

SYNOPSIS OF BIOCHEMISTRY COURSES OFFERED IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

BCH 201: GENERAL BIOCHEMISTRY I (2 UNITS) L:2 T:0 P:0

Principles of the chemical basis of life. The molecular basis of cellular structure – polysaccharides, lipids, proteins, nucleic acids. The cellular basis of life. Buffers, Acidity and alkalinity; pH and pKa values and their effects on cellular activities. Chemistry of carbohydrates, lipids, amino acids and proteins, nucleic acids and nucleoproteins. Enzymes and co-enzymes. Vitamins. (Pre-requisites: BIO 101, 102; CHE 101, 102, 104)

BCH 202: GENERAL BIOCHEMISTRY II (2 UNITS) L:2 T:0 P:0

Methods of studying metabolism. Metabolism of carbohydrates, lipids and proteins; Metabolism of purines, pyrimidines and nucleotides. Effects of acid and alkali on hydrolysis of nucleic acids. Structures and function of major cell components – prokaryotes versus eukaryotic organisms photosynthesis. (Pre-requisites BCH 201).

BCH 301: METABOLISM OF CARBOHYDRATES (2 UNITS) L:2 T:0 P:0

Digestion and degradation of carbohydrates – sugars, storage polysaccharides and cell walls. Reactions of sugars – Glycolysis, the tricarboxylic acid cycle, the pentosephosphosphate pathway, the Cori cycle, the Calvin pathway, gluconeogenesis and the disorders of carbohydrate metabolism (Pre-requisites BCH 201, 202).

BCH 303: METABOLISM OF LIPIDS (2 UNITS) L:2 T:0 P:0

A survey of structure, functions, biosynthesis and catabolism of different classes of lipids. The regulatory aspects of biosynthesis and catabolism of the lipids, especially in relation to homeostasis in the organism will be stressed. The lipids include: fatty acids, glycerides, phosphoglycerides, waxes, prostaglandins, terpenoids and steroids such as bile acids, steroid hormones, carotenoids and vitamin A, vitamin D and terpenoid quinones. Biological membranes. (Pre-requisites BCH 201, 202).

BCH 305: METABOLISM OF AMINO ACIDS AND PROTEINS (2 UNITS) L:2 T:0 P:0

Amino acids as building blocks of proteins; covalent backbone of proteins. Primary structure of proteins. Reactions of amino acid side chains. Secondary, tertiary and quaternary structures of proteins. Isolation, fractionation, purification and characterization of proteins. Protein-protein interaction. Biological functions of protein – correlation of structure with functions in a few specific proteins. Oxidative degradation of amino acids, NH₄ transport (pre-requisites BCH 201, 202). Biosynthesis of Proteins.

BCH 307: METABOLISM OF NUCLEIC ACIDS (2 UNITS) L:2 T:0 P:0

Metabolism of purines and pyrimidines. Structure and properties of nucleotides and nucleic acids. Hydrolysis of nucleic acids. Elucidation of DNA structure and properties. Genome organization and biosynthesis of protein. Abnormalities in nucleic acid metabolism – xeroderma pigmentations and skin cancer. (Pre-requisites BCH 201, 202, CHE 222)

BCH 309: BIOCHEMISTRY METHODS (2 UNITS) L:2 T:0 P:0

Principles of instrumentation. Principles, methodologies and applications of electrophoresis, chromatography, spectroscopy and spectrophotometry, centrifugation and isotopic techniques. Practical laboratory exercises emphasizing the applications of these techniques in biochemistry are expected to be carried out.

BCH 311: BIOENERGETICS (2 UNITS) L:1 T:1 P:0

A review of the laws of thermodynamics; free energy and chemical and electrochemical potentials. Nernst equation. High energy compounds. ATP hydrolysis, phosphate group transfer potential. ATP production and its regulation. Oxidative phosphorylation, substrate level phosphorylation, photophosphorylation, bioluminescence. Energy-dependent membrane transport. (Pre-requisites BCH 201, 202, CHE 231)

.BCH 313: EXPERIMENTAL BIOCHEMISTRY (1 UNIT) L:0 T:0 P:1

Practical classes in Biochemistry to cover most of the theories taught in class- metabolism, energetics, etc.

BCH 388: SEMINAR (2 UNITS) L:2 T:0 P:0

Seminars to be given by students on selected topics.

BCH 317: ENZYMOLOGY (2 UNITS) L:2 T:0 P:0

Classification and nomenclature of enzymes. Effects of temperature, pH, ions and inhibitors on enzyme-catalysed reaction, enzyme kinetics and inhibition. Mechanism of enzyme-catalysed reactions. Michaelis-Menten Equation. Allosteric/Regulatory enzymes. Estimation of kinetic parameters – enzyme activities, K_m , V_{max} , K_I Zymogen activator, digestive enzymes, etc. Coenzymes. (Pre-requisites BCH 201, 202, CHE 211, 222, 231; Co-requisites MAT 101, 102)

BCH 388: SEMINAR (2 UNITS)

BCH 398: INDUSTRIAL ATTACHMENT (6 UNITS)

Students will be attached to some industrial organizations for 24 weeks

BCH 401: ADVANCED BIOCHEMICAL METHODS (2 UNITS) L:0 T:0 P:2

The purpose of this course is to familiarize students with operations of latest biochemical equipments and with methods of research assimilation and dissemination of information. Students will therefore go round lecturers and laboratories housing specialized equipments with the aim of exposing them to such equipment under the supervision of the lecturer. Part of the course will also cover the effective use of the library, preparation of dissertations or theses, papers for journal publications and journal review. Special assignments and essays will be given to students. (Pre-requisites BCH 309)

BCH 403: BIOSYNTHESIS OF MACROMOLECULES (2 UNITS) L:2 T:0 P:0

Structure and functions of macromolecules. Storage and structural polysaccharides; mucopolysaccharides, glycoproteins, bacterial cell wall. Synthesis of complex lipids, lipoproteins and nucleic acids (Pre-requisites BCH 301, 303).

BCH 404: INDUSTRIAL BIOCHEMISTRY (2 UNITS) L:2 T:0 P:0

A short review of microbial physiology and genetics. A review of general metabolic pathways, control and application in industrial processes. Continuous culture methods – principles and applications. The chemostat and its application in industrial fermentations. Fermentations – alcoholic, amino acids, antibiotics and other secondary metabolites. Primary and secondary metabolism. Process evaluation and development. Over-production of metabolites – amino acids, taste enhancers, vitamins, toxins, etc. Methods for screening and selecting micro-organisms of industrial importance. Induction of mutation in micro-organisms and plants for the purpose of over-production. Strain selection/development and enhancement. Gene dosage and its application in industrial processes. Enzymes biotechnology – enzyme immobilization, enzyme reactors, industrial uses of enzymes (Pre-requisites BCH 308)

BCH 405: REGULATION OF METABOLIC PROCESSES (2 UNITS) L:2 T:0 P:0

The relationship of Kreb's cycle to protein, carbohydrate, lipid and nucleic acid metabolism. Integration of metabolic pathways. Illustration of regulation of linear and branched metabolic pathways using specific examples. Turnover rates and metabolic pools. Catabolite repression, end-product repression, the lactose and arabinose operons. Identification of different regulatory mechanisms in metabolic pathways. (Pre-requisites BCH 301, 303, 304)

BCH 406: PHARMACOLOGICAL BIOCHEMISTRY (2 UNITS) L:2 T:0 P:0

Review of different types of drugs with examples of structures. Action of drugs and foreign compounds in living organisms. Absorption, distribution and termination of action of drugs. Dose and time responses to drugs. Individual variability. Drug toxicity and aspects of drug abuse. Cellular metabolism in infected cells. Biochemical aspects of host-parasite relationships. Metabolic factors affecting chemotherapeutic agents. Theories of the mechanism of drug action. Drug resistance and other factors affecting drug efficacy. The physiological and biochemical action of some selected drugs. Nigerian traditional medicinal plants in the management and therapy of common ailments in Nigeria (malaria, sickle-cell, anaemia, common cold, hepatitis, etc.) (Pre-requisites BCH 302, 310).

BCH 407: GENETIC ENGINEERING (2 UNITS) L:2 T:0 P:0

Replication, transcription and translation – a brief review. Isolation and Manipulation of Nucleic acids. The genetic code and its relationship to cellular function. Gene mutation and mutagenic agents. Basic Techniques of Genetic engineering: Southern Blotting, Hybridization of Nucleic acids, Gene Probes, Polymerase chain Reaction, Gene sequencing, Gel electrophoresis of Nucleic acids. Site-directed mutagenesis, Enzymology of Genetic engineering i.e. Restriction endonucleases, ligases and others.

Cloning vectors, Gene cloning, Gene banks/libraries Expression of Eukaryotic Genes in E. Coli Cloning in plant cells and mammalian cells. Recombinant DNA techniques and applications. Uses of genetic engineering in Agriculture, Health and Industry. (Pre-requisite BCH 307, 314)

BCH 408: IMMUNOCHEMISTRY (4UNITS) L:3T:1 P:0

Basic concepts of immunology. Structure of antigens, antigenic determinants and cellular response. Structure and classification of immunoglobulins and antibodies. Antigen and antibody interaction. Genetic basis of antibody diversity. The complement system in immune response. Hypersensitivity, immunopathology, autoimmunity, tumour and transplantation immunology. Immunopathogenesis of HIV. Immunochemical techniques – haemagglutination and complement fixation, precipitation reactions, immunoblotting, isolation of lymphocyte population, cytotoxic assay, etc. (Pre-requisites BCH 201, 202, 302)

BCH 409: ADVANCED ENZYMOLOGY (2 UNITS) L:2 T:0 P:0

Steady state enzyme kinetics. Transient methods. Chemistry of enzyme catalysis. Regulatory enzymes. Molecular models for allostery. Multienzyme complexes. Enzyme assays. Criteria for determining purity of enzymes. Enzyme reconstitution. Regulation of enzyme activity and synthesis. (Pre-requisites BCH 304)

BCH 412: PLANT BIOCHEMISTRY (2 UNITS) L:2 T:0 P:0

Organization of plant cells, photosynthesis, alkaloids and flavonoids, plant hormones. Structure-function relationship of plant hormones. Biosynthesis of carotenoid pigments.

Biochemistry of plant development. The plant cell wall – structure, formation and growth. Lignin formation. Free amino acids, pyrimidines, purines and nucleosides in plants. Metabolism of auxins, gibberellins and cytokinins. Synthetic growth regulators and herbicides. (Pre-requisites BCH 201, 202)

BCH 414: BIOINORGANIC CHEMISTRY (1 UNIT) L:1 T:0 P:0

Relationship between the physico-chemical properties and biological functions of inorganic ions. Ligand complexes and their biochemical significance. Electrolyte metabolism. Nitrogen fixation and sulphur cycle. (Pre-requisites CHE 211, 312)

BCH 415: FUNCTIONAL BIOCHEMISTRY (2 UNITS) L:2 T:0 P:0

Body fluids; blood – plasma proteins, blood clotting, iron metabolism, electrolyte, water and acid-base balance. Muscle – composition, contractile process, source of energy for muscular work. Biochemistry of brain, conduction and transmission of nervous impulse. Bone; calcium and phosphate metabolism. Biochemistry of vision, reproductive tissues, hormones, immunochemistry and immunobiology. In-born errors of metabolism. Acquired immunodeficiency syndrome. Biochemistry of liver, kidney and adipose tissue. (Pre-requisites BIO 206, BCH 201, 202)

BCH 416: INTRODUCTORY BIOTECHNOLOGY (2 UNITS) L:0 T:0 P:0

Definition, history and evolution of biotechnology.

Scope (different areas) of biotechnology Genes and Genetic engineering, Tools and Practice of genetic engineering (Restriction and other enzymes, vectors, DNA cutting and ligation, cloning in prokaryotic cells etc.).

Cell culture, biomass production and technology. Enzyme technology: Production and Purification, Enzyme/cell immobilization. Fermentation technology, operations, bioreactors. Application of biotechnology in production of organic acids (citric and lactic acids), biofuels, in agriculture, health and food industries. Social and Economic implications of Biotechnology.

BCH 417: EXPERIMENTAL BIOCHEMISTRY II (1 UNIT) L:0 T:0 P:1

Practical classes in Biochemistry to cover metabolism of nutrients in normal and disease conditions, molecular biology, toxicology, etc.

BCH 419: NUTRITIONAL BIOCHEMISTRY (2 UNITS) L:2 T:0 P:0

Food nutrients. Energy values of foods and energy expenditure by mammals. Nutritive value of foods – carbohydrates, fats, proteins, vitamins, mineral elements and water. Nutritional disorders, prevention and therapy. Nutritional status and nutritional requirements. Recommended dietary allowances. Assessment of nutritional status. Nutrient requirements in relation to physical activity and ageing, diet and disease, obesity and under-nutrition□.

BCH 421: FOOD BIOCHEMISTRY (2 UNITS) L:2 T:0 P:0

Food Constituents. An introduction to the theory and application of physical and chemical methods for determining the constituents of food; processing, preservation and storage of traditional foods – root and stem tubers, fruit and fruit drinks, seeds and grains, greens and vegetable. Food poisoning and intoxication, prevention and cure. Chemical changes in foods, food enzymes and their uses.

BCH 423: INTRODUCTORY TOXICOLOGY (2 UNITS) L:2 T:0 P:0

History of Toxicology, Absorption, Distribution and Elimination of Toxicants. Detoxication mechanisms. The biochemical modes of action of pesticides and herbicides. Toxicological effects of expired drugs. Side effects of drugs as a result of use and/or misuse. Allergy and its biochemical basis. Toxins in processed foods and beverages. Screening for toxic pollutants in food, water, etc. biochemistry of aflatoxins and mycotoxins. Toxicological studies of food additives and food preservatives.

BCH 425: MEMBRANE BIOCHEMISTRY (1 UNIT) L:1 T:0 P:0

Structure, composition and functions of biological membranes. Isolation, characterization and classification of membrane bilayers e.g. the unit membrane hypothesis; Membrane transport system-active versus passive transport of sugars and amino acids ionophores.

BCH 499: RESEARCH PROJECTS (6 UNITS)

Independent research into selected areas/topics of interest to the academic staff. Students will be required to carry out literature survey on the topics, perform experiments and produce short reports. Students will be subjected to both seminar and oral examination on the projects undertaken.

**SYNOPSIS OF CHEMISTRY AND INDUSTRIAL CHEMISTRY COURSES
OFFERED IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY**

The units of Number of Lectures, Tutorials and Practical per course are indicated after each course title.

CHE 101: Physical Chemistry I**2-1-0****3 Units**

Atoms, molecules and structures. Binding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry. Rates of reaction, Equilibrium, acids, bases and salt. Redox reactions and introduction to electrochemistry.

CHE 102: Inorganic chemistry I**2-1-0****3 Units**

Electronic configuration periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Extraction of metals. Comparative chemistry of group IA, IIA and IVA and IVA elements. Introduction to transition metal chemistry and nuclear chemistry.

CHE 103: Organic Chemistry I**2-1-0****3 Units**

Tetravalency of carbon, structure, molecular composition and variety of carbon compounds functional group classes of carbon compounds, Reaction mechanism and kinetics. Skeletal classification of carbon compounds. The chemistry of alkenes and petroleum, alkenes including ozonolysis, , alkynes, benzene, alcohols including phenols, ethers, aldehydes, ketones, carboxylic acids and derivatives and amines, structure of simple sugars, starch and cellulose, peptides and proteins, Synthetic polymers from various classes of compounds. Mechanisms of reaction discussed in all cases and uses of compounds.

CHE 191 : Experimental chemistry I**0-0-1****1 Unit****CHE 192 : Experimental chemistry II****0-0-1****1 Unit**

CHE: 201 Analytical Chemistry I 2-0-0 2 Units
The mole concept, Chemical Equation and constants, stoichiometry and Chemical arithmetic, units of concentration and analytical Data Management, Presentation and Interpretation of Results.

CHE 202: Analytical Chemistry II 2-0-0 2 Units
Titrimetric Analysis Acid/Base, Redox, complexometric and Precipitation. Gravimetric techniques; contamination and handling of Precipitates.

CHE 203: Physical Chemistry II 2-0-0 2 units
Heat, work, first law of thermodynamics. Internal energy. State functions and differentials. Heat in chemical change and varieties of heat. Entropy, the second law of thermodynamics and applications. Gibbs function. The third law. Entropy and EMF equilibrium.

CHE 204: Organic Chemistry II 2-0-0 2 Units
The Chemistry of aromatic compounds compared with their aliphatic counterparts. Nitriles. Grignard Reaction Chemistry of bifunctional compounds. Aldol and related reactions. Energetics, kinetics and the investigation of reaction mechanisms. Simple compounds surveyed. Nomenclature and structure.

CHE 206: Inorganic Chemistry II 2-0-0 2 Units
Stereochemistry and molecular orbital theory of simple molecules including homo and hetero-atoms. Comparative group relations of the elements in the periodic table. Chemistry of Group IIIA (boron group) VA (nitrogen group), noble gases and 1st row or transition metals. Concepts of hard and soft acids and bases. Chemistry in aqueous and non-aqueous media. Oxidation and reduction reaction.

CHE 208: Environmental Chemistry II 2-0-0 2 Units
The nature and composition of the atmosphere. Basic chemistry of the geosphere and soil. Air pollution. Introduction to water chemistry, water pollution and wastewater treatment. Fertilizers and the environmental effects of Agric practices. Hazardous waste and disposal.

CHE 213: General Chemistry for Life Sciences I 2-0-0 2 units
Acids, bases & buffers. Biochemical relevance of pH. First and Second Laws of Thermodynamics. Applications of thermodynamics to biological systems. Kinetics of chemical reactions. Rate equations, order and molecularity of reaction. Effects of temperature and catalysis. Chemical equilibrium. Enzyme catalysis. Electron transport and the respiration chain. Basic analytical methods – separation from other extraneous matter, concentration and detection. Application to analysis of water, food, feedstock, soil and minerals

CHE 214: General Chemistry for Life Sciences II 2-0-0 2 units
Structure and properties of the atom. Build up of the periodic table. Block element properties. Inorganic applications in agriculture, medicine and industry. Comparison of aromatic compounds with their aliphatic counterparts. Bifunctional compounds. Naturally occurring compounds –

fatty acids, sugar, Carbohydrates, Amino acids, Peptides, terpenes, alkaloids and nucleic acids pesticides, plant and insect hormones.

ICH 201: Industrial Chemistry I **2-0-0** **2 Units**
Inventory, state and convertability of Nigeria's natural resources. Ore processing for selected metals. Their uses and reactions.
The chlor-alkali process in details. Industrial gases; purification and uses.

ICH 202: Industrial Chemistry II **2-0-0** **2 Units**
Petrochemical feedstocks and products evaluation. Primary and secondary petrochemical industrial processes and products. Economics of the organic chemical industry. Natural and Petroleum associated gases as sources of chemicals. Coal gasification and coal based-chemical processes and development. Fermentation processes, biodegradation, vegetation, agricultural products and wastes as industrial raw materials.

ICH 203: Large Scale Chemistry **2-0-0** **2 Units**
Introductory course, Economic and technical factors in scaling-up of laboratory experiments, Reactor design and optimization. Unit operations, fluid dynamics. Heat and material transfer, Fire and explosion hazards, toxicity, Qualities of construction materials. Instrumentation, control and the scale-up plant.

ICH 208: Petrochemicals and Utilization of Wastes **2-1-0** **3 Units**
Industrial Polymers; Thermoplastics, thermosetting plastics, phenoplasts and aminoplasts. Nature and uses of plasticizers, stabilizers, extenders and filters crystallization of polymers. Paints; Polyvinyl acetate, acrylics and water-based paints. Alkyd, nitrocellulose and other resins, titanium dioxides, lacquers, paint flow, Natural and synthetic rubbers vulcanization. Textile fibers. Soaps and detergents of all types. Phenomenology, theories and formulations. Soap economics. Dyes and pigments of all types and methods of their application. Local plants and pharmaceutical industry. Aspirin, sulphadiazine, barbiturates, antibiotics etc.

ICH 210: Heavy Inorganic Chemicals **2-0-0** **2 Units**
The Nitrogen based manufacturing industries including acids, fertilizers urea and methanol-Formaldehyde. Sulphur dioxide and Sulphuric acid industry. Potash extraction process; sylvite, local ores and Dead Sea sources. The phosphorous industry, borax industry and glass cement and asbestos industry chemical plant materials.

CHE 291: Experimental chemistry III **0-0-2** **2 Units**

CHE 292: Experimental chemistry IV **0-0-2** **2 Units**

CHE 295: Practical Chemistry for Life Sciences **0-0-1** **1 unit**

CHE 301: Physical Chemistry III **2-1-0** **3 Units**
Wave mechanics and application of boundary conditions Bohr's theory of atomic spectra and its limitations. The uncertainty principle. Operators and postulates of quantum mechanics. Term symbols schrodinger equation (for H and He atoms, hydrogen molecular ion and hydrogen

molecule) and application in the interpretation of spectra. Introductory molecular orbital theories for chemical bonding.

Macroscopic properties in terms of the microscopic. Boltzman distribution. Partition functions, Statistical thermodynamics discussion of entropy. Third law, Equilibria and chemical potentials, use of calorimetric data and of standard thermodynamic data tables. Activity, coefficients, non-ideal systems, and electrolyte solutions. Transport properties of ionic solutions, reversible potentials and applications.

CHE 303: Analytical Chemistry III 2-1-0 3 Units

Separation Methods: Ion Exchange, Gas, Paper, Liquid, Column electrophoresis, Atomic and molecular emission and absorption techniques. Electrophoresis. Atomic and molecular emission and absorption techniques. Electroanalytical techniques.

CHE 305: Organic Chemistry III 2-1-0 3 Units

Infra red and UV-Visible spectra in organic analysis 3, 4, 5 and 6-membered rings, N, and heterocyclic compounds (aromatic and non aromatic). Aromatic rules. Selected arrangement reaction e.g. Beckmann, etc, to illustrate various reactions mechanisms and types, reactive intermediates. Classes of naturally occurring compounds and isolation, Terpenoids - classification and non-terpenoids.

CHE 306: Analytical Chemistry for Non-majors II 2-1-0 3 Units

Instrumental and separation methods in the analysis of water, food and feed-stuff, soil and minerals. Classical, Instrumental and Separation Techniques in Analysis of Water, Food and Feedstuff, Soils, Solid Minerals and biological Material.

CHE 307: Inorganic Chemistry III 2-1-0 3 Units

Descriptive chemistry of transition metals series, Introduction to coordination chemistry, Nomenclature of inorganic compounds, Chemistry of non-metals in groups VIA and VIIA, Introduction to organo- metallic chemistry, e.g. Metal Role of metals in living systems.

CHE 309 : Organic Chemistry IV-Macromolecules 2-0-0 2 Units

Chemistry of amino acids. Reactions of amino acids. Properties of peptide bond. Level of organisation of proteins. Storage polysaccharides. Reaction of carbohydrates. Chemistry of fatty acids. Triglycerides. Classification of lipids. Chemistry, functions and biosynthesis of nucleic acids. Protein biosynthesis. chemistry of vitamins and co-enzymes. Vitamin deficiency disease. Immunoglobulins.

CHE 317: Inorganic Chemistry for Life Sciences 2-0-0 3 Units

Introduction to coordination chemistry and bioinorganic chemistry, Introduction to nuclear chemistry and application of the isotopes. Selected topics in inorganic chemistry such as Fertilizers. Water and Corrosion.

ICH 303: Unit Operation I Momentum Transfer) 2-0-0 2 Units

Required Momentum transfer in material transfer. Flow processes and related measurements. Bernoulli's equation and use. Pumping, compression and expansion Energy economy.

ICH 312: Industrial Attachment for 24 weeks 6 units

CHE 395: Experimental chemistry V 2 units

CHE 398: Chemistry Seminar 2 units

Five assessed and discussed essays on chemistry and society with titles selected from wide spread areas, e.g. Agriculture, Industries, Health and Medicine, the judiciary, the Military; etc.

CHE 401: Organic Chemistry V 2-1-0 3 units:

Ring forming and fission during reactions and Woodward Hoffmann rules. Signatropic shifts, indole, quinolines, imidazole and selected monocyclic heterocycles with N, S and O. Introductory chemistry of alkaloid, terpenoid, coumarin and flavonoid chemistries and biogenesis. Chemical fossils.

CHE 402: Symmetry, Group Theory and Electrochemistry I 2-1-0 3 Units

Symmetry and wave functional description of electron density, bond orders, energy levels and application to chemical reactivities and stereochemical prediction of reaction products. Symmetry elements, operations, and transformations. Group theory and its structure applications. Woodward Hoffman rules, activity coefficients, electrode processes power generation, corrosion and stability of metal.

CHE 403: Advanced Analytical Chemistry and Applications: 2-1-0 3 Units

Steps in Chemical Analysis, Data Treatment, Analysis of Water, Air, clinical samples, Foods, Drugs, soils and Rocks.

CHE 404: Quantum Mechanical treatment of chemical Building and Kinetics 2-1-0 3 Units

Quantum mechanical description of mplecular orbitals. Wave functions and energies of homo- and heteronuclear diatomic molecules correlation diagrams, ground and excited state potential energy diagrams molecules. Hybridization and stereochemical relations in simple polyatomic molecules, M. O. theories of unsaturated polyatomic (up to four atoms) molecules. Brief discussion of the theories of chain reactions combustion explosions and fast reaction in solution and gas phase.

CHE 406: Environmental Chemistry 2-1-0 3 Units

Environmental Concepts: Human Activities and Interaction with the environment. Scope of Environmental Chemistry; Environmental Media. Global Treaties and Conventions. Waste Characteristics and Management. Environmental Chemistry of soil, Water and Air Environmental. Assessment Techniques

CHE 407: Inorganic Chemistry IV 2-1-0 3 Units

Coordination Chemistry Preparation. Isomerism and Stability of coordination number and Stereochemistry. Theories of bonding. Magnetic and electronic spectral properties of metal complexes.

CHE 409: Applied spectroscopy 2-1-0 3 Units

Qualitative treatment of Raman H and ^{13}C N, M. R. and mass spectroscopy. Mention of C. D and O.R.D. curves, Integrated use of spectroscopy and chromatography in structure determination and separation of mixtures.

CHE 410: Advanced Chemical Kinetics 2-1-0 3 Units

Experimental methods in gas phase and fast reaction of solution. Theoretical Interpretation of reaction rates and applications-van't Hoff equation for chemical equilibria and forcing functions, chemical relaxation times, amplitudes and enthalpies. Temperature jump spectrophotometry.

CHE 411: Nuclear and Radio-Chemistry and Heavy Transition Metals

2-1-0 3 Units

CHE 412: Synthetic Methods

2-1-0 3 Units

Organic synthetic strategies illustrated by the synthesis of three or more complex natural products survey of general synthetic reactions and methods

CHE 413: Molecular spectroscopy 2-1-0 3 Units

Application of quantum theory to the interpretation of absorption and emission spectra in terms of molecular properties theory of electronic absorption and emission (fluorescence and phosphorescence), spectral intensities, energies, and polarization of transitions. Theory of vibrational and rotational spectra-IR, Raman Resonance Raman, F. s. R. and N. M. R. Hyperfine splitting and g-factor, Simple magnetic resonance spectra.

CHE 415: Colloid, Surface Chemistry and Advanced Electrochemistry

2-1-0 3 Units

Lyophobic/hydrophilic and lyophilic/hydrophobic Colloids, polydispersity, Size; shape and behavior of the various colloidal dispersion, colloidal electrolytes; polyelectrolytes, Surface active agents, absorption on solid surfaces. Electrochemistry of charged and polarized layers. Equilibrium properties of the electrochemical diffuse plane double layers. Charge transfer, electrocatalysis, and electrochemical energy conversion. Determination of surface area and porosity.

CHE 416: Photochemistry and Biologically Active Natural Products

2-1-0 3 Units

Rules of Photochemical reactions Fluorescence and Phosphorescence, Photoreactions of major functional groups and industrial phytochemistry; steroidal hormones; plant hormones & pesticides, glycosides, carciotonic glycoside, Penicillins, alkaloids and terpenoids. Selected synthesis reactions e.g. writing Birch reduction, complex hydrides, oxidation etc.

CHE 417: X-ray Crystallography 2-1-0 3 Units

The crystalline state, Principles and uses of X-ray diffraction from singly crystals, powders and polycrystalline materials. Diffraction patterns and structure determination. Brief discussion of electron microscopy of polymers, industrial applications of x-ray fluorescence and neutron diffraction.

ICH 401:	Unit Operation II	2-1-0	3 Units
ICH 402:	SPECIAL Topics in Industrial Chemistry	2-1-0	3 Units
ICH 414:	Process Chemistry	2-1-0	3 Units
CHE/ICH 499:	Research Project		6 Units
	Experimental Investigation of chemical research problems		
CHE 495:	Experimental chemistry VI	0-0-2	2 units