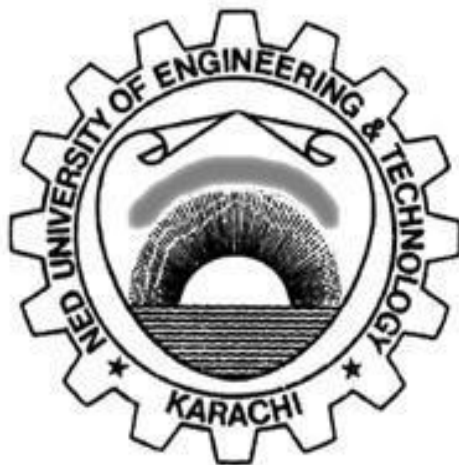


DEPARTMENT OF CHEMISTRY



SYLLABI OF COURSES

FOR

MASTER IN INDUSTRIAL CHEMISTRY PROGRAMME

UNIVERSITY OF ENGINEERING & TECHNOLOGY, KARACHI-75270 PAKISTAN

Compulsory Courses			
S. No.	Course Code	Course Title	Credit Hours
1.	CY-524	Laboratory Quality Assurance	3
2.	CY-501	Unit Operations	3
3.	CY-502	Advanced Chemical Kinetics	3
4.	CY-503	Chemical Thermodynamics	3
5.	CY-525	Advanced Chemical Analysis	3

Elective Courses			
S. No.	Course Code	Course Title	Credit Hours
1.	CY-505	Advanced Spectroscopic Techniques	3
2.	CY-506	Electroanalytical Techniques	3
3.	CY-507	Advanced Chromatographic Techniques	3
4.	CY-508	Surface Chemistry and Catalysis	3
5.	CY-509	Mathematical Methods	3
6.	CY-510	Applied Statistics	3
7.	CY-511	Research Methodology	3
8.	CY-512	Drug and Heterocyclic Chemistry	3
9.	CY-513	Organic Synthesis	3
10.	CY-514	Natural Product Chemistry	3
11.	CY-515	Paint and Surface Coatings	3
12.	CY-516	Paint Failure Analysis	3
13.	CY-517	Corrosion Chemistry	3
14.	CY-518	Agrochemicals	3
15.	CY-519	Dyes Chemistry	3
16.	CY-520	Soap, Detergent and Cosmetic Industries	3
17.	CY-521	Environmental Pollution Chemistry	3
18.	CY-522	Water Treatment	3
19.	CY-523	Nano Chemistry	3
20.	CY-5002	Thesis	6

Customized Courses

PHYSICAL CHEMISTRY (CY – 402)

Chemical Equilibrium: Spontaneous chemical reactions and equilibrium, effects of external stress on equilibria (Le Chatelier's Principle), the reaction quotient, 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.

Chemical Kinetics: Experimental techniques for the determination of reaction rate, flash photolysis, and electrochemical analysis, factors affecting the rate of chemical reaction, order and molecularity, kinetics' of zero, first, second and third order reactions (with same initial and different initial concentration), pseudo order reactions, relation between rate equations for the forward and backward reactions, reversible first order reactions, half-life for various order reactions, methods for the determination of order of reactions, collision theory, transition state theory,

Arrhenius theory, activation parameters, Hinshelwood theory of unimolecular reaction, bimolecular collision theory, trimolecular reactions, branched and unbranched chain reactions.

INSTRUMENTAL METHODS AND TECHNIQUES (CY-403)

Real Sample Analysis: Digestion, dissolution, extraction with solvents, solid phase extraction (SPE), Kjeldahl's method, fluxes, series dilution, calibration techniques.

Analytical Reactions in Solutions: Solution equilibria, potentiometry, acid-base titrations, complexation, redox and precipitation titrations, coulometric methods.

Optical and Chromatographic Methods of Analysis: Spectrophotometric titration, simultaneous determination of two components system, determination of complex composition, applications of spectrophotometric data, atomic absorption spectroscopy, atomic emission spectroscopy, flame emission spectroscopy, Inductively Coupled Plasma (ICP) and atomic fluorescence, Adsorption chromatography, partition chromatography, ion-exchange chromatography, gas liquid chromatography (GC), high pressure liquid chromatography (HPLC).

SEPARATION TECHNIQUES (CY-404)

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

Distillation: Boiling and distillation, vapour liquid equilibria, azeotropic mixture, multi component systems, flash distillation, steam distillation, vacuum distillation, extractive distillation, batch and continuous distillation, fractional Distillation, equipment and working of 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 filtrations, cake filtration parameters, washing filter cake, centrifugal filtration, Nutsch and continuous filters.

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

MATHEMATICS & STATISTICS (CY-415)*

Limits And Continuity: Limit point of sets, sequences, convergence of sequences, function and their graph, limit of function and continuous functions.

Differential Calculus: Differentiation by first principle, differentiation by rule, implicit function, logarithmic differentiation, successive differentiation, rate of change, Hopital's rule, extreme values of a function of one variable using first and second derivative test, asymptotes of a function, partial differentiation, exact differential and its application in computing errors, multivariate functions.

Integral Calculus: Indefinite integral, use of trigonometric relations, methods of substitution, integration by parts, reduction formulae, definite integrals and their convergence, Beta and Gamma Integrals.

Measurements, Results & Experimental Errors: Measures of Central Tendency and spread, Accuracy, Precision, Error and Uncertainty

Propagation of Uncertainty: Uncertainty When Adding or Subtracting, Uncertainty When Multiplying or Dividing, Uncertainty for Mixed Operations, Uncertainty for Other Mathematical Functions

The Distribution of Measurements and Results: Populations and Samples, Probability Distributions for Populations & samples, Confidence Intervals for Populations and samples

Statistical Analysis of Data Significance Testing, Constructing a Significance Test, One-Tailed and Two-Tailed Significance tests, Errors in Significance Testing, Linear Regression.

Statistical Methods for Normal Distributions: Comparing mean to m , Comparing s^2 to s^2 , Comparing Two Sample Variances, Comparing Two Sample Means, Outliers.

*For candidate who hasn't studied mathematics/statistics as subsidiary (undergraduate level) course at BS(Four Years)/M.Sc. level

GENERAL CHEMISTRY (CY-416)

Stereochemistry: Chirality, molecular dissymmetry, optical activity, isomerism.

Reaction Mechanism, Structure and Reactivity: Types of reactions, reaction intermediates and their stability.

Substitution Reactions: Nucleophilic & Aromatic Electrophilic Substitution Reactions: (mechanism and stereochemistry).

Addition to Carbon- Carbon Multiple Bonds: Mechanism and stereochemical aspects.

Elimination (E) Reactions: The E1, E2 and α , β mechanisms, orientation, reactivity.

Atomic Structure: Atomic structure theories, Schrödinger wave equation and its applications.

Periodic Table: Electronic configuration, periodicity, group trends.

s and p Block Elements: General characteristics, valence bond theory, molecular orbital theory, Valence Shell Electron Pair Repulsion (VSEPR) theory, hybridization.

d-Block Elements: General characteristics, coordination compounds, Crystal field theory (CFT), Molecular orbital theory (MOT), magnetic properties, d2-d8 ions energy level diagram, charge transfer spectra, calculation of μ_s , μ_{s+L} , μ_{eff} .

Chemistry of Lanthanide and Actinide Elements: General characteristics and comparison of two series.

Compulsory Courses

LABORATORY QUALITY ASSURANCE (CY-524)

Overview of Quality Assurance and Quality Control: Need for Quality, General Principle of QA and QC, Quality assurance systems,

Valid Analytical Measurements (VAM): Certification versus Accreditation. Salient features of Quality standards GLP, Salient features of Quality standard: ISO 17025

Meteorological Traceability & measurement uncertainty: Comparing of measurement results, Establishing metrological traceability, Top down and Bottom up (GUM) measurement of uncertainty, Tools used for uncertainty estimation.

Reference Materials: Parameters for characterization of reference materials

Certified reference materials and their practical applications.

Validation and Qualification of Analytical Methods: Classification and Sources of Methods, Method development and validation cycle, Method validation parameters and approaches, Standard Operating Procedures, Validations based on design qualification (DQ), Installation qualification (IQ),

Operational qualification (OQ) and performance qualification (PQ), System Suitability, Method Validation Protocol Method Transfer and Revalidation, Monitoring and quality reviews, Periodical trainings

Interlaboratory Comparisons: Classification, characteristics and organization of interlaboratory comparisons, Presentation and statistical analysis of interlaboratory comparisons.

UNIT OPERATIONS (CY-501)

Gaseous systems: Gas adsorption, principles, factors for controlling adsorption of gases, solution of gases, removal of gases from liquids, removal of gases from bulk solids and surfaces, degassing, sublimation, vacuum sublimation and applications

Mechanical Separation And Beneficiation: Crushing, Grinding, Mixing, Size Separation And Drying, Equipment for crushing, grinding and mixing, drying processes, tray, tunnels, drum and spray driers, equipment for determination of moisture in solids, liquids and gases. Screening sieves, equipment and use, gravity separation in settling process, removal of solid from gases, separation of coarse particle in liquid sedimentation and thickening, centrifugal and settling process, cyclone, hydrocyclone, sludge separation, dust filters, dust precipitators, electrostatic dust precipitators, colloidal particles and their removal, froth floatation, magnetic separation, scrubbers, chemical process, mud as resources, ion exchange separation, membrane separation, osmosis and reverse osmosis.

Utilities in Industry: Fuel, boilers, water, steam, air, fluid flow, pumps, heat exchange equipment.

ADVANCED CHEMICAL KINETICS (CY-502)

Chemical Kinetics: Theories of bimolecular reactions, bimolecular reactions in solution, solvent effect, effect of ionic strength, hydrostatic pressure.

Isothermal Reactors, Non Isothermal Reactors: Batch, Tubular and Stirred Tank Reactors, stable operating conditions in Stirred Tank Reactor, Non Ideal Reactor, Residence Time Distribution, Conversion models in Non-Isothermal Reactors.

Reaction Mechanism: Elementary reaction steps, unimolecular gas phase reaction, Lindemann mechanism, chain reactions, heterogeneous catalysis, homogeneous catalysis, catalysis by acids, bases, autocatalysis, oscillating reactions, enzyme catalyzed reaction, relaxation method, photochemical reaction kinetics, radiation chemistry kinetics.

Instrumentation and Application: Mixing reactants: magnetic stirring, stopped flow, continuous flow, kinetic base titrimetry, stat procedure, centrifugal mixing, techniques for monitoring reaction kinetics: absorptiometric detection, detection by means of light emission, fluorescence, phosphorescence, chemical luminescence, electrochemical detection, dilatometry, nanotechnology, techniques for gas phase, other methods, thermodynamic approach to chemical kinetics applications.

CHEMICAL THERMODYNAMICS (CY-503)

Laws of Thermodynamics: Thermodynamic relationships, Fluid Dynamics of heat transfer, Joule–Thompson effect, thermochemistry, Entropy, Clausius and Kelvin formulation of entropy, Maxwell relations, development of equation of state.

Chemical Equilibrium: Thermodynamic equilibrium calculations, response of equilibrium to pressure, volume and temperature change, Gibbs free energy change and equilibrium constant, evaluation of equilibrium and conversions, thermodynamics of phase equilibria, Duhem equation, chemical potential, activity coefficient, fugacity and fugacity coefficient, excess Gibbs free energy, phase equilibrium at low to moderate pressure, Ideal and Non-Ideal solutions, residual and excess property relation, property changes of mixing, heat effects of mixing, Vapour-Liquid Equilibria (VLE) with cubic equation of state, mixing rules, liquid models using UNIFAC and UNIQUAC, phase rule and Duhem Theorem for reaction systems, thermodynamic functions from cell potential measurements.

Statistical Thermodynamics.

INDUSTRIAL CHEMICAL ANALYSIS (CY-504)

Sampling and sample preparation of complex matrices for advanced analytical techniques. Hyphenated chromatographic analysis, i.e. Liquid chromatography with Ultraviolet (LC-UV), Refractive Index (LC-RI) and Diode Array Detection (LC-DAD), Liquid chromatography-mass spectrometry (LC-MS), Gas chromatography-mass spectrometry (GC-MS), interpretation of chromatogram/ spectra. Application of Scanning Electron Microscopy (SEM) with Electron Dispersive Spectroscopy (EDS), X-ray diffractometers (XRD), Infrared (IR) and Raman spectroscopy for sample characterization. Green Analytical Chemistry, Analytical Method Assessment, Tools and Techniques for Assessing Greenness of Analytical Methods. Concepts of Statistical Experimental Design and their application in Chemical analysis. Strategy of experimentation, basic principles, guidelines for designing experiments.

Elective Courses

ADVANCED SPECTROSCOPIC TECHNIQUES (CY-505)

Common Spectroscopic Techniques: Theoretical aspects, instrumentation and interpretation of spectra.

Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD): Instrumentation, sampling and applications.

Mass Spectroscopy: Instrumentation and sampling, Fragmentation patterns, Ionization techniques, elemental composition from mass spectrum.

NMR Spectroscopy: Interpretation of ^1H - and ^{13}C -NMR spectra, factors affecting the chemical shifts and coupling constants, recent advances and structure elucidation of organic molecules from 1D and 2D NMR spectroscopy including J-resolved, shift correlated and multiple quantum spectra, inverse measurements, nuclear Overhauser effect and its applications,.

X-Ray Crystallography: Principles and applications, crystal structures and classification, two-dimensional patterns, experimental methods, single crystal growth and structure determination, diffractometer, powder methods.

ELECTROANALYTICAL TECHNIQUES (CY-506)

Electroanalysis: Electrochemical cells, Faradaic and non-Faradaic methods of electrochemical analysis, electrolysis (pragmatic and kinetic treatment), electroanalysis (non-aqueous media).

Electroanalytical Techniques: Principle, instrumentation and applications of voltammetry, electrogravimetry, coulometry and conductometry, potentiometric titrations, reference, indicator and ion-selective electrodes, stripping electroanalytical methods.

Electroanalysis in Automated Chemical Control: Chemical control automation, automated electroanalysis in laboratory, plant and environment control.

ADVANCED CHROMATOGRAPHIC TECHNIQUES (CY-507)

Capillary electrophoresis (CE): Basic CE concepts, instrumentation (power supply, injectors, capillaries, detectors), CE modes (CZE, CGE, MECC, CEC, chiral CE).

Membrane separation: Technology and applications of membrane separation processes, structure and characteristics of membranes, principles of various membrane separation processes (reverse osmosis, nanofiltration, ultrafiltration, microfiltration, electrodialysis, membrane distillation, pervaporation and gaseous separations), design consideration for reverse osmosis, ultrafiltration and electrodialysis pervaporation, gaseous separations, liquid membranes, supported liquid membrane, membrane reactors.

Adsorptive separation: Types of adsorption, adsorbents types, preparation and properties, adsorption isotherms and their importance, mathematical modelling.

Other Methods of Separations: Reactive distillation, supercritical fluid extraction, surfactant based separations and bio filtration.

SURFACE CHEMISTRY AND CATALYSIS (CY-508)

Surface phenomena: Adsorption, solid-liquid interface, solid-gas interface, solid surface area, adhesion and cohesion, nucleation and crystal growth, gel formation.

Colloids and Surfactants: Liquid interfaces, surface tension, Langmuir-Blodgett films, surfactant, detergency, organised molecular assemblies, micro and macro emulsions, colloidal dispersions, coagulation and flocculation.

Catalysis: Homogeneous and heterogeneous catalysis, catalytic activity, geometric factor in catalysis, supported metal catalysts, catalytic reactors, catalytic preparation, deactivation and regeneration, characterisation of catalyst surfaces, applied catalysis in steam reforming reaction, methanation reaction, Fischer-Tropsch synthesis, ammonia synthesis processes.

Experimental Techniques in Surface Chemistry: Scanning Electron Microscopy (SEM) with Electron Dispersive Spectroscopy (EDS), X-ray diffractometers (XRD), IR and Raman spectroscopy.

MATHEMATICAL METHODS (CY-509)

Solutions of Differential Equations: Classification of ordinary and partial differential equations, analytical solutions, integrating factor, method of characteristics, separation of variables, fourier transformation.

Numerical Methods: Numerical Solutions of ordinary and partial differential equations, initial and boundary valued problems, finite element and finite difference methods, numerical integration.

Linear Algebra: Matrix algebra, linear and non-linear algebraic equations, eigen values and eigenvectors.

APPLIED STATISTICS (CY-510)

Probability Distributions: Uniform, binomial, hyper geometric, poisson, normal, exponential, Chi-square, F & T distributions.

Sampling and Sampling Distribution: Introduction, sampling techniques, sampling distribution of mean, central limit theorem.

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.

Regression and Correlation: Properties of least square, simple linear regression, nonlinear 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, adequacy of the model.

Introduction to Experimental Design: Comparing mean test, ANOVA, tests for the equality of several variances, multiple range test.

Nonparametric Statistics: Nonparametric tests, signed-Rank test, Wilcoxon test, Kruskal-Wallis test, Rank correlation coefficient.

RESEARCH METHODOLOGY (CY- 511)

Research Process and Methods: Problem identification and refinement, understanding and identifying concept, construct and variables, developing research questions/ hypothesis, critical review of literature (accessing relevant literature, reading critically, and ways to write about the reviewed literature), research approaches and methodologies, developing research design and selecting plausible methods, ensuring reliability and validity of the research design, data collection tools and process, data analysis and interpretation.

Research Writing and Publishing: Writing research proposals and scientific papers, writing and preparing papers for journals and conferences, writing thesis / dissertation, styles of writing, Vancouver Group style guidelines, understanding plagiarism policy and avoiding plagiarism in professional and scientific writings, presenting the research in a conference, thesis / dissertation defense.

Ethical Concerns & Issues in Research: Understanding issues related to authorship, ownership of data, intellectual property, copyright; patents; maintaining confidentiality, anonymity, safety and well-being of research subjects, sites, resources, and data; transferring the ownership of data and research findings.

DRUG AND HETEROCYCLIC CHEMISTRY (CY 512)

Drug design: Development of new drugs, procedures followed in drug design, concepts of pro drugs and soft drugs, theories of drug activity, quantitative structure activity relationship (QSAR), concepts of drug receptors

Study of the drugs: Antibiotics, anti-malarial, analgesic & antipyretics, anti-inflammatory, anti-tubercular & anti-leprotic, anaesthetics, antihistamines, tranquilizers, anti AIDS, cardiovascular, anti-neoplastic drugs, cancer chemotherapy, recent development in cancer chemotherapy, hormones and natural products.

Synthesis and reactions of Heterocycles: a) Small ring heterocycles: Three membered and four membered Heterocycles, b) Benzo- fused five membered heterocycles, c) Six membered heterocycles with one heteroatom, d) Six membered heterocycles with two and more heteroatoms, e) Seven membered heterocycles.

ORGANIC SYNTHESIS (CY-513)

Carbon-Carbon Bond Formation Reactions (CCBF): Ortho strategy for aromatic compounds.

Carbon-Carbon Double Bonds: Synthesis of double bonds of defined stereochemistry, stereo-controlled vinyl anion equivalents, electrophilic attacks on alkenes, vinylcations, palladium-catalyzed C-C coupling, allyl alcohols, allyl equivalents.

Stereochemistry: Asymmetric induction I-III: Reagent-based strategy, asymmetry catalysis, formation of C-H, C-C, C-O and C-N bonds, substrate-based strategy, stereo chemical control.

Rearrangement in Synthesis: Nucleophilic, electrophilic and free-radical rearrangements, thermal rearrangement of amino ketones.

Pericyclic Reactions in Synthesis: Electrocyclic reactions, cycloaddition reactions, sigma tropic rearrangements, stereochemistry.

Synthesis of Natural Products using Retrosynthesis: Synthesis of five or more natural products from recent research journals.

NATURAL PRODUCT CHEMISTRY (CY-514)

Chemistry of Natural Products: General Introduction with reference to terpenes & steroids, plants sterols, C-28 and C-29 sterols, isolation, structure elucidations, Vit.D, estrogens, cardiac steroids.

Chemistry of Glycosides: Glycosides of flavonoids, coumarines, and saponins: Isolation, detection and chromatographic separation, acid alkaline and enzymatic hydrolysis to aglycons, identification of sugar residue, Spectroscopic determination of aglycone and glycoside structures, derivatization, structural elucidation and biological importance of glycoside.

Biosynthesis of Natural Products: Biosynthesis of fatty acid and triglycerides, isoprenoids, amino acids and alkaloids, metabolites from shikimic acid and metabolites derived from acetates and mevalonate.

Plant Growth Regulators: Naturally occurring plant hormones: Auxins, Gibberellins (Introduction, occurrence, physiological properties, isolation, biosynthesis, synthesis, and structure activity relationship).

Fatty lipids and Prostaglandin (Hydroxy and Ketohydroxy fatty acids): Identification and extraction, biogenesis and metabolism of prostaglandin, stereochemistry, physical methods of characterization, chemical degradation studies.

PAINT AND SURFACE COATINGS (CY-515)

Paint & Coatings: Basics of paint and coating, composition and their function.

Coating Types: Oil-based coatings, cellulose-based coatings, vinyls, phenolics, acrylics, polyesters, polyurethanes, bituminous coatings, silicone-modified coatings, polyureas, powder coatings, nano-coatings, self-healing coatings, recent new development in paints and coatings.

Coating Formulation: Principles of coating formulation, important factors of coating formulation, testing of coatings and its parameters, preparation of technical data sheets.

Adhesion of Coating: Principle of adhesion, understanding of adhesion and cohesion, description of substrates, testing of Adhesion.

Paint Rheology: Introduction, fundamental of measuring paint rheology, paint rheology during manufacture and storage.

PAINT FAILURE ANALYSIS (CY-516)

Trouble Shooting: Common paint film defects, causes of paint defects.

Common Failure Modes: Mechanical stress, internal stress, chemical attack, weathering stress, osmotic blistering, electroosmotic blistering, application-related problems, case studies of paint and coating failures.

Types of Failures: Adhesion, flexibility and impact resistance, solvent resistance, weathering resistance, chemical resistance, Freeze–Thaw, application variables.

Analytical Methods: Infrared Spectroscopy (IR), Gas Chromatography (GC), Gel Permeation Chromatography (GPC), Ion Chromatography, Scanning Electron Microscopy (SEM), Differential Scanning Calorimetry (DSC), miscellaneous methods of analysis.

CORROSION CHEMISTRY (CY-517)

Corrosion Thermodynamics and Kinetics: Gibbs free energy, Nernst equation, hydrogen electrode, standard hydrogen scale, the oxygen electrode, differential aeration cell, the emf and galvanic series, liquid junction potentials, reference electrodes, polarization diagrams of corroding metals, influence of polarization on corrosion rate, calculation of corrosion rates.

Corrosion in Different Environments: Atmospheric corrosion, natural and sea water corrosion, corrosion in soils, reinforced concrete corrosion, microbes and biofouling, corrosion in petroleum industry.

Forms of Corrosion: Uniform corrosion, galvanic corrosion, concentration cell corrosion, pitting corrosion, crevice corrosion, filiform corrosion, intergranular corrosion, stress corrosion cracking, corrosion fatigue, fretting corrosion, erosion-corrosion, de-alloying, hydrogen damage, microbial corrosion, cavitation, exfoliation corrosion.

Corrosion Control: Design, material selection, protective coatings, inhibitors, galvanic protection.

Corrosion Testing: Test methods, testing procedures, electrochemical testing, cathodic protection monitoring, monitoring of process plants and other environments, corrosion auditing.

Agrochemicals (CY-518)

Nitrogen Fertilizers: Urea, ammonium nitrate, ammonium sulfate, non-pressure nitrogen solutions, aqua ammonia, anhydrous ammonia, ammonium thiosulfate, sulfur-coated urea, urea-formaldehydes, Isobutyrdiurea (IBDU), polymer-coated urea.

Phosphorus fertilizers: Diammonium phosphate, mono-ammonium phosphate, ammonium polyphosphate, concentrated superphosphate.

Potassium Fertilizers: Potassium chloride, potassium sulfate, potassium-magnesium, sulfate, potassium nitrate.

Sulfur, Calcium and Magnesium Fertilizers: Micronutrient fertilizers, using micronutrient fertilizers, applying fertilizers, solubility of fertilizers: liquid vs. dry.

Pesticides: Insecticides (insects), fungicides (fungi), bactericides (bacteria), herbicides (weeds), acaricides, miticides (mites), rodenticides (rodents), formulation and toxicity of pesticides, synthetic pesticides, 1st, 2nd 3rd and 4th gen. future trends of pest control, control of weeds, household agrochemicals, micronutrients, plant growth regulators, Chlorinated, organophosphate, carbamate, parathyroid hazards associated with the use of agrochemicals and environmental aspects.

Toxicity of Pesticides: Oral exposure, dermal exposure, inhalation exposure, toxicity: carcinogenesis, teratogenesis, mutagenesis, blood disorders (hemotoxic effects), endocrine disruption, reproductive toxicity.

DYES CHEMISTRY (CY-519)

Dyes: Classification, nomenclature, manufacturing.

Dye Chromophores: Reactive dyes, disperse dyes, direct dyes, anthraquinone dyes, indigoids dyes, sulphur dyes, cationic azo dyes, cationic methine dyes, acid dyes, naphthoquinone and benzoquinone dyes. **Textile Dying:** Cellulose, wool, silk, polyamide, polyesters, acrylic and other fibres.

Non- Textile Dying: Leather dyes, fur dyes, paper dyes, hair dyes, food dyes, ink dyes, photographic dyes, indicator dyes.

Optical Brighteners: Classes, paper brightening, fibre whitening, textile whitening and colour correcting/brightening additives.

Health and Safety Aspects: Health, safety, toxicology, toxicity, sensitization, mutagenicity, carcinogenicity, dye containing wastewater, legislation, special regulation for dyes, environmental chemistry of dyes, end uses (applications).

SOAP, DETERGENT & COSMETIC INDUSTRIES (CY-520)

Soap: Raw materials, chemistry of soaps, classification of soaps, manufacturing of soaps: Batch Kettle process, flow diagram and details, Monasavon process, Delaval process, Sharpless process, environmental aspects.

Detergent: Classification, examples of cationic, anionic, nonionic and amphoteric detergents and their action with water, binders, opacifying agents, flavours, moisturizers of soap industry, principle groups of synthetic detergents, surfactants, inorganic builders, sundry organic builders, manufacturing of detergents.

Cosmetic Industry: Cosmetics types, classification and uses. preparation of skin care & cosmetic products, preparation of creams, lotions and sun-block preparations, medicated creams, oil in water & moisturizing preparations, depletory creams, preparation of tooth pastes and tooth powders, mouth wash and gargles, preparation of hair dyes, hair creams, shampoos, other hair softening and conditioning products, preparation of health care products, disinfectants, odour masking products and deodorizers, environmental aspects of cosmetics industry.

ENVIRONMENTAL POLLUTION CHEMISTRY (CY-521)

Atmospheric Chemistry: Atmospheric temperature and pressure profile, photochemical smog, particulate matter in atmosphere, atmospheric aerosols, acid rain, industrial pollutants, radioactivity, global warming, green-house gases, stratospheric ozone, the ozone hole, CFCs, ozone depletion and protection.

Water Pollution And Water Treatment: Sources of water pollution, heavy metals contamination, eutrophication, detergents and phosphates in water, water quality criteria, water purification, removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Soil Pollution: Soil and mineral resources, heavy metals contamination, bio-accumulation of heavy metals, organic matter in soil, macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Sampling of waste/pollutants: Sampling of air, liquid and solid pollutants, composite and grab samples, sampling strategy (for BOD/COD study), preparation, transportation, analysis of samples, number and size of samples, sample analysis for toxic metals, gases, microbiological systems, radioactive waste.

Analytical techniques: Spectral analysis, gravity filtration, precipitation methods, electroanalytical methods, GM counter for radioactive wastes, microbiological methods.

NANO CHEMISTRY (CY-522)

Chemistry of nanomaterials: Different types of nanomaterials (metal nanoparticles, semiconductor nanoparticles, nanowires, nanorods, nanotubes, quantum dots, fullerenes, clusters)

Theoretical foundations for the properties of nanomaterials: Thermodynamics, structure, magnetic and electronic properties, principle of self-assembly, methods of self-assembly, templated structures.

Synthesis and characterization of nanomaterials

Novel methods for synthesis of advanced nanomaterials and detailed growth mechanisms, advanced characterization techniques for nanomaterials: Synchrotron radiation techniques (XAFS and XRD), HRTEM, TEM, AFM, XPS, Raman, FTIR, FESEM, BET surface analyzer, VSM, Zeta Potential, etc

Nano-toxicology Mapping: Environmental fate of nanomaterials: key behavior on transport, transformation, bio-distribution, exposure, safety, and toxicity to humans and other species.

Nano products: Commercial products based on different nanomaterials, advanced biomedical and commercial applications of different nanomaterials: metal oxides, ferrites, silicon, gold, and silver, cadmium sulfide.

WATER TREATMENT (CY-522)

Water quality: water sources and their chemistry and quality such as acidity, alkalinity, total dissolved solid, suspended particle, oxygen, plant nutrients, salinity.

Water treatment processes: coagulation and sedimentation, clarification, filtration, Membrane processes, Activated carbon, Biological treatment processes, Pathogen removal, Disinfection chemistry, oxidative processes, Fluoridation, kinetics, and thermodynamics.

Waste water treatment: Wastewater treatment (preliminary treatment design, primary tank design/secondary treatment, advanced wastewater treatment); land-based, low-energy and sustainable wastewater treatment systems; sludge handling, treatment & disposal; effluent disposal (including re-use).

Reverse-osmosis (RO) desalination plant

- i. Membranes (micro, ultra, nano and reverse osmosis), Media Filters (sand anthracite and GAC) Filter Underdrain Systems, Biological Filters, Slow Sand Filtration, Backwashing and Air-Scour.
- ii. Chemical Feed Systems including designs and types (Liquid Feed Systems, Dry Feed Systems, and Specialized Feed System).
- iii. Feed water treatments involving Ion Exchange, Adsorption Technologies, Precipitation Technologies, Aeration/degassing Technologies, Iron and Manganese Removal, Nitrate and Arsenic Removal.
- iv. Distribution Water Quality: Corrosion Control, Disinfection by Product Reduction, Prevention of Nitrification, Contaminant Prevention technologies.