langmuir and Rideal mechanisms – Promoters and poisons – Enzyme catalysis – Oxidation, hydrogenation, cracking and acid catalysis in industries.

Nitration, Sulphonation and Amination: Nitrating agents, kinetics and mechanism, thermodynamics and industrial nitration processes. Sulphonating and Sulphating agents, kinetics; mechanism and thermodynamics, desulphonation, industrial processes. Aminating agents and catalysts, factors affecting ammonolysis, kinetics and thermodynamics, ammonia recovery Amination by reduction processes.

Oxidation, Hydrogenation and Halogenation

Oxidizing agents and oxidative reactions, liquid phase and vapour phase oxidation, kinetics and thermo chemistry catalytic hydrogenation and hydrogenolysis, kinetics and thermodynamics, industrial processes Halogenation reactions, kinetics and thermodynamics.

Hydrocarbon Synthesis

Constituents Petroleum – Methods - Refining Synthetic Petrol – Cracking – Thermal Cracking, Catalytic Cracking – Polymerization - Hydrocarbon Synthesis – Fischer Tropsch processes for hydrocarbon synthesis. Thermodynamics and kinetics of Fischer – Tropsch processes, Industrial process.

Esterification, Hydrolysis and Alkylation: Esterification by organic acids, carboxylic acid derivatives – Esters by addition of unsaturated systems Esters by inorganic acids Hydrolysis – Hydrolyzing agents – Kinetics – Equilibrium of hydrolysis. Alkylation – types, agents, factors controlling alkylation.

CY-314 NATURAL PRODUCTS

Introduction: Primary and secondary natural products, Biochemistry (Scope and history), Cell structures and their functions, Origin and nature of biomolecules.

Vitamins: Introduction, Fat and water soluble vitamins, Chemistry and structural determination of vitamin B₁ (Thiamine), B₂ (Riboflavin) and Vitamin B₆ (Pyridoxine).

Carbohydrates: Introduction to carbohydrates, Monosaccharaides: Natural occurrence. Structure, Stereochemistry and absolute configuration, Stereo chemical relationship with glyceraldehyde, Stereoisomers of aldoses from D and L glyceraldehyde, Determination of ring size of aldoses and pentoses, Structure determination of D-(+)Glucose: Chemical methods, Spectroscopic methods, Reactions of monosaccharaides, Structure, occurrence and importance of deoxysugars, Amino sugars and Dihydroxy sugars. **Steroids:** Introduction to steroids, Cholesterol, Occurrence, Isolation, Physical properties, Medicinal importance and Structure elucidation by chemical methods and spectroscopic methods.

Proteins: Chemistry, Classification, Physical and chemical properties of amino acids, Biological significance of amino acids, Peptides and Proteins, Primary, Secondary, Tertiary and Quaternary structure of proteins, Denaturation of proteins.

Alkaloids: Introduction, Occurrence, Classification, Nomenclature, General methods for the detection of structure of alkaloids, Physical methods: IR, UV, Mass, ¹H-NMR and ¹³C-NMR spectroscopy and chemical Methods: Oxygen functions; Hydroxyl, Carboxylic, Carbonyl, Ester, Lactone, Amido, Lactam or betaine, Methoxy and methylenedioxy group, Zerewittinoffs active hydrogen, Nitrogen functions, Determination of basic skeleton: Hoffmann's exhaustive methylation, Emed's modification, Von-Braun's method, ZnCl₂-distillation, Fusion with KOH, Oxidation, Reduction, Presence of unsaturation.

Terpenes and Terpenoids: General introduction, Classification, Isoprene rule, General methods of determining the structure. Monoterpenes: Acyclic: Chemistry and synthesis of myracene, citral and geraniol, Monocyclic: Terpenol, Bicyclic: Chemistry and synthesis of pinene and camphor, Diterpenes, Gibbrellins: Chemistry and structural determination using spectroscopic methods.

CY-315 NUCLEAR & RADIATION CHEMISTRY

Atomic nucleus, Nuclides, Nuclear stability, Modes of decay, Nuclear models (shell + liquid drop model), Fusion and fission, Non spontaneous nuclear processes, Nuclear reactors, Beta decay, Systematic nuclear spins.

Nuclear Reactor: Design types and working of reactor.

Detection Methods: Methods based on ion collection, Scintillation detectors, Semiconductor detectors, Discussions on specific applications of detection devices.

Study of Labeled Compounds: Preparation and dispersion of labeled compounds, Details of job oriented labeled compounds.

Statistics of Radioactive Decay: Decay rate and statistics, Practical consideration, Optimum counting rate, Background count.

Radiation Protection and Control: Units of radiation exposure, Safety measures.

Radioisotopes in Chemical Applications: Radiocarbon dating, Isotope dilution techniques, Neutron activation analysis, Radiometric analysis, Gravimetric methods, Radio immune assay, Applications of radioisotopes in pharmaceutical dispersions, Radio tracers in chemical applications, Study of self-exchange reactions.

Mosbauer Spectroscopy: Basic information, Experimental technique Parameters and chemical applications of Mossbauer spectroscopy.

Radiation Dosimetry: Dose, Absorbed dose units, Radiation yields, Dosimetry methods of absolute measurement, Chemical dosimetry, Fricke dosimeter, Dosimetry in pulse radiolysis.

Reactions in Radiation Chemistry: General energy transfer, Characteristics and applications of gas, liquid and solid phase radiolysis, Instrumentation, Purity of chemicals and methods, Recent applications of radiation chemistry, Radiation hazards and safe disposal of radioactive wastes.

CY-402 ENVIRONMENTAL CHEMISTRY

Atmospheric Chemistry: The air around us, atmospheric temperature and pressure profile, Temperature inversion and photochemical smog, particulate matter in the atmosphere, Industrial pollutants, radioactivity, atmospheric aerosols, Acid rain –major sources, mechanism, control measures and effects on buildings and vegetation, Global

warming – major greenhouse gases, mechanism, control measures and global impact, The stratospheric ozone – the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Water Pollution and Water Treatment: sources of water pollution-industrial sources and agricultural sources, heavy metals contamination of water, Eutrophication, detergents and phosphates in water, water quality criteria, Water purification – primary, secondary and advanced treatment, Removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Soil Pollution: Soil and mineral resources, general principles of metal extraction, Heavy metals contamination of soil, toxicity of heavy metals, bio-accumulation of heavy metals, Organic matter in soil, Macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Green Revolution: pest control, pesticides, toxicity of pesticides, integrated pests management. Energy Production and Environment: liquid and gaseous fuel, hydrogen economy. Renewable Energy: nuclear energy, solar energy, geothermal and tidal energy.

CY-416 NANOTECHNOLOGY

Nanochemistry: Introduction, definition, length scales, importance of nanoscale and its technology, self-assembly of materials, self-assembly of molecules, porous solids, nanowires, nanomachines and quantum dots.

Nano Particles: Introduction, types of nanoparticles, preparation, properties and uses of gold, silicon, silver, zinc oxide, iron oxide, alumina and titania nanoparticles.

Synthetic Techniques: Equipment and processes needed to fabricate nano devices and structures, top down and bottom up approaches, common growth methods.

Nano Materials: Preparation, properties and applications of carbon nanotubes, nanorods, nano fibre and nanoclay.

Instrumental Techniques: Electron microscopes – scanning electron microscopes (SEM) – transmission electron microscopes (TEM) – scanning probe microscopy – atomic force microscopy (AFM) – scanning tunneling electron microscope (STEM) – basic principles only.

CY-403 BEVERAGE INDUSTRIES

Introduction: Definitions and Classifications

Mineral Water: Technology; Chemical Constitutions and Microbiology.

Soft Drinks: Carbonated & Non-Carbonated Beverages. Classifications; Compositions; Processing; Production; Bottling and Canning.

Fruit Juices: Citrus and Non-Citrus - Definitions; Classifications; Compositions; Processing; Production; Bottling and Canning.

Stimulating Beverages: Tea & Coffee - Types and Classification, Cultivation, Fresh Leaf Composition; Black Tea Manufacturing; Instant Tea Manufacturing; Biological Activity of Tea, Chemistry of Coffee; Green Coffee Processing; Conversion of Green Coffee into Black, De-caffeination of Coffee.

Chocolate Based Drinks: Introduction, Agronomy, Technology, Cocoa-Based Beverages; Biological Activity; Chemistry and Microbiology of Cocoa.

CY-406 FATS AND OILS

Introduction: Sources of Oils & Fats; General Uses; Classification of Lipids; Structure and Nomenclature of Fat; Chemical Compositions.

Extraction: Methods of Oil Extraction from Seeds and Fruits; Expeller & Screw Press; Solvent extraction; Rendering - Wet & Dry Rendering.

Processing: Refining Methods; Physical and Chemical Refining; De-gumming; Neutralization; Bleaching; Deodorization; Fractionation; Winterization; Hydrogenation; Interesterification; Esterification; Refining Efficiency; Refining By-products; Soap Stock; Processing & Refining of different Oils.

Characteristics of Oil & Fats: Physical & Chemical Characteristics of Oils and Fats.

Spoilage: Oxidative and Hydrolytic Rancidity; Causes & Inhibition.

Industrial Fats: Frying Oil; Shortenings; Margarine and Mayonnaise

Additives & Processing Aids:Antioxidants used in Edible Oils; Potential Hazards of Approved Antioxidants; Color Agents used in Edible Oils and Fats; Natural Identical Colors.

CY-414 PHARMACEUTICAL CHEMISTRY

Transformation of Chemicals into Drugs: Physiochemical Properties In Relation To Biological Action: Complex events between drug administration and drug action. Solubility, partition coefficient and drug-receptor interactions.

Factors Influencing Dosage Formations:Disintegration, dissolution and absorption of drugs, their pre-requisites, Effective blood level, Placebo effects, MIC values etc. and Drug-drug interactions.

Drug Metabolism:Factors influencing metabolism of drugs. Site of metabolism, Metabolic changes in GI tract, Types of metabolic reactions and Reactions based on functional groups.

Structure-Activity Relationship (SAR):Chemical structure in relation to biological activity of molecules, stereochemical factors, prodrugs, isosters and pharmacophoregroups.Synthesis, physical and chemical properties, mode of action, SAR studies and toxicity of the following drugs.

Sulfa drugs:Sulfa drugs in current therapy (human and veterinary use).

Drugs acting on NIDDM:Sulfonylureas. Antibiotics: Penicillin and related compounds, cephalosporins, tetracyclines chloramphenicol and quinolones. Antiviral agents and antineoplastic agents. Histamines and antihistamines: H1 and H2-receptor antagonists, development of H3 receptors and proton pump inhibitors.

Anti-malarial drugs, Analgesics (peripheral as well as centrally acting), local anesthetics

Recent trends in drug development:Quantitative structure activity relationship (OSAR), computer models and stimulations with examples including a case study of at least one drug.

CY-411 SURFACE COATINGS

Raw materials for paints and pigments; Classification and properties of surface-coating constituents; Classification and manufacture of pigments; Production of paints, varnishes, distempers, enamals and lacquers; Chemistry involved in the drying phenomena of paints; Drying oils for paint and classification of drying oils.

CY-413 SURFACTANTS AND COSMETICS

Soaps and Detergents: Introduction of soap, Raw materials for the manufacture of soap, Batch Kettle process, flow diagram and details, Monasavon process, Delaval process, Sharpless process, Introduction to detergents, Raw materials for the manufacture detergents, Classification, Examples of cationic, Anionic, Nonionic and Amphoteric detergents and their action with water binders, Opacifying agents, Flavors, Moisturizers, of soap industries, Chemistry involved in the production of soap and detergents, Action of builders, Additives, Brighteners and surfactants, Cleansing action soaps, Effect of acidic species and hard water on soap, Production of transparent soap.

CY-408 POLYMER TECHNOLOGY

Classification of polymers, bonding in polymers, stereoisomerism, Polymer synthesis: Condensation, addition polymerization, copolymerization, bulk, solution, suspension and emulsion polymerization, Molecular weight and molecular weight determination, Polymer solutions and polymer solution thermodynamics, Physical states and transitions in polymers, Crystallinity and morphology of polymers, Introduction to rheology: elasticity, purely viscous flow, linear viscoelasticity, Basic processing operations: Extrusion process (Single and twin screw extruder), Injection moulding, Blow moulding (extrusion blow moulding, injection blow moulding, and stretch blow moulding), Mould and dies, Calendaring, Film blowing, Thermoforming, Vacuum forming, Pressure forming, Rotational moulding, Compression and transfer moulding, Reaction injection moulding. Mechanical properties of polymers, Commercial polymers, additives. Blending: Definitions of polymer blends, method of blending, compatibility and miscibility of polymer blends, thermodynamics of polymer-polymer mixing, blend morphology & characterisation. Examples of polymer blends.

INTERDISCIPLINARY COURSES

HS-104 FUNCTIONAL ENGLISH

Listening: Types of Listening, Problems in listening and coping strategies, Listening skills, sub skills, Practice in Listening, Note taking: Techniques for taking notes from lectures, from books, Note taking in different forms paragraphs, points, figures, processes, tables, graphs etc. Vocabulary development: Enhancing current vocabulary to reflect a better usage of words in spoken and written language, Tips/ strategies in vocabulary enhancement, Practice in vocabulary development. Reading: Reading skills, sub skills, Reading comprehension levels, Reading strategies, Reading practice through variety of reading texts and comprehension exercises, Beyond reading[outline, précis, speech and presentation]. Writing: Process of Writing, Informal Writing strategies, Writing correctly: sentence structure and punctuation, error correction, Paragraphs: Structure, types, topic and the topic sentence, and unity, adequate development and coherence in paragraphs, Essays: Types, Five paragraphs long essays, and structure (thesis statement and the paragraphs), Short Reports: Structure, format, and types (informational and analytical), Letters: elements, style, formatting (digital letter writing), organization and structure of the letter, and types (Routine requests and intimation, invitation, thank you and condolence letters etc.) The Elements of International Style: A Guide to writing correspondence, reports, Technical Documents, and internet pages for a global Audience by Edmond H Weiss.

PH-123 GENERAL PHYSICS-I

Mechanics: Vector algebra and its applications, Line and Surface Integrals and their applications, Gradient, Curl, Divergence and applications, Newton's laws and their applications, Motion in two dimension, Moment of inertia, Angular momentum and its conservation, Work, energy and power, Efficiency, Work done by a variable force.

Properties of Matter: Elasticity, Bulk Modulus, Modulus of Rigidity, Young's Modulus, Poisson's ratio for rubber,

Torsion Pendulum, Bending Beams, Fluids, Liquids and Gases, Hydrostatic Pressure, Hydrostatic Pressure due to Liquid Column, Manometer, Viscosity, Coefficient of Viscosity, Variation of Viscosity with Temperature, Molecular Forces, Surface Tension, Explanation of Surface Tension, Surface Films and Surface Energy, Capillary action in a liquid, Surface Tension and its variation with Temperature.

Heat & Thermodynamics:

Temperature and heat, thermal properties of matter, laws of thermodynamics, statistical mechanics, Heat transfer, Heat engines and refrigerators

Waves and Optics: Wave properties, types and behaviour. The wave equation. Progressive and standing waves. Nature of sound: propagation, velocity, infrasonic and ultrasonic waves, Variation of velocity of sound with temperature, Sound intensity, loudness and the decibel. The Doppler Effect. Water waves, wave motion in deep and shallow water, tides. Principles of Meteorology, wind systems, Electromagnetic spectrum: general properties of Reflection, Refraction, Snell's Law, Total internal reflection, fibre optics and their applications, lenses and associated applications. Interference, diffraction. Polarisation. Microscopes and Telescopes, Sextant, Spectrometer.

MT-173 CALCULUS

Vectors: Review of vectors, Vector derivatives. Line and surface Integrals. Gradient of a Scalar.

Complex Number: Argand diagram, De Moivre formula, roots of polynomial equations, curve and regions in the complex plane, standard functions and their inverses (exponential, circular and hyperbolic functions).

Limits and Continuity: Bounds and bounded sets, Limit point of sets, Sequence, Convergence of sequences monotonic sequences, Function and their graph, limit of function and continuous functions.

Differential Calculus: Differentiation and Successive differentiation and its application; Leibnitz theorem, Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, Taylor and Maclaurin series, L'Hopitals Rule, extreme values of a function of one variable using first and second derivative test, asymptotes of a function, curvature and radius of curvature of a curve, partial differentiation, exact differential and its

application in computing errors, Multivariate functions, Maxima and Minima for multivariate functions, Maxima Minima under certain conditions (Language Multiplier).

Integral Calculus: Indefinite integrals and their computational techniques, reduction formulae definite integrals and their convergence, Beta and Gamma functions and their identities, double and triple integration with applications. (Area, Volume, centroid, inertia, arc length).

Vector Algebra: Scalar and Vector quantities, physical and geometrical meanings. Algebra of vectors. Scalar and Vector triple products.

HS-105 PAKISTAN STUDIES

An Outline of Emergence of Pakistan:

A brief historical survey of Muslim community in the sub-continent. War of Independent 1857 and Aftermath. Sir Syed Ahmed Khan, Development of Two Nation Theory. Formation of Muslim League. Lucknow Pact. Khilafat & Non-Cooperation Movement. Political Events from 1924 to 1937. Pakistan Resolution - Struggle for Pakistan from 1940 to 1947. Emergence of Pakistan. **Land of Pakistan:** Geophysical conditions, Territorial situation and its importance, Natural Resources - Mineral and Water. **Constitutional Process:** Early effects to make constitution - Problems and issues. Constitution of 1956 and its abrogation. The constitution of 1962 and its annulment. Constitutional and Political Crisis of 1971; The constitution of 1973. Recent constitutional developments. **Post-Independence Development:** Education in Pakistan; Planning & Development in the Field of Education. Development of Science and Technology with special reference to Engineering and Architecture. **Brief survey of Pakistan Economy:** Industrial and Agricultural Development. Internal and external trade. Economic planning and prospects. **Cultural Development in Pakistan:** Definition, Contents and Contributing factors in culture, Development of Art, Philosophy and literature. **Foreign Policy:** Relations with neighbors, Super powers and the Muslim World.

HS-127 PAKISTAN STUDIES (FOR FOREIGNERS)

Land of Pakistan: Land & People – Strategic importance – Important beautiful sights – Natural resources (some portion of economics of Pakistan) **A brief Historical Background:** A brief historical survey of Muslim community in the sub-continent – British rule & its impacts – Indian reaction – Two nation theory Origin and development – Factors leading towards the demand of a separate Muslim state – Creation of Pakistan. **Government & Political Development in Pakistan:** Constitution of Pakistan – A brief outline – Governmental structure Federal and Provincial – Local Government Institutions – Political History a brief account. **Pakistan & the Muslim World:** Relations with the Muslim countries. **Language and Culture:** Origins of Urdu Language - Influence of Arabic & Persian on Urdu Language & Literature - A short history of Urdu literature - Dominant Culture features.

EE-119 FUNDAMENTAL OF ELECTRICAL ENGINEERING

Electrical Elements and Circuits: Energy and energy transfer, Electric charge, electric current, potential difference & voltage, Electric power & energy, Electric circuits, Sources & element resistance, Ohm's Law Inductance, Capacitance, Fundamental circuits Laws, Kirchhoff's Laws, Direct application of fundamental laws to simple resistive networks, Node voltage and loop current methods.

Steady State AC Circuits: An introduction to periodic functions, RMS or effective, Average and maximum values of current & voltage for sinusoidal signal wave forms, An introduction to phasor method of analysis, Applications of phasor methods to simple AC circuits, Power and reactive power, Maximum power conditions.

Magnetic Circuits and Transformers: Magnetic effects of electric current, Magnetic circuit concepts, Magnetization curves, Characteristics of magnetic materials, Magnetic circuits with AC excitation, Hysteresis and eddy current losses, Introduction to transformer, The ideal transformer.

Electromechanical Energy Conversion: Basic principles, Generated voltage, Electromagnetic Torque, Introduction of Magnetic Fields, Alternating current generators, Commutator action, DC machines, Direct current Generators, Electric motors, Losses and efficiency, Machine Application consideration.

Sinusoidal Steady State Analysis: Network response to sinusoidal driving functions, Complex impedance and admittance functions, Development of concept of phasors, Power consideration, Complex power, Maximum power transfer, Tuned circuits, Series and parallel RLC tuned circuits, Definition of Quality factor.

CT-158 FUNDAMENTALS OF INFORMATION TECHNOLOGY

Introduction to IT, recent advances in IT, IT systems, Development of the modern computer. Introduction to Software, data structures, coding. Programming and problem solving algorithms. Data types and representation. Basic organization of computer, Number systems. Introduction to Data communication, database, Information System and MIS, Networks and Internet concepts.

PH-124 GENERAL PHYSICS-II

Coulombs Law, Electric Field, Continuous charge distribution, Electric Field due to charge distributions, Gauss's Law and its applications, Electric field around conductors. Electric Potential, Capacitors and dielectrics. Electric current and its heating effect, Power and its relationship with current and resistance, Chemical effects, Passage of current through a conducting solution, Primary and secondary cells and batteries, Alternating voltage and currents in outline, Frequency phase relationship, Peak instantaneous and r.m.s values, Reactance, Impedance, Power dissipation, RLC circuits. Simple A.C and D.C circuits. Magnetic Field, Magnetic force on a moving charge particle, Hall Effect, The magnetic field caused by current and resulting effects, the effect on a current carrying conductor in a magnetic field, Biot-Savart law, Amperes law, Magnetic field of rings and Coil, Magnetic Dipole moment of atom, Theory of Magnetism, Laws of Magnetism, Intensity of Magnetization, Permeability, Retentivity, Hysteresis Curve for ferromagnetic materials, Pole Strength, Field strength, Magnetic Moment and Couple, Band theory of solids, Energy levels in a semiconductor, Hole concept, Intrinsic and Extrinsic regions, Law of Mass Action, Different types of LED. Wave nature of light, wave particle duality, De-Broglie hypothesis, Photoelectric effect, Characteristics of different types of photo cell, Electron Microscopes, Laser and its applications, Atomic Spectra, Generation and Properties of X-ray, X-ray spectra, Nuclear Radiation, Nuclear Reactions, Carbon dating, Nuclear radiation detectors, Hazards and use of Nuclear Radiation.

HS-205 ISLAMIC STUDIES

Quranic Verses, Tauheed: Al-Ambiya-22, Al-Baqarah - 163&164, Prophethood: Aal-e-Imran-79, Al-Hashr-7, Al-Maidah-3, Here-After: Al -Baqarah-48, and one Hadith, Basic Islamic Practices, Al-Mu' minun-1-11, and two Ahadith, Amer-Bil-Ma'RooF Wa-Nahi Anil Munkar, the concept of Good & Evil, Importance and necessity of Da'wat-e-Deen Aal-e-Imran-110, Method of Da'wat-e-Deen An-Nahl-125, Aal-e-Imran-104, and two Ahadith, Unity of the Ummah, Al-Imran-103, Al-Hujurat-10, Aal-e-Imran-64, Al-An' am -108, and two Ahadith, Kasb-e-Halal, Ta ha-81, Al- A'raf-32-33, Al-Baqarah-188, and two Ahadith, Haquq-ul-Ibad, Protection of life Al-Maidah-32, Right to Property Al-Nisa-29, Right to Respect & Dignity Al-Hujurat-11-12, Freedom of Expression: Al-Baqarah-256, Equality: Al-Hujurat-13, Economic Security: Al-Ma'arij-24-25, Employment Opportunity on Merit: An-Nisa-58, Access to Justice: An- Nisa-135, Women's Rights, An-Nahl-97, Al-Ahzab-35, An-Nisa-07, Relations with Non-Muslims, Al-Mumtahanah-8-9, Al-Anfa'al-61 and The last Sermon of Hajj of Holy Prophet (PBUH): Relevant extracts, Seerat (life) of the Holy Prophet (PBUH), Birth, life at Makkah, declaration of prophet hood, preaching & its difficulties, migration to Madina, brotherhood (Mawakhat) & Madina Charter, The Holy Wars of the Prophet (Ghazwat-e-Nabawi), Hujjat-ul-Wida, The last sermon of Khutbatulwida: Translation and important points, Islamic Civilization, In the sub-continent: pre-Islamic civilizations, The political, social & moral impacts of Islamic civilization, In the world: academic, intellectual, social & cultural impact of Islam on the world.

HS-209 ETHICAL BEHAVIOR (FOR NON-MUSLIMS)

Introduction to Ethics, Definition of Ethics, Definition between normative and positive science, Problem of freewill, Method of Ethics, Uses of Ethics, Ethical Theories, History of Ethics: Greek Ethics, Medieval, Modern Ethics, Basic concept of right and wrong: good and evil, Utilitarianism, hedonism, self-realization: egoism, intuitionism, rationalism, Kant's moral philosophy, Ethics & Religion, The relation of Ethics to religion, Basic ethical principles of major religions: Hinduism, Judaism, Buddhism, Zoroastrianism, Christianity, Islam, Ethics,

Society, and moral theory, Ethical foundation of Rights and Duties, Applied Ethics, Society as the background of moral life, Universalism and Altruism, Theories of punishment,

MT-223 ORDINARY DIFFERENTIAL EQUATIONS & FOURIER SERIES

1ST Order Differential Equations: Basic concept, Formation of differential equations and solution of differential equations by direct integration and by separating the variables, Homogeneous equations and equations reducible to homogeneous form, Linear differential equations of the order and equations reducible to the linear form, Bernoulli's equations and orthogonal trajectories, Application in relevant Engineering.

2nd and Higher Orders Equations: Special types of 2nd order differential equations with constant coefficients and their solutions, the operator D; Inverse operator 1/D, solution of differential by operator D methods, Special cases, Cauchy's differential equations; Simultaneous differential equations, Simple application of differential equations in relevant Engineering.

Partial Differential Equation: Basic concepts and formation of partial differential equations, Linear homogeneous partial differential equations and relations to ordinary differential equations, Solution of first order linear and special types of second and higher order differential equations, D' Alembert's solution of the wave equation and two dimensional wave equations, Lagrange's solution: Various standard forms.

Laplace Integral & Transformation: Definition, Laplace transforms of some elementary functions, First translation or shifting theorem, Second translation or shifting theorem, Change of scale property, Laplace transform of the nth order derivative, Initial and final value theorem Laplace transform of integrals, Laplace transform of functions in $F(t)$ and $F(t)/t$, Laplace transform of periodic function, Evaluation of integrals, Definition of inverse Laplace transform and inverse transforms, Convolution theorem, Solutions of ordinary differential using Laplace transform.

Fourier series: Periodic functions and expansion of periodic functions in Fourier series and Fourier coefficients, Expansion of function with arbitrary periods, Odd and even functions and their Fourier series, Half range expansions of Fourier series, "DFT and FFT, Fourier Spectrum".

MT-331 Probability and Statistics

Introduction: Types of data & variables, presentation to data, object, classifications, Tabulation, Frequency distribution & their types, Graphical representation, Simple & Multiple Bar diagrams, Pie-Diagram, Histogram, Frequency Polygon, Frequency Curves.

Measure of Central Tendency and Dispersion: Statistical Averages, Median, Mode, Quartiles, Range, Moments, Skewness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient.

Probability: Set Theory, Basic concepts, Permutation & Combination, Definitions of probability Applying set theory to probability, Probability axioms, some consequences of the axioms, Conditional probability, Independence, Baye's rule.

Random Variables: Introduction, Discrete & Continuous random variables, Random Sequences and transformations, Probability distribution, Probability density function, Distribution function, Mathematical expectations, Moment Generating Function (M.G.F.).

Probability Distributions: Introduction, Discrete probability distributions, Binomial, Poisson, Hypergeometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential, Gamma, Weibull & Normal distributions & their practical significance.

Sampling and Sampling Distributions: Introduction, Population, Parameter & Statistic, Objects of Sampling, Questionnaire Designing, Sampling Techniques, Sampling & Non-Sampling Errors, Random Sampling, Probability and Non Probability Sampling, Sampling with & without replacement, Simple Random Sampling, Stratified Random Sampling, Systematic Sampling, Cluster Sampling, Sampling Distribution of Mean, Standard Errors, Central Limit Theorem

Curve Fitting: Introduction, fitting of a first and second degree curve, fitting of exponential and logarithmic curves related problems, Principle of least squares, Introduction to Time series.

Regression and Correlation: Properties of Least Square, Simple Linear Regression, Non Linear Regression, Multiple Regression, Estimates of Regression parameters, Confidence Limits & Test of Significance, Choice of a Regression Model, Correlation, Multiple and Partial Correlation, Coefficient of Determination.

CT-153PROGRAMMING LANGUAGES

Language: Definition, structures, survey of some programming languages, special and general purpose languages, data types. Comparative study by means of primitive and composite data structures, Control structures by means of expression of algorithms.

CH-202 FLUID MECHANICS-I

Introduction: Liquids and gases, properties of fluids, Force, mass and weight, Units and Conversions. Fluid Statics: Basic equations, pressure forces on surfaces, Pressure vessels, piping, Buoyancy, pressure measuring devices. Pressure in accelerated rigid body motions. General mass balance for single and multi -component fluids. Bernoulli's equation and its applications; diffusers and sudden expansion: Torricelli's equation, cavitation and unsteady flows. Fluid Friction: Reynolds Experiment; laminar and turbulent flows; Friction factor method, fitting losses, enlargements and contractions, friction in non-circular channels, economic pipe diameter, flow around submerged objects. Momentum: Momentum balances; steady flow applications, relative velocities, starting and stopping flows, angular momentum balances. One dimensional high velocity gas flows, shock waves, choking flow, ideal gas considerations, nozzles and diffusers. Dimensional Analysis: Buckingham –Pi Theorem; Reynold's law of Similitude.

HS- 301 BUSINESS& ORGANIZATIONAL COMMUNICATION

Business Communication Foundations: Definition of business, organization and communication, Goals, patterns, principles, channels, tools, levels, Qualities(7 C's) and process of communication, Forms and functions of organizational communication, Communication barriers, Feedback and its types, Listening & Understanding Nonverbal Communication, International and cross cultural communication,

Communication Technologies and Techniques: Tools for digital communication, Etiquettes and ethics of using communication technologies

Communicating in Teams: Improving your performance in Teams (team communication, group dynamics, Etiquette in team settings), Making your meetings more productive (preparing for meetings, leading and participating in meetings, Meeting Notice, Agenda and minutes, Meeting simulation

Business Writing: Planning Audience Centered Business Messages & Applying the three step Writing Process, Letter and Memos (Structure and elements) Practice in writing letters and memos, Three Types of Business Messages and situations: Routine/Neutral/Positive/Good news and Goodwill Msgs, Negative/Bad News Msgs, Persuasive Msgs

Employment Communication: Resume/CV, Job application (solicited and unsolicited)

Writing Proposals and Reports: Finding and Communicating Information, Communicating Information Through Visuals, Writing effective Proposals, Short Reports (analytical and informational reports, memo and letter reports), Formal Reports (structure and organization)

MT- STATISTICS-II

Statistical Inference & Hypothesis Testing: Confidence and Significance Level, Sample Size Determination, Point & Interval Estimates, Interval Estimates for Population Mean, Population Standard Deviation, & Population Proportion, Type I, Type II Errors, One Tail & Two tail tests, Tests concerning Means, Proportions & Variances, Chi-square tests.

Experimental Design: Comparing Mean test, Analysis of Variance(ANOVA), One Way equal and unequal size, Two Way ANOVA, Complete Randomized Design (CRD), Randomized Complete Block Design (RCBD), Latin Square Design (LSD), Tests for the Equality of several variances, Multiple Range test.

Multiple Regressions: Fitting the Multiple Linear Regression Model, Goodness of fit of the Model, Statistical Inference for Multiple Regression, ANOVA table for Regression, Testing subset of Parameters, Regression

Diagnostics, Multicollinearity, Polynomial Regression, Variable Selection Methods, Best Subset Regression, and Adequacy of the Model.

Nonparametric Statistics: Introduction, Nonparametric tests, Signed-Rank test, Kruskal-Wallis test, Rank Correlation Coefficient.

Control Charts: Properties of the distribution of sample means, Sample range estimation of standard deviation, Chance and assignable causes, Control charts for mean & range, Control charts for mean & standard deviation, Control charts for proportion defective & defects per assembly, Tests of significance to compute confidence limits.

Acceptance Sampling: Introduction, OC curve, Consumer & producer risks, AQL & LTPD, sampling errors, Acceptance sampling for continuous production, Acceptance by variables, Single double, & sequential sampling.

Quality, Reliability, & Maintainability: Definitions, Management of quality control, Total quality control, Taguchi method, Economic aspects of quality decisions, Process capability & variability analysis, Various aspects of life testing, Reliability & maintainability, Introduction to ISO 9000.

ME 203 FLUID MECHANIC

Introduction: Liquids and gases, properties of fluids, Force, mass and weight, Units and Conversions.

Fluid Statics: Basic equations, pressure forces on surfaces, Pressure vessels, piping, Buoyancy, pressure measuring devices. Pressure in accelerated rigid body motions. General mass balance for single and multi-component fluids.

Bernoulli's equation and its applications; diffusers and sudden expansion: Torricelli's equation, cavitation and unsteady flows.

Fluid Friction: Reynolds Experiment; laminar and turbulent flows; Friction factor method, fitting losses, enlargements and contractions, friction in non-circular channels, economic pipe diameter, flow around submerged objects.

Momentum: Momentum balances; steady flow applications, relative velocities, starting and stopping flows, angular momentum balances. One dimensional high velocity gas flows, shock waves, choking flow, ideal gas considerations, nozzles and diffusers. Dimensional Analysis: Buckingham -Pi Theorem; Reynold's law of Similitude.

CH-206 THERMODYNAMICS

Chemical thermodynamics: Scope and definitions; Isolated, closed and open systems; Intensive and extensive properties; State and functions of state;

First law; Internal energy U; Enthalpy H; Reversibility; Calorimetry; Enthalpies of formation and reaction; Bond dissociation energy and mean bond energy; Dependence of U and H on temperature; First law as applied to ideal gases; Isothermal; Isometric; isobaric; polytropic and adiabatic processes involving an ideal gas; P-V-T relationships for non ideal gases.

Second law; Entropy; Equilibrium and observable change; Changes in entropy with changes in P, V, and T. Helmholtz function A. Gibbs function (free energy) G. Fundamental equations for closed systems. Maxwell relationships. properties of mixtures of ideal gases. G for ideal and non-ideal gases. Fugacity. Partial molar quantities. Chemical potential. Excess Thermodynamic Functions. Third law of Equilibrium (reversible) and spontaneous (irreversible) change.

Phase equilibria: Phase rule; One component systems; Clapeyron and Clausius-Clapeyron equations. Two component systems. Liquid-vapor equilibria. Ideal and Non-ideal solutions; Composition of vapor in equilibrium with liquid; Azeotropes. Mixing. Liquid-solid equilibria. Eutectic. Compound formation. Solid solutions.

Chemical equilibria; equilibrium constants for gas phase reactions. Temperature dependence of Gibbs free energy and equilibrium constants; factors affecting degree of conversions, condensed phases, solution equilibria, fuel cells, liquification.

MM-301 CORROSION: PROTECTION AND PREVENTION

General concepts of corrosion applied to materials, corrosive environments, atmosphere, water, chemicals, gases, general corrosion, galvanic corrosion, oxygen concentration cell, atmospheric corrosion, chemical corrosion, corrosion in gas, types of scale, mechanism of scale protection, oxide, defect structure, oxidation rates, high

temperature gas reactions, localized corrosion, pit and crevice corrosion. Mechanically assisted corrosion, stress corrosion cracking, corrosion fatigue, hydrogen damage, corrosion in ceramics and plastics, atmosphere water, chemical corrosion, corrosion prevention and protection. Chemical inhibitors, environmental control, anodic and cathodic protection, mechanical protection, coatings, anodizing, painting, corrosion resistant materials, corrosion of carbon steels, stainless steel, aluminum alloys, case studies. Corrosion of metals: simple electrochemical theory, polarisation curves, activation and concentration polarisation; Evans diagrams, Passivity, pitting, localised corrosion, Common problems: galvanic corrosion, differential aeration, crevice corrosion, Corrosion Prevention: Cathodic protection, anodic protection, inhibitors, Paint; modes of protection, inhibitive and metallic pigments, Metal coatings; action, methods of application, Anodising of aluminium. Design and materials selection.

CH-306 CHEMICAL PROCESS CONTROL

Incentives for chemical process control. Feedback and feed-forward control configurations. Design of controllers. Mathematical modeling of dynamic processes. Linearization of nonlinear systems. Laplace transforms. Solution of linear ordinary differential equations using Laplace transforms. First-order systems, second-order systems, higher-order systems, time delays, inverse response systems, transfer functions. Components of a control loop. Closed-loop transfer functions. Transient response of simple closed-loop control systems. Types of controllers. Stability of controller operation. Frequency response methods. Nyquist Stability Theorem. Feedback control. Feed-forward control. Cascade Control. Multivariable control systems.

CH-405 INDUSTRIAL SAFETY AND MAINTENANCE MANAGEMENT

Introduction: Accident and loss statistics, public perception of chemical industry, the accident process, some significant disasters as case studies; Toxicology: how toxicants enter and are eliminated from biological organisms, effects of toxicants, dose versus response models, threshold limit values.

Industrial Hygiene: Government regulations, identification and evaluation and control of various exposures in chemical industry. Fires and explosions: fire triangle, flammability characteristics of liquids and vapors. Design to prevent fires and explosions. Hazard identification and risk assessment, Accident investigations and case histories. Forms of maintenance, scheduling of maintenance. Computerized Maintenance. Nondestructive testing techniques. Forms of corrosion, prevention and inhibition,; Preparation for startup and shutdown. Preventive and predictive maintenance.

CH-410 WATER PURIFICATION PROCESSES

Description of methods of water purification and treatment. Fundamentals involved in Multi Stage Flash Distillation, reverse osmosis, electro dialysis etc. Study of properties of water and aqueous solutions. Detailed discussion and analysis of design maintenance, energy requirements and economics of the major process of purification.

CH-411 ENVIRONMENTAL POLLUTION CONTROL

Introduction, hydrological cycle, water quality parameters, acid/base chemistry, reaction kinetics, mass flux of pollutants, water quality management, water treatment processes, coagulation and flocculation, softening, settling and Sedimentation, filtration.

Waste water treatment, Wastewater Characteristics, Effluent Standards, Primary Treatment (Screening, Communiting, Grit Removal, Flow Measurement, Primary Sedimentation), Secondary Treatment, Activated Sludge Treatment, BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), Disinfection of Effluents, Growth and Food Utilization, Attached-Culture System. Sludge Treatment and Disposal, Advanced Waste Water Treatment, Nutrient Removal, Solid Removal, Waste water Disposal and Reuse.

Air pollutants and standards, modeling air pollutants dispersions, air pollution control devices
Solids waste management, hazardous wastes.

CH-406 PETROLEUM REFINING & PETROCHEMICALS

Origin & formation of petroleum, Composition of petroleum, Petroleum processing, Crude classification, Crude evaluation, Thermal properties of crude, Crude analysis, Crude fraction properties, Pretreatment of crude, Distillation of petroleum (ADU & VDU), Pipe still heater of crude, Arrangement of towers, Treatment techniques, Thermal and catalytic processes Petrochemicals: Methanol, Formaldehyde, Ethylene production by steam cracking of naphtha, Ethylene dichloride, Vinyl chloride monomer, Vinyl acetate monomer, Ethylene oxide, Acetaldehyde Propylene, Acrylonitrile, Propylene oxide, MTBE, Butadiene, BTX separation, Benzene by dealkylation of toluene.