

**GODFREY OKOYE UNIVERSITY
ENUGU, ENUGU STATE, NIGERIA**

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B.SC INDUSTRIAL CHEMISTRY

**The Core Curriculum Minimum Academic
Standards (CCMAS)**

September, 2023.

Overview

Industrial Chemistry is the index of industrial development everywhere in the world. The frontiers of chemistry are very large, ranging from one extreme of natural products to those synthesized by man. The enormous strides made by man in the understanding, exploitation of nature and synthesis of new products all have their roots in chemistry and chemical technology. For economic sustenance and technological breakthrough, the undergraduate programme is designed to encompass an appreciation of the centrality of chemical sciences in the entire undergraduate curricula. The programme is designed to equip students for employment in virtually all types of industries. Consequently, a lot emphasis is placed on practical work and industrial training during the course of the programme which may be run as a 4-year programme or a 5-year programme. For institutions opting for the 4-year programme, students are to undertake two industrial attachments of 12 weeks duration each, the first at 200-level and the second at 300-level. Institutions wishing to expose their students to more intensive industrial training should adopt the 5-year programme in which case the students will spend the entire 400-level (36 weeks) on industrial attachment. The programme is also planned to arouse entrepreneurial spirits needed for self-employment and economic emancipation.

Philosophy

The philosophy is to train graduates who will apply scientific approach through verifiable and reproducible methodologies to solving developmental needs of the society.

Objectives

Objectives of the Industrial Chemistry programme include:

- provide students with scientific knowledge and skills from which they can proceed to further studies in specialized and/or multi- disciplinary areas;
- provide students with a broad and balanced foundation of scientific knowledge and practical skills as may be applicable in their different programmes;
- develop in students the ability to apply scientific knowledge and skills to solving theoretical and practical problems;
- develop in students, a range of transferable skills that are of value in any employment and society they might find themselves;
- provide, through training and orientation, an appreciation of the rewards inherent in inter- and multi- disciplinary approach to the solution of complex life problems, and engender in students an appreciation of the fact that no nation can develop without science and its application.

The specific objectives of the Industrial Chemistry Programme are as follows:

- provide students with a thorough grounding in principles and sound knowledge of scientific methods of the chemical sciences;
- arouse a sense of curiosity and enquiring mind, in order to encourage and develop creative thinking and research aptitudes;
- generate in students an awareness of the enormous resources in their immediate environment so as to enhance solutions to the challenges of our time in a march towards nation building;
- educate and train chemists, particularly applied chemists, who can think fundamentally about their subject and who can acquire as graduates, a meaningful picture of the chemical industry;
- and

inculcate in students appropriate skills and abilities to manage and administer technological operations within the field of chemistry and allied areas.

Unique Features of the Programme

The unique features of the programme include:

the programme is rich through a combination of various subjects for a better understanding of industrial chemistry;
cognitive abilities and skills relating to solution of problems in industrial chemistry and other allied chemical industries;
practical skills relating to the conduct of laboratory work in chemical industries. mastering industrial processes that take place in pharmaceutical, food and beverages, petroleum and petrochemical, paints and textile industries and metallurgical and ceramic industries;
general skills relating to non-subject specific competencies, communication, interpersonal, organization skills; and
graduate of industrial chemistry will be equipped for graduate self-employment.

Employability Skills

Industrial chemistry graduates are specially equipped for employment in various industries in such areas as production supervision, quality control, research and development, technical marketing etc. Some typical industries where industrial chemistry graduates can be employed include chemical, food and beverage, pharmaceuticals, petroleum and petrochemicals, metallurgical and ceramic industries, textile, paper and wood, paint, and environmental agencies as well as several other regulatory agencies. The programme is also designed to equip students for self – employment.

21st Century Skills

Creativity
Computer Literacy
Organization Skills
Communication And It Skills
Teamwork
Innovation
Problem Solving Skills
Critical Thinking

Admission and Graduation Requirements

Admission Requirements

There are two different pathways by which candidates can be admitted into the programmes in the discipline: the Indirect Entry and the Direct Entry.

Indirect Entry

Admission through indirect entry shall take the student to 100 level. The candidate must have Senior Secondary Certificate (SSC) credit passes in five subjects at not more than two sittings in SSCE, NECO or GCE (ordinary level). The credit passes are required in the following subjects:

English language, Mathematics, Chemistry, Physics and Biology. The UTME subjects are: English Language, Physics, Biology and Chemistry.

Direct Entry

Admission by direct entry is into second year (200 level) of the programme. Candidates for direct entry should possess passes at GCE (advanced level) at one sitting in at least two of the following subjects: Physics, Mathematics, Biology and Chemistry or National Diploma (ND) at a minimum of Upper Credit level in Lab technology (chemistry option) and any other related course from any recognized institution.

Graduation Requirements

To be eligible for the award of a Bachelor's Degree in Industrial chemistry, a student must pass a minimum 120 credit units for those admitted through UTME and 90 units for Direct Entry, including all the compulsory courses of the Department, the Faculty courses namely A student admitted through UTME must complete the programme in 4 years (8 semesters), while a student admitted through Direct Entry must complete the programme in 3 years (6 semesters); both can be given extra two years (4 semesters) to complete their programme provided their CGPA is not below 1.0.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
MTH 101	Elementary Mathematics I	2	C	45	-
MTH 102	Elementary Mathematics II	2	C	45	-
COS 101	Introduction to Computing Science	3	C	30	45
CHM 101	General Chemistry I	2	C	45	-
CHM 107	General Practical Chemistry I	1	C	-	45
CHM 108	General Practical Chemistry 11	1	C		45
CHM 102	General Chemistry11	2	C	30	
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Practical Physics I	1	C	-	45
PHY 108	General Practical Physics II	1	C	-	45
GET 102	Engineering Graphics and Solid Modelling	2	C	30	45
	Total	22			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	
ENT 211	Entrepreneurship and Innovation	2	C	30	
CHM 210	Physical Chemistry I	2	C	30	
CHM 211	Organic Chemistry I	2	C	30	
CHM 212	Inorganic Chemistry I	2	C	30	
CHM 207	General Practical Chemistry 1	1	C		45
CHM 208	General Practical Chemistry 11	1	C		45
ICH 213	Analytical Chemistry I	2	C	30	
ICH 251	Process Science I	3	C	45	-
ICH 252	Process Science II	3	C	45	-
COS 201	Computer programming 1	2	C	30	45
GOU-ICH 201	Food Chemistry and Biotechnology	3	E	45	-
GOU-ICH 202	Instrumentation Chemistry and Analytical Methods	3	C	15	45
	Total	26			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict resolution	2	C	30	
ENT 312	Venture Creation	2	C	15	45
ENT 314	Entrepreneurial skill in Industrial Chemistry	3	C	30	45
CHM 301	Physical Chemistry II	2	C	30	
CHM 302	Inorganic Chemistry II	2	C	30	
CHM 303	Organic Chemistry II	2	C	30	
ICH 305	Petroleum Chemistry	2	C	30	-
ICH 306	Polymer Chemistry	2	C	30	
ICH 317	Industrial Raw Materials Resource Inventory	1	C	15	-
ICH 318	Management and Chemical Industry I	2	C	30	-
ICH 319	Glass blowing Practical	1	C		45
*ICH 399	Industrial Attachment (12 Weeks)Industrial Attachment II (12 Weeks)	3	C		
GOU-ICH 301	Computational Chemistry and Molecular Docking	2	C	15	45
GOU-ICH 302	Colour Chemistry Technology	2	E	30	-

GOU- ICH 303	Corrosion and control Chemistry	2	C	30	-
GOU- ICH 304	Nanoscience and Nanotechnology	2	E	30	-
GOU- CH 305	Medicinal Chemistry	2	C	30	-
GOU- ICH 306	Natural Local Products Chemistry	3	E	30	-
	TOTAL	46			

***CHM 399 is only for students in institutions running a 4-year industrial chemistry programme.**

400 Level:

Course Code	Course Title	Units	Status	LH	PH
ICH 422	Entrepreneurship for Industrial chemistry	2	C	30	
ICH 400	Seminar in Chemistry	2	C		

Course Code	Course Title	Units	Status	LH	PH
ICH 401	Research Project	6	C	-	270
ICH 453	Chemistry of Industrial Processes	3	C	45	-
ICH 454	Chemical Processes Technology	3	C	45	-
ICH 455	Macromolecular Chemistry II	3	C	45	-
GOU-ICH 401	Geochemistry	3	C	45	-
GOU-ICH 402	Cement and Fertilizer Chemistry	2	E	30	-
GOU-ICH 403	Heterocyclic Chemistry	2	C	30	-
GOU-ICH 404	Organometallic Chemistry	2	E	30	-
GOU-ICH 405	Environmental Chemistry and waste management	3	C	45	-
GOU-ICH 406	Organic Synthesis	2	E	30	-
GOU-ICH 407	Chemo statistics	3	C	15	45
TOTAL		42			

*ICH 499 is only for students in institutions running Industrial Chemistry as a 5 -year programme. In such a case the 4th year will be spent entirely on Industrial Attachment and all the other indicated 400-Level will be taken in the 5th year as 500-Level courses
There are institutions running B.Sc. Industrial and Environmental Chemistry, Industrial Attachment I (12 Weeks) is usually a whole semester of the third session'

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English

(2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to
 identify possible sound patterns in English Language;
 list notable Language skills;
 classify word formation processes;
 construct simple and fairly complex sentences in English;
 apply logical and critical reasoning skills for meaningful presentations;
 demonstrate an appreciable level of the art of public speaking and listening; and
 write simple and technical reports.

Course Contents

Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies.

Logical and critical reasoning for meaningful presentations. Art of public speaking and listening.
Report writing.

GST 112: Nigerian Peoples and Culture

(2units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

- analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
- list and identify the major linguistic groups in Nigeria;
- explain the gradual evolution of Nigeria as a political unit;
- analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian people towards national development;
- enumerate the challenges of the Nigerian State towards Nation building
- analyse the role of the Judiciary in upholding people's fundamental rights
- identify acceptable norms and values of the major ethnic groups in Nigeria; and
- list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)

(2 Units C: LH 30)

Learning Outcomes

At the end of this course students should be able to:

- explain basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
- solve quadratic equations;
- Solve trigonometric functions;
- identify various types of numbers; and
- solve some problems using Binomial theorem.

Course Contents

Elementary set theory, subsets, union, intersection, complements, venn diagrams. Real numbers, integers, rational and irrational numbers. Mathematical induction, real sequences and series. Theory of quadratic equations. Binomial theorem. Complex numbers. Algebra of complex numbers. The Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus)

(2 Units C: LH 30)

Learning Outcomes

At the end of this course students should be able to:

- identify the types of rules in differentiation and integration;
- describe the meaning of function of a real variable, graphs, limits and continuity; and
- solve some applications of definite integrals in areas and volumes.

Course Contents

Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences

(3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

- explain basic components of computers and other computing devices;
- describe the various applications of computers;
- explain information processing and its roles in the society;
- describe the Internet, its various applications and its impact;
- explain the different areas of the computing discipline and its specializations; and
- demonstrate practical skills on using computers and the internet.

Course Contents

Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

CHM 101: General Chemistry I

(2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

- define atom, molecules and chemical reactions;
- discuss the Modern electronic theory of atoms;
- write electronic configurations of elements on the periodic table;
- justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
- identify and balance oxidation – reduction equation and solve redox titration problems;
- illustrate shapes of simple molecules and hybridized orbitals;
- identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
- apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
- analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
- determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents

Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry. Rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II

(2 Unit C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

- state the importance and development of organic chemistry;
- define fullerenes and its applications;
- discuss electronic theory;
- determine the qualitative and quantitative of structures in organic chemistry;
- describe rules guiding nomenclature and functional group classes of organic chemistry;
- determine rate of reaction to predict mechanisms of reactions;
- identify classes of organic functional group with brief description of their chemistry;
- discuss comparative chemistry of group 1A, IIA and IVA elements; and
- describe basic properties of Transition metals.

Course Contents

Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses as nanotubes, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction

mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I

(1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

- describe the general laboratory rules and safety procedures;
- collect scientific data and correctly carrying out Chemical experiments;
- identify the basic glassware and equipment in the laboratory;
- identify the differences between primary and secondary standards;
- perform redox titration;
- recording observations and measurements in the laboratory notebooks; and
- analyse the data to arrive at scientific conclusions.

Course Contents

Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II

(1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

- identify the general laboratory rules and safety procedures;
- collect scientific data and correctly carrying out Chemical experiments;
- identify the basic glassware and equipment in the laboratory;
- identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
- perform solubility tests on known and unknown organic compounds;
- conduct elemental tests on known and unknown compounds; and
- conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents

Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

PHY 101: General Physics I (Mechanics)

(2 Units C: LH 30)

Learning Outcomes

At the end of this course, the student should be able to:

- identify and deduce the physical quantities and their units;
- differentiate between vectors and scalars;

describe and evaluate motion of systems on the basis of the fundamental laws of mechanics.
apply Newton's laws to describe and solve simple problems of motion.
evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects.
explain and apply the principles of conservation of energy, linear and angular momentum.
describe the laws governing motion under gravity; and
explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Courses Contents

Space and time. Units and dimension, Vectors and Scalars. Differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics. Conservative forces. Conservation of linear momentum. Kinetic energy and work. Potential energy. System of particles. Centre of mass. Rotational motion: Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia. gyroscopes and precession. Gravitation: Newton's Law of Gravitation. Kepler's Laws of Planetary Motion. Gravitational Potential Energy. Escape velocity. Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the student should be able to:

- describe the electric field and potential, and related concepts, for stationary charges;
- calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential;
- describe and determine the magnetic field for steady and moving charges;
- determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
- describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
- explain the basic physical of Maxwell's equations in integral form;
- evaluate DC circuits to determine the electrical parameters; and
- determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics; electric charge and its properties, methods of charging. Coulomb's law and superposition. electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators, current, voltage and resistance. Ohm's law and analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step-down transformers: Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, resistance, and combinations.

PHY 107: General Practical Physics I**(1 Unit C: PH 45)****Learning Outcomes**

At the end of this course, the student should be able to:

- conduct measurements of some physical quantities;
- make observations of events, collect and tabulate data;
- identify and evaluate some common experimental errors;
- plot and analyse graphs; and
- draw conclusions from numerical and graphical analysis of data.

Course Contents

This introductory course emphasizes quantitative measurements, the treatment of measurement errors and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity etc., covered in PHY 101 and PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II**(1 Unit C: PH 45)****Learning Outcomes**

At the end of this course, the student should be able to:

- conduct measurements of some physical quantities;
- make observations of events, collect and tabulate data;
- identify and evaluate some common experimental errors;
- plot and analyse graphs;
- draw conclusions from numerical and graphical analysis of data; and
- prepare and present practical reports.

Course Contents

This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements. The treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

GET 102: Engineering Graphics and Solid Modelling I**(2 Units C: LH 15; PH 45)****Learning Outcomes**

Upon completion of this course students should be able to:

- recognise design thinking and be obsessed with the determination to apply such to solving simple every day and also complex problems;
- explain the fundamental concepts of engineering drawing and graphics;
- exhibit skills to represent the world of engineering objects in actionable solid models, and put such models in a form where they can be inputs for simulation and analyses;
- analyse such models for strength, cost and improved upon;

prepare the objects for modern production and manufacturing techniques of additive and subtractive manufacturing;
demonstrate the idea that engineering is multidisciplinary in the sense that mechanical, electrical and other parts of physical structures are modelled in context as opposed to the analytical nature of the courses they take;
master the basics of mechanical and thermal loads in engineering systems.

Course Contents

Introduction to design thinking and engineering graphics. First and third angle orthogonal projections. Isometric projections; Sectioning, conventional practices, conic sections and development. Freehand and guided sketching – pictorial and orthographic. Visualization and Solid modelling in design, prototyping and product-making. User Interfaces in concrete terms. Design, Drawing, Animation, Rendering and Simulation Workspaces. Sketching of 3D objects. Viewports and sectioning to Shop drawings in Orthographic projections and perspectives. Automated viewports. Sheet Metal and surface modelling. Material selection and rendering. This course will use latest professional design tools such as Fusion 360, Solid Works, Solid Edge or equivalent.

200 Level

GST 212: Philosophy, Logic and Human Existence

(2 Units C: LH 30)

Learning Outcomes

A student who has successfully gone through this course should be able to:

- know the basic features of philosophy as an academic discipline;
- identify the main branches of philosophy & the centrality of logic in philosophical discourse;
- know the elementary rules of reasoning;
- distinguish between valid and invalid arguments;
- think critically and assess arguments in texts, conversations and day-to-day discussions;
- critically assess the rationality or otherwise of human conduct under different existential conditions;
- develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
- guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation

(2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

- explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking
- state the characteristics of an entrepreneur;
- analyse the importance of micro and small businesses in wealth creation, employment, and financial independence
- engage in entrepreneurial thinking;
- identify key elements in innovation;
- describe stages in enterprise formation, partnership and networking including business planning;
- describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world;
- state the basic principles of e-commerce.

Course Contents

Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and joint ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

CHM 210: Physical Chemistry I

(2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

- state the kinetic theory of gases and solve problems related to ideal and real gases;
- derive the formula for molecular velocity of gases and use the derived formula to solve problems;
- describe and explain the fundamental concepts of physical chemistry including those of statistical mechanics, chemical Kinetics, quantum mechanics and spectroscopy;
- apply simple models to predict properties of chemical systems;
- define and state type of solutions; define different concentration terms which include molarity, normality etc. explain vapour pressure lowering of the solvent, boiling point elevation of solutions, freezing point depression of solution and measurement of osmotic pressure;
- apply numerical or computational methods to calculate physical properties of Chemical systems and assess the appropriateness of different computational techniques and numerical approximations for solving chemistry problems;

design and plan an investigation by selecting and applying appropriate practical, theoretical, and/or computational techniques or tools; and states Ohms law and describe the electrolytic conduction, states the Faraday's Law and Conductance Law of solution and calculation on electrical conductance on different electrolyte solution.

Course Contents

Kinetic theory of gases; science of real gases; the laws of thermodynamics; entropy and free energy; reactions and phase equilibria; reaction rates; rate laws; mechanism and theories of elementary processes; photochemical reactions; basic electrochemistry.

CHM 211: Organic Chemistry I

(2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

- describe and solve problems in chemistry of aromatic compounds;
- describe the structures of simple sugars, starch and cellulose, peptides and proteins and show the difference in their conformation structure;
- describe and solve problems in chemistry of bifunctional compounds;
- explain the mechanisms of substitution, elimination, addition and rearrangement reactions;
- describe stereochemistry and its application;
- describe condition and pathways of the following organic reactions - Grignard reaction, Aldol and related reactions; and
- describe simple alicyclic carbon compounds and their synthesis.

Course Contents

Chemistry of aromatic compounds. Structures of simple sugars, starch and cellulose, peptides, and proteins. Chemistry of bifunctional compounds. Energetics, kinetics, and the investigation of reaction mechanisms. Mechanisms of substitution, elimination, addition, and rearrangement reactions. Stereochemistry. Examples of various named organic reactions e.g., Grignard reaction, Aldol and related reactions. Simple alicyclic carbon compounds and their synthesis.

CHM 212: Inorganic Chemistry I

(2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

- list the first-row transition elements and explain their characteristics and properties;
- explain crystal field theory (CFT) and draw the diagram to illustrate with examples of coordination compounds;
- state the advantages of CFT over other bonding theories;
- discuss the comparative Chemistry of the following elements. (I) Ga, In, Tl (II). Ge, Sn, Pb (III). As, Sb, Bi (IV). Se, Te, Po;
- define organometallic Chemistry;
- give relevant examples with illustrations;
- classify organometallic compounds with examples;
- list the roles of metals in biochemical systems;
- discuss the concepts of hard and soft acids and bases.

list examples of item 9 above;
explain oxidation and reduction reaction; and
illustrate the above (11) with appropriate reactions.

Course Contents

Chemistry of first row transition metals. Introduction to coordination chemistry including elementary treatment of crystal field theory. Comparative Chemistry of the following elements: (a) Ga, In, Tl, (b) Ge, Sn, Pb, (c) As, Sb, Bi (d) Se, Te, Po. Elementary introduction to organometallic chemistry. Role of metals in biochemical systems. Concepts of hard and soft acids and bases. Oxidation and reduction reactions.

ICH 213: Analytical Chemistry I

(2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

- explain analytical processes which include description of chemist as a problem solver;
- describe and differentiate forms of error;
- explain its implication on laboratory analysis;
- state different statistical tool use in treatment of data;
- solve practical problems using the statistical tools;
- define sampling and give reasons for sampling in field work;
- state and describe different sampling techniques;
- state different forms of sample collection and processing;
- describe volumetric method of analysis and solve some practical problems; and
- describe gravimetric method of analysis and solve some practical problems.

Course Contents

Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric, data analysis and presentation and Physicochemical methods, Optical methods of analysis; separation methods.

CHM 207: General Chemistry Practical III

(1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the students will be able to:

- describe the measurement of pH;
- determine the relative molar mass from the colligative properties;
- demonstrate the partition coefficient of two immiscible solvents;
- demonstrate temperature measurements and heat of dissolution, heat of neutralization and many others
- determine the critical solution temperature of water-Phenol system; and
- measure the molar volume of a gas and universal gas constant.

Course Contents

pH Measurement. Determination of Relative Molar Mass from Colligative Properties. Demonstration of Partition Coefficient in two Immiscible Solvents. Temperature Measurement and Heat of Dissolution Heat of Neutralisation. Determination of Critical Solution Temperature of

Water- Phenol System Ideal Gas Law. Measuring the Molar Volume of a Gas and the Universal Gas Constant.

CHM 208: General Chemistry Practical IV

(1 Unit C: PH 45)

Learning outcomes.

At the end of this course, the students will be able to:

- identify general laboratory rules;
- demonstrate the preparation of simple organic compounds (esters, aldehydes and ketones);
- describe the analysis of vinegar;
- demonstrate A simple experiment on thin layer chromatography;
- perform an experiment on the dehydration of alcohol; and

6. conduct experiments on qualitative analysis of common functional groups.

Course Contents

The Preparation of Esters. The preparation of Aldehydes and Ketones. Vinegar Analysis. Chromatography. Thin Layer Chromatography. Dehydration of Alcohol. Qualitative Analysis of Common Functional Groups

ICH 251: Process Science I

(3 Units C: LH 45)

Learning Outcomes

After completing the course, the students will be able to:

- explain the problems of scale and cost;
- discuss handling of fluids;
- describe the mechanism of heat transfer;
- explain change of phase correlation of heat transfer data; and
- demonstrate handling of continuous fractional distillation.

Course Contents

Commercial process, problems of scale and cost. Process flow sheet and stoichiometry. Handling of fluids; conservation laws and dimensional analysis applied to a moving fluid. Process heat transfer, mechanisms of heat transfer coefficients in batch and continuous processes. Use of mean temperature difference. Change of phase correlation of heat transfer data. Distillation differential, batch, fractional and continuous fractional distillation; number of stages; effects of operating variables.

ICH 252: Process Science II

(3 Units C: LH 45)

Learning Outcomes

After completing the course, the students will be able to:

- discuss mass transfer processes such as drying and solid-liquid-separation;
- know the process of absorption and extraction;
- predict rate, determine steps;
- discuss solid –liquid separation; and
- discuss Stoichiometry.

Course Contents

Mass transfer processes; single phase and inter-phase, mass transfer drying as a heat-mass transfer process. Extraction and Absorption; solvent extraction in mixer settlers and columns; number of ideal stages; number of stages in gas absorption by HTU method; gas film and liquid film rate determining steps. Solid-liquid separation by filtration and sedimentation. Stoichiometry for systems involving recycles.

COS 201: Computer Programming I

(3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

- Explain the principles of good programming and structured programming concepts;
- Explain the programming constructs, syntax and semantics of a higher-level language;
- Describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
- Describe the programme control structures, functions and parameter passing, and structured decomposition; and
- Develop simple programmes in the taught programming language as well as debug and test them.

Course Contents

Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

GOU-ICH 201: Food Chemistry and Biotechnology (3 Units; Compulsory; LH = 45; PH= 0)

Senate – Approved Relevance

Food could be a natural product, fresh or processed substance consumed by human beings for nourishment. Foods are composed of various constituents like carbohydrates, proteins, vitamins, minerals and enzymes. Food chemistry is an interdisciplinary field of study. In order to key into the mission and vision Godfrey Okoye University which is aimed at giving quality education and inculcating in the students strong personality that will promote of religions, cultural and epistemological dialogue, the course is designed to expose students of industrial chemistry to the chemical and the biotechnology processes involve in food production and management. This is also in line with the sustainable development goal number 2 (SDG 2) which is aimed at ending hunger, achieving food security and improved nutrition as well as promote sustainable agriculture.

Overview

The challenge of food shortage in our contemporary society is a very serious problem that need urgent attention. This is cause by a number of factors which include adverse weather conditions, lack of adequate preservation techniques, lack of improved varieties that could withstand diseases and poor management procedures. To overcome these challenges deliberate efforts must be put in place to find a solution. The university being a center of knowledge acquired through cutting edge research is an ideal environment to proffer such solutions.

The course touches the study of the various classes of food like carbohydrates, fats, proteins, vitamins, minerals, water, fibre and other food groups like tubers, cereals, fruits, legumes, meat, fish, and leafy vegetables. Most importantly to be covered also is the study of some African traditional foods especially those found in the south east region of Nigeria and methods of processing and preservation would be discussed. Students will be exposed to the procedures of analyzing the chemical and biological properties of these food stuffs and their nutritional values will be determined and also look for ways to improve their values.

Objectives: The objectives of the course are to:

- i. Explain classes of food and describe their processing steps and the chemistry behind them.
- ii. Explain food spoilage and food intoxication and proffer ways for prevention and preservation of different five types of food.
- iii. Describe types of fermented African food and ways through which they can be processed biotechnologically for global acceptability.
- iv. Mention and explain the techniques of preserving food chemically or biotechnologically.
- v. Explain biotechnological production of natural food ingredient and lab cultured food.
- vi. Explain the methods of analysis the food substances.

Learning Outcomes

On the completion of the course, students should be able to:

- i. Explain five classes of food and describe their processing steps and the chemistry behind them.
- ii. Explain food spoilage and food intoxication and proffer five ways for prevention and preservation of different five types of food.
- iii. Describe five types of fermented African food and ways through which they can be processed biotechnologically for global acceptability.
- iv. Mention and explain five techniques of preserving food chemically or biotechnologically.
- v. Explain biotechnological production of natural food ingredient and lab cultured food.
- vi. Explain five methods of analysis the food substances.

Course Contents

Carbohydrates. Fats. Proteins. Vitamins. Minerals. Water. Fibre. Food Groups. Tubers. Cereals. Fruits. Legumes. Meat. Fish. Leafy vegetables. Fermented African foods and beverages (traditional processing techniques). Palm wine (distillation chemical components and nutritional values). Garri (chemical components and nutritional values). Burukutu (chemical components and nutritional value). Ogiri (chemical components and nutritional values). Food pigments. Confectioneries. Sugar (configuration and conformation). Food contaminants. Toxic substances in foods. Food poisoning and intoxication. Prevention and cure. Chemistry of food processing, preservation and storage. Deterioration and spoilage agents of foods. Chemical and Biotechnological methods to increase shelf lives of food crops. Biotechnological production of

natural ingredients for food industry. New applications of biotechnology in food industry - genetically engineered α -amylase. Lipase and condiments. Genetically engineered crops and animals. Ethical, Biosafety and socio-cultural challenges. Promoting local food production and processing for global acceptability. World food problems. Hunger eradication/elimination. Novel sources of proteins. Neglected and underutilized animal and plant protein sources. Laboratory cultured meat. Plant based meat production.

Minimum Academic Standard: As found in 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 202: Instrumentation Chemistry and Analytical Methods (3 Units; Compulsory; LH = 15; PH = 45)

Senate – approved relevance

The study of chemistry cannot be possible without the use of instrument to carryout chemical analyses. An understanding of instrumentation in chemistry helps chemists to solve analytical and chemical problems. Instruments used in chemical analysis and separation convert information about physical or chemical characteristics of a compound to information that can be integrated by a person. The training and use of instruments for observation, measurement or control is very important for students to be successful in the chemistry profession. This course is meant to expose students to different chemistry analytical instruments available in the department in order to gain knowledge and practical skills to solve chemical problems and contribute their quota to the society. This is in accordance with the Godfrey Okoye University mission and vision which lay emphasis on imparting quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications and ensure inclusive and equitable quality education and promote lifelong learning opportunities for all as enshrined in SDG 4.

Overview

The issue of marching practical and theory has always been a very big challenge in the sciences. This is due to so many factors which include no availability of laboratories, standard equipment, lack of trained personnel and funding. The implication is that students graduate from most of the science disciplines with little or no practical knowledge and skill in the laboratory instruments. This affect the students' chances of getting good jobs and even pursuing further studies. In order to address this identified problem, conscious effort would be put in place to expose our students to instrumentation in chemistry.

Instrumentation is the development or use of measurement or tools for the observation, monitoring or control of chemical processes. Research in this area ranges from development of new instrument to novel applications of existing ones for understanding complex and chemical process. This course shall help students to be familiar with the names and uses of different analytical instrument used in chemistry, these include ultra-violet (UV) spectrophotometer, Fourier transform infrared spectrophotometer (FTIR), nuclear magnetic resonance spectrophotometer, High performance liquid chromatography (HPLC) and atomic absorption spectrophotometer, etc. It is expected that students who graduate from our department should be able to measure up with their counterparts in other universities in Africa and the developed countries in instrumentation.

Objectives: The objectives of the course are to:

- i. Name different types of instruments use in chemical analysis.
- ii. Describe UV spectroscopy.
- iii. Explain FTIR spectroscopy.
- iv. Describe NMR spectroscopy.
- v. Explain gas chromatography.
- vi. Describe High performance liquid chromatography (HPLC).
- vii. Describe Atomic absorption spectroscopy.

Learning Outcome

On completion of this course, students should be able to;

- i. Name six different types of analytical instruments use for chemical analysis.
- ii. Operate a UV spectrophotometer and use it to for chemical analysis.
- iii. Operate an FTIR spectrophotometer and use it to for chemical analysis.
- iv. Prepare TLC plates and use them to monitor chemical reactions.
- v. Operate an HPLC machine and use it to for chemical analysis.
- vi. Operate an AAS machine and use it to for chemical analysis.

Course content

Fluorescence. Phosphorescence. Electroanalytical methods. Voltammetry. Spectroscopy. UV-spectroscopy. IR- spectroscopy. NMR- spectroscopy. Theory and practices of thin lay and gas chromatography. Thermal methods of analysis. High performance liquid chromatography. Automated analytical methods. Enzymatic methods. Atomic absorption spectroscopy. Spectra interpretations. Practical classes on UV spectroscopy. Practical classes on IR-spectroscopy. Practical classes on Atomic absorption spectroscopy.

Minimum academic standard: Chemistry laboratory, reagents, laboratory equipment (UV, IR, AAS,) machines, library collections. Virtual HPLC and NMR machines.

300 Level

GST 312: Peace and Conflict Resolution

(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

- analyse the concepts of peace, conflict and security;
- list major forms, types and root causes of conflict and violence;
- differentiate between conflict and terrorism;
- enumerate security and peace building strategies; and

describe roles of international organisations, media and traditional institutions in peace building

Course Contents

Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation

(2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

- describe the key steps in venture creation;
- spot opportunities in problems and in high potential sectors regardless of geographical location;
- state how original products, ideas, and concepts are developed;
- develop business concept for further incubation or pitching for funding;
- identify key sources of entrepreneurial finance;
- implement the requirements for establishing and managing micro and small enterprises;
- conduct entrepreneurial marketing and e-commerce;
- apply a wide variety of emerging technological solutions to entrepreneurship; and
- appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, Small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic book keeping, Nature of family

business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - *Artificial Intelligence (AI)*, *Virtual/Mixed Reality (VR)*, *Internet of Things (IoTs)*, *Blockchain*, *Cloud Computing*, *Renewable Energy* etc. Digital Business and E-Commerce Strategies).

ENT 314: Entrepreneurship skill in industrial Chemistry (3 Unit C: LH 30; PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

- demonstrate the entrepreneurial skills;
- identify international entrepreneurship opportunities;
- develop competency in identification of new business ventures;
- identify legal issues and business environments;
- discuss marketing strategies; and
- identify cost accounting.

Course Contents

Entrepreneur perspectives and strategies. International entrepreneurship opportunities, identification, pursuit of new ventures (Water treatment, production of bio -renewable plastics such as polylactic acids PLA, textile and clothing: medical textiles, military and industrial textiles, electronics: semiconductors, food and drinks, packaging, drug designs, soap and hand sanitizers etc), marketing strategies in business ventures, creativities and the business ideas, legal issues and business environment, and cost accounting. Field trips.

CHM 301: Physical Chemistry II

(2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students will be able to:

- describe the general knowledge of Gibbs function;
- explain the concept of thermodynamics compare to kinetics; and
- explain the concept of statistical thermodynamics and use statistical equation to solve problems in ideal and non-ideal solution.

Course Contents

A review of Gibbs Function. Chemical thermodynamics. Introduction to statistical thermodynamics. Ideal solutions and non-Ideal solutions. Properties of electrolytes. Colligative Properties. Studies on biochemical systems.

CHM 302: Inorganic Chemistry II

(2 Units C: LH 30)

Learning outcomes

At the end of this course, students will be able to:

- analyse inorganic chemistry information;
- demonstrate and apply knowledge of inorganic chemistry;

explain the electronic structure and general properties of group 1A and Group IIA elements; compare Group IA and Group IIA in terms of the parameters mentioned in 3 above; explain the chemistry of Boron; carbon and Silicon; Nitrogen and phosphorus; Oxygen and sulphur; explain the halogen chemistry; explain the periodic properties of the transition metals and to use these to predict and/or rationalise the chemistry of these metal ions and their complexes; use Crystal Field Theory to explain and understand some of the key features of complexes of the first-row transition metals including their shapes, colours, and magnetic properties; synthesis and characterise a metal coordination compound using practical inorganic chemistry techniques; describe ligand and crystal field theories; draw the diagram showing crystal and ligand field theories with specific examples; list advantages and limitations of these bonding theories; define radioactive decay processes and nuclear radiation; explain the principles of utilizing radioactivity applied to chemistry, chemical processes and adjacent fields where chemistry is an integral part; discuss the principles of radiation hygiene and the interaction of radiation and matter; explain current methods in radiochemistry; define radioactivity; define and describe all three types of radioactivity (alpha, beta, and gamma radiation); and explain the roles of metals in living systems.

Course Contents

The Noble gases. Hydrogen. Electronic structure and general properties and comparative study of Group IA and Group IIA elements. Chemistry of Boron. Carbon and Silicon. Nitrogen and Phosphorus. Oxygen and Sulphur. The halogens. Transition elements. Separation of metals. Introduction to co-ordination chemistry. Introductory organo-metallic chemistry. Ligand and Crystal field theories. Introduction to radiochemistry. Radioactivity and the periodic table. Role of metals in living systems.

CHM 303: Organic Chemistry II

(2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

- recognize and distinguish between aromatic and Alicyclic compounds by their structures;
- identify the properties of aromatic and Alicyclic compounds, and the chemical consequences of aromaticity;
- recognize and be able to write the mechanism of electrophilic aromatic and Alicyclic substitution;
- outline the completed electrophilic aromatic substitution reactions of the following types: halogenation, nitration, sulfonation, and Friedel-Crafts acylation & alkylation;
- explain the chemistry of heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds);
- describe the Reactive intermediates – carbocations, carbanions, carbenes, nitrenes;

express the rearrangement reactions e.g., Beckmann, Baeyer-Villiger etc. illustrate with various reaction mechanisms and types; and organize Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

Course Contents

Pre –requisite –CHM 211

Aromatic and Alicyclic chemistry. Survey of representative polycyclic compounds. Heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds). Reactive intermediates – carbocations, carbanions, carbenes, nitrenes etc. Selected rearrangement reactions such as, Beckmann, Baeyer-Villiger, and many others to illustrate various reaction mechanisms and types. Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

ICH 305: Petroleum Chemistry

(2 Units C: LH 30)

Learning Outcomes

After completing the course, the students will be able to:

- Give an overview of the chemical composition and physical properties of petroleum, petroleum products and renewable motor fuels;
- Specify quality criteria for petroleum products and renewable motor fuels;
- Present the chemistry of the most important refinery processes;
- Give an overview of the resource base for petroleum and renewable alternatives;
- Find information and perform individual evaluations of questions pertaining to production and use of petroleum from different sources and renewable motor fuels;
- Use geophysical and geological knowledge to interpret and map data for identification of potential prospects;
- Contribute to development of geo-based technology for exploration and improved recovery of petroleum resources;
- Explain the theory of hydraulics applied to fuels in pump-pipeline systems;
- Explain the fundamentals of electricity with emphases on electrical safety in petroleum; and
- List lubrication and wear with importance attached to physical and chemical properties of lubricants.

Course Contents

Petroleum in the contemporary energy scene. Nature, classification and composition of crude petroleum and natural gases. Natural product chemical markers of petroleum and geological sediments. Distribution of petroleum and natural gas resources (the global and Nigerian situations). Petroleum technology, survey of refinery products and process. Petrochemicals in industrial raw materials. Prospects for the petrochemical industry in Nigeria. Aviation fuels; present and future Formulation of Lubricants. Theory of Hydraulics, as applied to fuels in pump-pipeline systems. Fundamentals of electricity with emphases on electrical safety in petroleum Lubrication and wear, with importance attached to the physical and chemical properties of lubricants.

ICH 306: Polymer Chemistry

(2 Units C: LH 30)

Learning outcome

At the end of this course, the students should be able to:

- explain the nature of polymer and their nomenclature;
- outline the sources of raw materials for polymers;
- explain polymer processes in details, condensation polymerisation in details;
- explain Solubility and solution properties of polymers;
- explain structure and physiochemical properties polymers and their uses;
- explain in detailed the mechanisms of polymerisation; addition process; stereospecific reactions.; copolymerisation reaction;
- identify and discuss phase system reactions;
- define thermoplastic and thermosetting and their industrial importance;
- explain the electrical and mechanical properties of polymers;
- carry out standard Analyses and testing on polymers; and
- explain polymer degradation.

Course Contents

The nature of polymer nomenclature. Outline of sources of raw materials for polymers. Polymerisation process, condensation polymerisation in details. Solubility and solution properties of polymers. Structure and properties of polymers. Electrical conducting organic wires, smart/sim cards, flat screen televisions. Fibre forming polymers. Bullet proof vests and vehicle bodies from polymers. Polymerisation mechanisms; detailed treatment of addition processes. Stereospecific reactions, copolymerisation reactions. Phase systems for reactions. Industrially important thermoplastic and thermosetting polymers: Polyurethanes. Rubber elasticity. Mechanical properties of polymers. Analysis and testing of polymers. Degradation of polymers.

ICH 317: Industrial Raw Materials Resource Inventory (1 Unit C: LH 15)

Learning Outcomes

At the end of this course, the students should be able to:

- explain the industrial raw materials and resource inventory;
- describe the types of inventory costs;
- survey industries in Nigeria and their raw material requirements;
- describe the chemistry of minerals, fossils and their uses;
- describe plants and animal products;
- define the followings: Nuclear; aerodynamic; wind and hydrodynamic sources of energy;
- explain the listed items in 5 above;
- describe the potentials and applications of locally available raw materials as industrial feed stock; and
- describe how service firms apply inventory management methods to their operations.

Course Contents

Survey of Nigeria's industries and their raw material requirements. Mineral chemistry. Fossils and their uses. Plant and animal products. Nuclear, solar, aerodynamic/wind and hydrodynamic

sources of energy. Potentials and applications of locally available raw materials as industrial feed stocks.

CHM 318: Industrial Chemical Processes

(2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

- identify production of primary intermediate and synthesis of industrial and organic chemicals;
- define the following terms: Polymers, adhesives, dyes, explosives, insecticides, pesticides, herbicides, flavouring agents and pharmaceuticals;
- describe fermentation processes;
- describe chemical processing of materials;
- describe Metallurgy and hydrometallurgical processes;
- use basic electrochemical concepts and relationships for analysis of electrochemical processes;
- perform simple electrochemical experiments and evaluate data to draw conclusions from the results;
- describe electrochemical applications as batteries, fuel cells, electrolytic processes;
- describe different types of electrochemical energy storage (batteries, fuel cells, electrolysis for hydrogen production) in a future sustainable energy system; and
- identify important reagents used in the manufacturing of some heavy inorganic chemicals; Cement and binding materials; Inorganic fertilizers.

Course Contents

Production of primary intermediates and synthesis of industrial organic chemicals; Polymers, adhesives, dyes, explosives, insecticides, pesticides, herbicides, flavouring agents and pharmaceuticals. Fermentation process. Chemical processing of minerals. Metallurgy and hydrometallurgical processes. Industrial electrochemistry. Manufacture of some heavy inorganic chemicals. Cement and binding materials. Inorganic fertilizers.

ICH 319: Management and Chemical Industry II

(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

- explain the concept of anatomy of management, industrial relation and production;
- demonstrate organisational design;
- explain and discuss management of personnel;
- plan for productivity; and
- solve process of creative thinking.

Course Contents

An introduction to the anatomy of management. Industrial Relation. Public Relations. Industrial Psychology. Organizational Design: Management of Personnel. An introduction to the production functions. planning for productivity General Problem-solving processes and creative thinking. Analytical methods of investigation.

CHM 319: Glassblowing Practical

(1 Unit C: PH 45)

Learning Outcomes

At the end of the course, students will be able to:

- students will be able to explain the concept of glass production, types of glass and identification of basic tools;
- recognise glass coefficient of expansion, working temperature;
- identifies basic tools for glass production;
- know basic safety measure during glass production; and
- Produce various shapes of glass

Course Contents

Properties of glass in general use. Manufacturers' symbols and what they represent. Types of glass used for laboratory wares. Identification methods, working temperatures. Coefficient of expansion, annealing, thermal resistance, correlation of these factors. Identification of basic tools, Gas supplies, safety measures, Cutting, rotation techniques, drawing simple butt joining bulb blowing and bending, rounding off end of tube, taper drawing and reaming, ring seal and side grinding and polishing.

CHM 399: Industrial Attachment II (12 Weeks)

(3 Units C: PH 135)

Learning Outcomes

At the end of this course, the students should be able to:

- have basic knowledge Production report writings;
- identify basic elements of research which includes: Introduction, literature reviews, methodology/experimentation/materials and methods, results and discussion, conclusion, recommendations and referencing;
- identify various types of referencing e.g., APA, Chicago, Harvard etc
- identify Spacing and paragraph used in presentation writings; and
- identify the use of multimedia in seminar presentations.

Course Contents

Students should be attached to some industrial organizations for additional 12 Weeks at the 300 Level preferably during the long vacation for more real-time relevant industrial experience. Students to be assessed based on seminar presentations, their reports and assessment by supervisors. This only applies to institutions that operate a 4-year industrial chemistry programme.

GOU-ICH 301: Computational Chemistry and Molecular Docking (2 Unit; C; LH = 15; PH=45)

Senate Approved Relevance

The field of computational and molecular docking is a rapidly growing area of molecular modelling and drug discovery, and this course is designed to provide students of Industrial Chemistry with a comprehensive understanding of the principles and practices of molecular docking. This course is designed to equipped students with knowledge in the use of computer soft wares and applications for drug designing and drug discovery which would make them relevant in the society. This in line with the mission and vision of GOUUni which dedicates itself to impart quality education aims at inculcating in the students strong personality that will or promotion of religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all

ramifications. The importance of the course also aligns with the sustainable development goal number 4 (SDG 4) which ensures inclusive and equitable quality education and long-life learning opportunities for all.

Overview

Computational chemistry is currently attracting serious attention from the scientific and industrial community. It is the application of computer simulation in the designing of drugs molecular and predicting their pharmacological properties. It is also known as *in silico* studies. It is therefore very important for chemistry undergraduates to acquire adequate knowledge and skills in computational chemistry to be relevant in this field of study.

Molecular docking is a method which analyses the conformation and orientation of molecules into the binding site of a macromolecular target. Searching algorithms generate possible poses, which are ranked by scoring functions. Several software were developed during the last decades, amongst which are some well-known examples, such as AutoDock, AutoDockVina, DockThor, GOLD, FlexX and Molegro Virtual Docker. This course is designed to address this challenge by equipping students with knowledge and skills in Computational chemistry and how this knowledge can be used to develop new technologies.

Objectives: The objectives of the course are to:

- i. Explain the concepts of computational chemistry and molecular docking.
- ii. Describe coding formats and organizational structure of chemical databases interactions with such databases.
- iii. Identify and explain potential lead molecules for drug development.
- iv. Draw and explain the structure of biomolecules and more importantly link the structure and dynamics together.
- v. Describe the structure and dynamics in a quantitative way which enables rational drug discovery.
- vi. Compute and explain the binding energies and other pharmacological properties of ligands using Autodock soft wares.

Learning Outcomes

On completion of this course students should be able to:

- i. Describe correctly the meaning and concepts of computational chemistry and molecular docking.
- ii. Determine and explain the formats and organizational structure of chemical databases and state their interactions with such databases.
- iii. Locate and identify compounds that are potential lead as drug molecules.
- iv. Draw the structures of ligands and optimized them using discovery studio.
- v. Download protein targets from protein data bank (PDB) and prepare them for molecular docking.
- vi. Compute and evaluate the binding energies of docked molecules.
- vii. Generate a library of chemical compounds and develop their associated pharmacological properties.

Course Content

Definition of molecular Docking. Conventional methods to modern drug design. Molecular docking techniques. Types of docking. Modes of docking. Sampling algorithms. Pose selection. Docking targets. Target preparation. Retrieving ligand molecules from data bank. Autodock. Preparation of protein targets. Molecular docking for identification of potential targets for drug design. The use of machines and learning of algorithms in molecular docking. Application of molecular docking for the degradation of organic pollutants in the environmental remediation. Molecular modeling and ligand docking for solute carrier (SLC) transporters. Improvements, trends, and new ideas in molecular docking. Interpretation of molecular docking results.

Minimum academic standard: Computational Chemistry laboratory, computers sets installed with molecular docking soft wares, computational chemistry library collections.

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-1CH 302: Colour Chemistry Technology (2 Units; Compulsory; LH = 30; P = 0)

Senate – approved relevance

Colour Chemistry and Technology is an emerging field of industrial Chemistry because all substances around us have different colours that make them appealing to sight and acceptable or not. The clothes we wear have colours, the houses we live in are painted with coloured substances called paints, the soaps, and detergents we used on a daily basis have colours as well as the food we consumed. Since the first synthetic dye was discovered by Mauveine Perkin in 1856, a lot of researches have been going on and different types of dyes and pigments are developed by chemists. Colour. Our environment especially the south east of Nigeria is blessed with so many grasses and trees which are very good sources of dyes and pigments that can be of industrial importance if well harnessed with improved technologies. This course is designed to provide students with basic knowledge of preparing dyes and pigments from the locally available raw materials like grasses, trees as well as chemical methods of synthesis of dyes and pigments for commercial and industrial purposes. This will help them fit in very well for the labour market after graduation or by setting up their own industrial outfits and become employers of labour as contain in the mission and vision of Godfrey Okoye University which dedicates itself to impart quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications and also as stipulated in sustainable

development goal number 9 (SDG 9) which is aimed at building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation.

Overview

Innovation and creativity is very important in every area of life. However, creating a colour that could be applied and can also remain on a substrate for long without causing any harm or fading away is a major challenge in the colour industry. Many industries that make use of coloured substances like textile, photography, printing and painting industries are in need of different types of colours which are products of dyes and pigments to produce new brand of materials. These pigments and dyes can be obtained from local materials readily available in plants but the major challenge is that they are needed in large quantities and the only way to augment the supply is by chemical synthesis which can only be carried out by a trained chemists.

This course is designed to equip the students with basic knowledge and practical skills of identifying, sourcing and producing good pigments and dyes from local raw materials for commercial and industrial purposes. Emphasis would be also be laid on chemical synthesis and analysis of colours, dyes and pigment, how fibres and related polymers are produced from natural sources and synthetic forms. In addition to the above, the applications of colours, dyes and pigments in fibres and polymers will also be discussed. New challenges and economic importance of these chemical materials in our emerging economy will also be looked into.

Objectives: The objectives of the course are to:

- viii. Explain the concept of color, pigments, dyes and related materials.
- ix. Identify and explain each of the colours, dyes and pigments, their properties and uses.
- x. Explain the production processes of colours, dyes and pigments.
- xi. Explain the relationship and differences between colours, dyes and pigments.
- xii. Describe the challenges in the production of colours, dyes and pigments.
- xiii. Demonstrate the basic mechanism and processes involved in dyeing and pigments.

Learning Outcome

On completion of this course, students should be able to:

- i. Explain in details the concept colours, pigments, dyes and related materials.
- ii. Identify and explain five colours, dyes and pigments.
- iii. List and explain five properties and uses of colours, dyes and pigments.
- iv. Describe two production processes colours, dyes and pigments.
- v. List and explain three challenges in the production of colours, dyes and pigments.
- vi. Describe with three examples the basic mechanisms and processes involved in dyeing and pigments.

Course Content;

Definitions of colours. Pigments. Chemical compositions and structures of pigments. Extraction of pigments from local sources. Dyes. Chemical composition and structures of dyes. Types of colours (pigments and dyes). Application of colours. Applications of pigments and dyes. Classification of dyes. Natural dyes and dyeing processes. Synthetic dyes and fibres. Synthetic fibre. Polymer fibres. Dyeing mechanisms. Textile dyeing. Dyeing machines. Chemical analysis of pigments. Chemical analysis of dyes.

Minimum academic standard: As found in the 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 303: Corrosion chemistry and control (2 Units; Compulsory; LH = 30; P H= 0)

Senate – Approved Relevance

Corrosion is a very serious problem that effect the surfaces of most of the metallic items in our environment. When a metal is attacked by substances such as moisture, acids etc. it said to corrode and the process is called corrosion for example the rusting of iron. Corrosion is a very serious challenge that need attention because the deterioration and disintegration of vital structures, pipelines and other productive assets affect the safety and reliability of industries and the economy. Therefore this problem must be addressed for safety reasons and also to minimize environmental consequences. This could achieved through a systematic study of chemistry of corrosion to help student acquire basic knowledge to identify and control corrosion. This area of study will open opportunities for graduate to carry maintenance of structures and further research to improve the qualities of materials used for construction especially iron and its alloys. The acquisition of such knowledge is in tandem with the Godfrey Okoye University mission and vision which dedicates itself to impart quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications and also as stipulated in sustainable development goal number 9 (SDG 9) which is aimed at building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation

Overview

Corrosion is the degradation of a materials usually metals and their alloys as a result of interaction with the surroundings and can occur at any point or at any time. It is a natural and a chemical process. As a reverse extractive metallurgy, it depends on the concentration of environmental stress, erosion and temperature. It accounts for 1-5% of GNP economic losses per year for any nation. In addition, corrosion does not only increase the cost of component but it is responsible for life losses and safety hazards. Efforts must be put in place to tackle corrosion.

Consequently, in this course we shall address the chemistry of corrosion with emphasis on the distinct types of corrosion, causes, nature of corroding environment. The chemistry of oxygen and moisture (water) which are the major factors responsible for corrosion shall studies extensively. Efforts would also be geared toward looking at different ways of preventing corrosion of materials

In order to gain better understanding of some the issues related to corrosion, the subject of electrochemistry shall be handled to give student a clear picture of oxidation-reduction reactions.

Objectives: The objectives of the course are to:

- i. Define corrosion.
- ii. Explain the causes of corrosion.
- iii. List and explain the factors affecting corrosion.
- iv. Describe the nature of corroding environment.
- v. Explain the role of oxygen in corrosion.
- vi. Explain types of corrosion and corrosion mechanism.
- vii. Describes methods of corrosion prevention.
- viii. Define chemical equilibra, ionic equilibra, and conductance.
- ix. Define electrode potentials.
- x. Define electromotive force and state its measurements.

Learning Outcome

On completion of this course, students should be able to;

- i. State the correct definition of corrosion.
- ii. Explain and list four causes of corrosion.
- iii. List three factor affecting corrosion.
- iv. State three components of a corroding environment.
- v. Illustrate the role of oxygen in corrosion with three examples.
- vi. List and explain five type of corrosion and their mechanisms.
- vii. List and explain three methods of preventing corrosion.
- viii. State the correct meaning of electrochemistry, equilibra, ionic equilibra, and conductance.
- ix. List and explain two types of electrode potentials.
- x. Define and calculate mathematic problems involving electromotive force of cells.

Course outline

Meaning of corrosion. Causes of corrosion. Factors affecting corrosion (nature of metals, purity of metals and nature of surface films). Nature of corroding environment (temperature, humidity and p^H). The role of oxygen in corrosion. Oxidation and reduction reactions. Corrosion mechanism. Types of corrosion. General and localized corrosion. Pitting and crevice corrosion. Stress and cracking corrosion. Inter granular corrosion. Galvanic corrosion. Waterline corrosion. Corrosion prevention. Electrochemical cells. Chemical equilibra. Ionic equilibra, Conductance. Acids and bases in relation to corrosion.

Minimum academic standard: As found in the 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 304: Nanoscience and Nanotechnology (2 Unit; C; LH = 30, PH = 0)

Senate Approved Relevance

Nanotechnology as an emerging field of modern research deals with the designing, synthesis, and manipulation of particle structures ranging from approximately 1-100 nm in size. Nanoparticles (NPs) have wide applications in areas like health care, cosmetics, food and feed, environmental health, mechanics, optics, biomedical sciences, chemical industries, electronics, space industries, drug-gene delivery, energy science, optoelectronics, catalysis, single electron transistors, light emitters, nonlinear optical devices, as well as photo electrochemical applications.

This course has been designed to expose students to this emerging area of research in order to enable them follow the current trend in chemistry and this is aligned with the mission and vision of the university which is to impart quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications as well as the (SDG 9) which is aimed at building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation.

Overview

However, one of the main factors in nanoscience has to do with the synthesis of these nanomaterials since they exhibit properties which differ from those of bulk materials and has been discovered that optical, magnetic and electrical properties are sensitive to size effects. In addition, nanosized particles are also very efficient especially in the field of catalysis due to the high ratio of surface to volume they possess. In order to tackle the issue of size control, morphology, structure and chemical composition, different methods of synthesis have been designed. Being an emerging area of research in sciences, it would benefits our students if they are exposed to it at this early stage of their studies.

The synthesis of nanomaterials is an important milestone in the pursuit. A lot of significant developments have been made in the improvement of methods of synthesis of nanomaterial by chemists, materials scientists and engineers. In this course various methods of fabricating nanomaterials will be discussed. They include Mechanical ball milling, mechanochemical method, etching techniques, sputtering, laser ablation, gas condensation, vacuum deposition and vaporization, chemical vapor deposition (CVD) and chemical vapor condensation (CVC), electrodeposition, chemical precipitation, sol-gel techniques, sonochemical method, thermolysis of metal complexes, microwave synthesis, electrochemical method and biological method. The equipment used for the characterization of nanoparticle will also be discussed.

Objectives: The objectives of the course are to:

- i. Define nanoscience and nanotechnology.
- ii. Explain the meaning of nanoparticles.
- iii. List and explain examples of nanoparticles.
- iv. Explain top down and bottom up approaches of synthesizing nanoparticles.
- v. List different methods of producing nanoparticles.
- vi. Describe the methods of producing nanoparticles.
- vii. List the instruments used for the characterization of nanoparticles.

Learning Outcomes

On completion of the course students should be able to;

- i. State and explain the correct meanings of nanoscience and nanotechnology
- ii. Describe nanoparticles
- iii. Mention and explain 5 examples of nanoparticles
- iv. Describe with three examples top-down and bottom-up approaches of synthesizing nanoparticles
- v. Enumerate 5 methods of producing nanoparticles
- vi. Discuss at least 5 methods of producing nanoparticles
- vii. State and explain five examples of instruments for characterization of nanoparticles

Course Content

Concept of nanoscience and nanotechnology. Types of nanostructured materials. Types of nanoparticles. Top-down and bottom up approaches of synthesizing nanoparticles. Mechanical ball milling. Mechanochemical method. Etching techniques. Sputtering. Laser ablation. Gas condensation. Vacuum deposition and vaporization. Chemical vapor deposition (CVD). Chemical vapor condensation (CVC). Electrodeposition. Chemical precipitation. Sol-gel techniques. Sonochemical method. Thermolysis of metal complexes. Microwave synthesis. Electrochemical method. Biological method. Applications of nanoparticles.

Minimum academic standard: As found in the 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 305: Medicinal Chemistry (2 Units; Compulsory; L = 30; P = 0)

Senate – Approved Relevance

The importance of good health for the actualization of life ambitions and set goals cannot be overemphasized. There is a popular statement which says “health is wealth”. Virtually everything we consume either as food substance or medicine are made of chemical substances. One of the importance of Industrial chemistry programme is to equipment graduates with the knowledge of drug development from the natural plants available in our environment. With the emergence of different and new type of diseases affecting man, the incorporation of medicine chemistry into the Industrial chemistry programme is very importance. This is in alignment with the mission and vision of Godfrey Okoye University which is committed to imparting quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications as well as SDG 3 is which targeted at ensuring healthy lives and promote well-being for all at all ages.

Overview

Enugu state and Nigeria as a whole is blessed with different species of plants. Most of these plant have medicinal compounds known as phytochemicals or secondary metabolites that can be extracted and used directly as drugs for the treatment of different diseases. These compounds could further isolated, characterized and purified in order obtain their exact chemical structures so as to understand their mechanisms in the systems. Modifications could also be made on the existing structures in order to improve their chemical and biological activities.

This course would help graduates of industrial chemistry to be familiar with the medicinal plants around them, methods of extraction, purification, formulation of drugs and their uses. The scope of this course covers the following, the historical background of traditional or native medicine, Medicinal plants in Enugu states, uses and their advantages and disadvantages. The development of drug, classes of drugs, their syntheses and pharmaceutical effects. Emphases shall be laid on drugs like analgesics, antacids, antibiotics, antihistamine, anti-inflammatory agents, anti-obesity drugs (anorectics), anti-nauseants, cardiovascular agents, contraceptives, cold and cough preparations, diuretics, laxatives, psychopharmacological agents, sedatives and hypnotics,

Objectives: The objectives of the course are to:

- i. Describe the historical, traditional or native medicine
- ii. Identify and explain some medicinal plants in Enugu State
- iii. Explain drug development from plants.
- iv. Identify therapeutic classes of drugs, their syntheses and pharmaceutical effects
- v. Describe with examples analgesics, antacids, antibiotics, antihistamine, anti-inflammatory agents
- vi. Explain with examples anti-obesity drugs (anorectics), anti-nauseants, cardiovascular agents, contraceptives, cold and cough preparations, diuretics, laxatives
- vii. Describe psychopharmacological agents, sedatives and hypnotics, chemotherapeutic agents, vaccines and vitamins.
- viii. Explain structure-activity relationships (SAR)
- ix. Describe drug formulation and manufacturing processes;

Course Learning Outcome

On completion of this course, students should be able to;

- i. Narrate the historical background of traditional or native medicine
- ii. Explain the emergence of drug formulation from plants
- iii. List and explain therapeutic classes of drugs

- iv. Describe their synthesis and explain their pharmaceutical effects
- v. State and explain three examples each of analgesics, antacids, antibiotics, antihistamine, anti-inflammatory agents
- vi. State and explain three examples anti-obesity drugs (anorectics), anti-nauseants, cardiovascular agents, contraceptives.
- vii. Describe how to formulate cold and cough preparations, diuretics and laxatives
- viii. Explain structure-activity relationships (SAR).
- ix. Explain the formulation and manufacturing processes some aspirin and other analgesics

Course Content

Historical aspects of traditional or native medicine. Medicinal plants. Uses of medicinal plants advantages and disadvantages. Drug development. Therapeutic classes of drugs. Syntheses and pharmaceutical effects of some local drugs. Analgesics. Antacids. Antibiotics. Antihistamine. Anti-inflammatory agents. Anti-obesity drugs (anorectics). Anti-nauseants. Cardiovascular agents. Contraceptives. Cold and cough preparations. Diuretics and laxatives. Psychopharmacological agents. Sedatives. Hypnotics. Chemotherapeutic agents. Vaccines. Vitamins. Structure-activity relationships (SAR). Drug formulation and manufacturing processes.

Minimum Academic Standard: As found in the 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 306: Local Natural Products Chemistry (3 Units; Compulsory; L = 30; P = 0)

Senate – Approved Relevance

Mother Nature has blessed mankind with different type of products. These products are either organic or inorganic with tremendous importance if fully discovered and harnessed. Many of these product are found beneath the earth, in water bodies, animals and plants. It is expected that graduates of Industrial chemistry would be equipped with practical skills and knowlege to identify natural products of importance, isolate and convert them to useful products that can improve the quality of life when used directly or converted to other forms of supplement. This is in line with SDG 3 is which targeted at ensuring healthy lives and promote well-being for all at all ages as well as with the mission and vision of Godfrey Okoye university that is committed to imparting quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications.

Overview

Natural products are found everywhere around, but the challenge is that their very nature and uses of most of them have not been fully explored. Many organisms, plants and animals contain natural products that are very useful to man. Some of these include terpenes, steroids, alkaloids, Flavonoids, tannins, saponins and many other products of pharmaceutical importance. The challenge encountered with these is identification, extraction and purification which require the basic knowledge of chemistry and organic synthesis. This knowledge can be gained through a systematic and empirical study of natural products.

In this course, efforts would be made to expose students of Industrial Chemistry to the general methods of isolation, purification, structure determination and syntheses of natural products. Students will be expected to be at home with the meaning and importance of natural products as well as the importance of natural product chemistry. The course will also expose students to the different classes of natural products available in plants and animals and how to detect and identify them. These include alkaloids, terpenes, steroid, flavonoids, etc. Students will also be guided to understand the general methods of isolating alkaloids, terpenes, steroids, flavonoids etc. from their natural sources and methods of purification as well as their uses and importance.

Objectives: The objectives of the course are to:

- i. Explain the meaning of natural products.
- ii. List and explain examples of natural products.
- iii. Explain the general method of isolating natural products.
- iv. Explain the general methods of purifying natural products.
- v. Explain the general methods of synthesis of natural products.
- vi. State the uses of natural products.
- vii. Describe the spectroscopic methods of determining their structures.

Learning Outcome

On completion of this course, students should be able to:

- i. Explain in detail the meaning of natural product.
- ii. Explain the meaning of natural product chemistry.
- iii. List and explain three types of natural products found in plants and animals.
- iv. Explain the meaning of alkaloids and give three examples.
- v. Explain the meaning of terpenes, steroids and flavonoids and list four examples of each.
- vi. Describe the methods of isolating alkaloids, steroids, terpenes and flavonoids.
- vii. List and explain four uses of each of the above natural products.
- viii. Describe with three examples different methods of structural elucidation of these natural products.

Course Content

Meaning and importance of natural products. Meaning and importance of natural product chemistry. Classes of natural products. Natural products found in plants and animals. Alkaloids (meaning, examples and types). Terpenes (meaning, examples and types). Steroids (meaning, examples and types). Flavonoids (meaning, examples and types). General method of isolation of alkaloids. Isolation of terpenes. Isolation of steroids. Isolation of flavonoids. Chemical tests for alkaloids, steroids, flavonoids etc. Methods of purification of alkaloids. Methods of purification of terpenes. Methods of purification of steroids. Methods of purification of flavonoids etc. Chemical structure and synthesis of alkaloids. Chemical structures and synthesis of terpenes. Chemical

structures and synthesis of steroids. Chemical structures and synthesis of flavonoids. Natural products of pharmaceutical importance.

Minimum Academic Standard: As contained in the 70 CCMAS

400 Level

ICH 400: Seminar in Chemistry

(2 Units C: PH 90)

Restricted Special topics to be covered include the following: -

Mining and Metallurgy: Mineral Processing: performance and separation criteria. Crystalline and non-crystalline structures. Metal solidification and heat treatment. Phase transformation and microstructure. Fabrication and uses of materials;

Ceramics and Glasses: The crystal structure of ceramic materials including silicates, phosphates and nitrides, crystallization of glass formation, glass forming materials. Forming process of glass and ceramic. Chemotherapeutic agents;

Chemistry of Paints and Adhesives: Classification of paints in terms of use and constitution. The manufacturing process and principles of formulation. The paints and their physical properties. Composition and classification of adhesives. Physical properties, formulation and application of paints and adhesives;

Cement Chemistry: Classification of cements, cement raw materials and process of manufacture. Structure of cements. Physical and chemical properties of cement. Cement production processes;

Leather Chemistry: Chemistry of animal skin. Theory of tanning. Pretanning processes. Vegetable tanning process. Materials, their properties and chemistry. Synthetic tanning materials: Chrome and other tonnages. Leather/Tanning;

Chemistry of Brewing: Bio-organic chemistry of malting and mashing. Chemistry of hop constituents, wort boiling and hop extraction. Techniques in the brewing process. Fermentation. Additive and preservatives. Quality control in Brewing;

Soaps and Non-Soap Detergents: Introduction to surface chemistry. Micelle formation and the detergency process. The manufacturing processes of soaps and detergents. Synthetic surfactants Anionic, cationic and non-ionic surfactants. Synthetic surfactants. Soaps and Detergents; and

(8) Writing Research Proposals: Methodology and Process

*Topics may be chosen from any three of the above in addition to (8) above.

ICH 401: Research Project

(6 Units C: PH 270)

Learning Outcomes

At the end of this course, the students should be able to:

- have basic knowledge Production report writings;
- choose a Chemistry related Topic for the final year project;
- identify basic elements of research which includes: Introduction, literature reviews, methodology/experimentation/materials and methods, results and discussion, conclusion, recommendations and referencing;
- identify various types of referencing e.g. APA, Chicago, Harvard etc;
- identify Spacing and paragraph used in presentation writings;
- express the use of multimedia in project seminar presentations; and
- assessment and grading of the written and oral presentation.

Course Content

Research projects into selected topics in industrial chemistry. Students will be expected to carry out literature survey on chosen topics, perform experiments and produce reports. Students will be subjected to both seminar and oral examinations on their projects.

ICH 453: Chemistry of Industrial Processes

(3 Units C: LH 45)

Learning Outcomes

At the end this course, students will be able to:

- explain chemical process, raw materials availability and industrial reactions;
- identify location of raw materials;

highlight the main uses of primary products;
describe legal aspect of factory acts; and
recognise industrial products such as oil, fertiliser, plastics and detergents

Course Contents

Overview of chemical processes and products with emphasis on the nature, origin and application of the products of the chemical and allied industries. Raw materials; availability, location, energy, primary chemical products: Industrial reactions, chemical plant, process costing. Consumer and Secondary products: main uses of primary products. Legal aspects; Factory Acts. Etc. Case studies based on industries and/or chemical networks e.g. Industries: Oil, fertilizer, plastics, Detergents etc, chemical networks; Alkali, Chlorine, Fluorine, Coal/Oil etc.

ICH 454: Chemical Process Technology

(3 Units C LH 45)

Learning Outcomes

At the end of this course, the students should be able to:

- use approximate design of multi-component distillation column;
- recognise the concepts of mixing and agitation, liquid-liquid, solid-liquid and gas-liquid systems;
- distinguish the types of control systems, primary and final elements;
- list the types of controls; and
- use of effectiveness number of transfer units applied to heat exchangers.

Course Contents

Mixing and agitation; liquid-liquid, solid-liquid and gas-liquid systems. Scale up. Residence distribution functions for continuous flow systems. Correlation of heat transfer data. Use of effectiveness number of transfer units applied to heat exchangers. Solvent extraction with partially mixable liquids, selection of suitable extracting agents. Column height and cross section in gas washing. Multi-component vapour-liquid equilibria, bubble points and dew points; key components partial material balances.

The approximate design of Multi-component distillation columns. Minimum reflux ration, minimum number of theoretical stages; feed point location. Rigorous simulation procedure; multi-component composition profiles. Small refinery configurations. Optimization. Case studies covering fluid mechanics, heat and mass transfer processes. Linear Programming. The need for process control. Types of control; open loop, feed forward, feed-back, cascade feedback and adaptive control. Primary elements, final elements. Nature of offset; one, two and three term algorithms. Response to disturbances. Controller optimization. Control of systems with non-linear response characteristics. Direct digital control. Programmed control regimes.

ICH 455: Macromolecular Chemistry

(3 Units C: LH 45)

Learning Outcomes

At the end of this course, the students should be able to:

- use approximate design of multi-component distillation column;
- explain the concepts of mixing and agitation, liquid-liquid, solid-liquid and gas-liquid systems;
- identify types of control systems, primary and final elements;

list the types of controls; and
use of effectiveness number of transfer units applied to heat exchangers.

Course Contents

Polymerization processes; mechanism and kinetics of free radical, ionic and stereo-specific polymerization. Additions of polymerization in bulk, solution, suspension and emulsion. Ring opening polycondensation processes. Gelation Theory. Copolymerization: Addition copolymerization, reactivity ratios, the copolymer-equation. Prediction of reactivity ratios. Degradation of polymers: by thermal, oxidative, photochemical and chemical environments. Kinetics and mechanism of degradation. Inhibitors and retarders. Biopolymers: Organization in protein and nucleic acid structures, super-cooling. Inorganic macromolecules; condensed oxanion structures, silicates; silicon. Solution properties of macromolecules: Thermodynamics of polymers solutions. Morphology, Crystallinity and Orientation

CHM 499: Industrial Attachment (6 months)

(6 Units C: PH 270)

Learning Outcomes

After completing the course, the students will be able to:

- use various analytical equipment for quality control.
- apply basic knowledge acquire in the classroom to solve practical problems in the laboratory.
- give a seminar presentation of new knowledge gain during the industrial training.
- demonstrate the use of multimedia for seminar presentation.

Course Contents

All candidates enrolled in a 5-year Industrial Chemistry Programme and who have successfully completed all specified required courses for this degree option are required to proceed on industrial attachment normally during their 7th & 8th semesters of residence. A student enrolled in this course would be required to submit a report and give presentation at the end of the period of industrial attachment. The grading will normally be based on the reports, seminars and assessment of supervisors. For 4-year Industrial chemistry programme, students should be attached to some industrial organizations for additional 12 Weeks at the 300 Level preferably during the long vacation for more industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors.

Minimum Academic Standards

Equipment

- Gas chromatography (GC)
- GCMS
- HPLC
- GCFID
- Mass spectrometry
- UV/ visible
- IR
- Carbon/Nitrogen analyser
- Sulphur analyser

AAS
XRF
XRD
Muffle furnace
Electrophoresis
Flame photometer

*** These equipment and laboratory requirements are in addition to the equipment and laboratories required for the B.Sc. Chemistry programme.**

GOU-ICH 401: Geochemistry (3 Units; Compulsory; LH = 45; PH = 0)

Senate – Approved Relevance

The study, sourcing and management of natural resources for the wellbeing and development of any society is a very important aspect of human endeavor. It requires the training of chemists and other scientists to acquire the needed skills for exploration of those resources. In order to shift emphasis from petroleum which is now considered as the major source of revenue in Nigeria today and diversify to other available resources especially coal which is found in larger deposit in Enugu state, the department through the industrial chemistry programme is committed to producing chemists that would be able to carry out the study of the chemistry of coal, its by products as well as the methods of transforming them into useable source of energy and products of industrial importance in Enugu state and its environs in accordance with the SDG 7 which is aimed at ensuring access to affordable, reliable, sustainable and modern energy for all. The acquisition of knowledge in this courses is in line with the mission and vision of Godfrey Okoye University which positioned itself to impart quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications.

Overview

The neglect of coal which was one of the main sources of energy supply in the South Eastern State of Nigeria is a thing of concern. Many people do not know that the chemical constituents that are present in petroleum are also present in coal. Some countries depend entirely on coal not only as a source of energy but also as a source of raw materials that feeds their chemical industries.

This course is designed to address the challenge faced by the coal industry in Enugu state, produce chemists with sound knowledge of coal chemistry by undertaking an in-depth study of coal in order to revive the sector, provide information that would enable the state and individuals tap from the abundant resources and opportunities available in the coal industry and also train man power on the processes of converting its by products to useful materials for domestic and industrial uses. The course covers area like the concept of geochemistry, isotope geochemistry, and introductory mineralogy. The physical and chemical properties of coal obtained in Enugu shall be studied as well as methods of analyzing coal samples. Pyrolysis of coal and fire chemistry shall also be discussed as well as purification and concentration of coal products. Furthermore, introduction to water chemistry and analysis of water sample in coal related areas shall be covered. Other topics to be handled include measures of pollution control in coal exploration sites, analysis of soil samples in Enugu and the South Eastern States and some aspects of organic geochemistry mineral processing.

Objectives: The objectives of the course are to:

- i. Explain what geochemistry entails in the context of coal production.
- ii. Describe the physical and chemical properties of coal.

- iii. Identify and explain the methods of coal extraction.
- iv. Explain the chemistry of transformation of coal to its constituent products.
- v. Identify and explain the chemical component present in coal.
- vi. Identify and explain the various uses of the chemical components of coal.
- vii. List and explain equipment that can be used for destructive distillation of coal to obtain its by products.
- viii. Identify and describe ways to prevent environmental pollution caused by the exploration.

Learning Outcome

On completion of this course, students should be able to:

- i. Explain the concept of geochemistry as related to coal.
- ii. List and explain five physical and chemical properties of coal.
- iii. Identify and explain three methods of coal extraction.
- iv. Describe the chemistry involved in transformation of coal to its products.
- v. List and five different chemical components found in coal.
- vi. Explain the chemistry involved in combustion and fire making and fighting.
- vii. List and explain three uses of each of the components of coal above.
- viii. Explain destructive distillation of coal and the equipment used.
- ix. Explain measures taken to prevent environmental pollution from coal exploration.
- x. Explain the effect of coal on water.
- xi. Explain the analysis of three different soil samples in Enugu state and its environment to determine their mineral composition.

Course Content

The concept of geochemistry. Some aspects of isotope geochemistry. Introductory mineralogy. Coal and its abundance in Enugu state. Geochemical classification of coal. Occurrence of coal in selected locations in Enugu state. Physical and chemical properties of coal. Chemical analysis of coal samples. Destructive distillation of coal. Combustion and fire chemistry. Purification and concentration of coal products. Introduction to water chemistry. Analysis of water sample in coal related areas. Measures of pollution control in coal exploration sites. Analysis of soil samples in Enugu and the South Eastern States. Some aspects of organic geochemistry mineral processing.

Minimum Academic Standard: As contained in 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

Cements and Fertilizer Chemistry (2 Units; Compulsory; LH = 30; PH = 0)

Senate – Approved Relevance

Shelter, food and clothing are the three basic needs of man. Any activities that can promote the knowledge and skills to actualize these three basic needs is very important to be engaged in. The chemistry of cement is very important because the uses of cement cannot be overemphasized as a component of architectural buildings which include houses, bridges, roads, poles etc. Fertilizers on the other hand help in the improvement of the soil to boost crop production. Undertaking a course in the chemistry of cement and fertilizers places a graduate of industrial chemistry on an advantage of acquiring skills and practical knowledge to pursue career in such industries, and

contribute to the society in the area of shelter and food in line with the SDG 2 which is aimed at ending hunger, achieving food security and improved nutrition and promote sustainable agriculture and SDG 11 which lays emphasis on making cities and human settlements inclusive, safe, resilient and sustainable. Knowledge and skills acquisition in this courses is also in line with the mission and vision of Godfrey Okoye University which positioned itself to impart quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications.

Overview

Food and shelter are basic needs of life and by implication cement used for buildings structures like houses, bridges, roads and fertilizers meant for crops growth and production need to be given attention as a research area for improvement. Recently, there have been reports of building collapse as a result of the use of substandard building materials, amongst them is cement. The composition of cement from the point of manufacturing, packaging, storage and usage must be given serious attention. Poorly formulated cement products will constitute danger when used for the construction of structures. It is therefore very important for students in the industrial chemistry programme to be trained in the processes of cement production so as to acquire the needed knowledge and skills that will enable them pursue careers in cement related chemical industries.

In another development, food supply would be enhanced when crops are provided with the correct and adequate formulated fertilizer products. A good training given to students in understanding of fertilizer and soil chemistry would positioned them to build promising career life in agriculture and related industries. Therefore this course is designed to engage students of this programme on the chemistry cement and fertilizers with emphasis on formulation, analyses, uses and pollution control. The course laid covers the following areas, meaning, composition of cement and types of cements, basic chemistry of cement and the raw materials of cement. A survey of sources and locations where the raw materials could be obtained would be discussed as well as the manufacturing processes. Pollution control in cement production, analysis of cement samples and a survey of cement factories in Nigeria shall be considered also. Other topics to be covered also include the meaning, compositions of fertilizers and types of fertilizers, chemistry and analysis of fertilizers and raw materials of fertilizers. A survey of fertilizer industries in Nigeria will also be considered, methods of production of fertilizers, applications of fertilizers and soil chemistry as well as pollution associated with fertilizer production shall be studied.

Objectives: The objectives of the course are to:

- i. Describe cement.
- ii. Enumerate the types of cement.
- iii. Describe the chemistry of cement.
- iv. List and explain the raw material used for cement production and their sources.
- v. Describe the manufacturing processes of cement.
- vi. Describe fertilizers.
- vii. Identify and describe the types of fertilizers.
- viii. List and explain the raw materials used for fertilizers production.
- ix. Mention and explain ways of preventing environmental pollution in cement and fertilizers production.

Learning Outcome

On completion of this course, students should be able to:

- i. Explain what cement is all about.
- ii. List and explain the types of cement.

- iii. Identify and explain four raw materials used in cement production.
- iv. Describe with examples the manufacturing processes of cement.
- v. List and explain three cement factories in the South East region of Nigeria.
- vi. Explain what fertilizers are all about.
- vii. List and explain three uses types of fertilizers.
- viii. Describe with examples the production of fertilizers.
- ix. Mention and explain four ways of preventing pollution caused by cement and fertilizers production.

Course Content

Meaning and composition of cement. Types of cements. Chemistry of cement. Raw materials of cement. Types of cement. Sources and locations of raw materials. Manufacturing processes of cement. Pollution control in cement production. Analysis of cement samples. A survey of cement factories in Nigeria. Meaning and compositions of fertilizers. Types of fertilizers. Chemistry of fertilizers. Raw materials of fertilizers. A survey of fertilizer industries in Nigeria. Methods of production of fertilizers. Applications of fertilizers and soil chemistry. Pollution control in fertilizer production.

Minimum academic standard: As found in the 70 CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 414: Heterocyclic Chemistry (2 Units; Compulsory; LH = 30; PH= 0)

Senate – Approved Relevance

Most of the substances that we consume as food stuffs, beverages, drugs and supplements are organic compounds that contain five and six-membered heterocyclic systems in which nitrogen, oxygen and sulphur are the hetero-atoms. A good knowledge of the chemistry and uses of these class of compounds would help students of industrial chemistry programme to fit in very well in pharmaceutical and related industries upon graduation where these compounds find applications in the manufacturing of different domestic and industrial products. Research in this area help students to make innovation by discovering importance chemical compounds that could impart life positively as contained in SDG 4 which is to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. Knowledge and skills acquisition in this courses is also in line with the mission and vision of Godfrey Okoye University which positioned itself to impart quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications.

Overview

The study of heterocyclic compounds is an interesting aspect of chemistry that brought about the discovery of many important compounds containing pharmacological properties. For example many drugs we take are mostly heterocyclic compounds. The building of heterocyclic ring systems like phenothiazines, phenoxazine, sulphonamides etc brought a positive revolution in the pharmaceutical industry. There many of these compounds that have not been produced, therefore

giving students training in this area and exposing them to the chemistry of such would position them to build very good career as heterocyclic chemists.

The chemistry of five and six-membered heterocyclic systems in which -nitrogen, oxygen and sulphur are the hetero-atoms will be covered. This course will also cover the chemistry of five and six-membered and their benzo-derivatives derivatives as well as those containing more than one hetero-atom such as pyrimidine, cinnoline and pyrazine the synthesis of three heterocyclic compounds containing more than one hetero-atom and the uses of such compounds

Objectives: The objectives of the course are to:

- i. Define heterocyclic chemistry.
- ii. Define heterocyclic compounds.
- iii. Explain five membered heterocyclic compounds with examples.
- iv. Explain six membered heterocyclic compounds with examples.
- v. Describe the synthesis of five membered heterocyclic compounds.
- vi. Describe the synthesis of six- membered heterocyclic compounds.
- vii. List examples of their benzo-derivatives of heterocyclic compounds.
- viii. Describe the synthesis of benzo-derivatives of heterocyclic compounds.
- ix. Identify heterocyclic compounds containing more than one hetero-atom.
- x. Describe the synthesis of heterocyclic compounds containing more than one hetero-atom.
- xi. Mention the uses of heterocyclic compounds.

Learning Outcome

On completion of this course, students should be able to:

- i. Define heterocyclic compounds.
- ii. Define heterocyclic chemistry.
- iii. State the meaning of five- membered heterocyclic compounds with four examples.
- iv. State the meaning of six- membered heterocyclic compounds with four examples.
- v. Describe the synthesis of five membered heterocyclic compounds.
- vi. Describe the synthesis of six- membered heterocyclic compounds.
- vii. List and explain five examples of benzo-derivatives of heterocyclic compounds.
- viii. Outline the synthesis of three benzo-derivatives of heterocyclic compounds.
- ix. Identify and explain four heterocyclic compounds containing more than one hetero-atom.
- x. Outline with three examples the synthesis of three heterocyclic compounds containing more than one hetero-atom.
- xi. Mention explain five uses of heterocyclic compounds.

Course Content

Meaning of heterocyclic compound and heterocyclic Chemistry: The chemistry of five membered heterocyclic systems. The chemistry of six- membered heterocyclic systems in which -nitrogen, oxygen and sulphur are the hetero-atoms. The chemistry of benzo-derivatives. Quinoline. Isoquinoline. Acridine, Indole, etc. The synthesis of five membered heterocyclic compounds. The synthesis of six- membered heterocyclic compounds. Synthesis of benzo-derivatives of heterocyclic compounds. Heterocyclic compounds containing more than one hetero-atom. Pyrimidine. Cinnoline. Pyrazine. Synthesis of three heterocyclic compounds containing more than one hetero-atom. Uses of heterocyclic compounds.

Minimum Academic Standard: As found in the 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 404: Organometallic Chemistry (2 Units; Compulsory; L H= 30; PH = 0)

Senate – Approved Relevance

The combination of organic compounds and metallic elements gave birth to this branch of chemistry that has become very important especially in designing and production of metal complexes that have very wide applications, for example, in the treatment of cancerous cells, and production of solvents as well as other chemical compounds of domestic and industrial importance. Students with good knowledge of the chemistry of organometallic compounds are equipped with skills to fit into any chemical or pharmaceutical industry involved in the production of such metal complexes and their related compounds. Such knowledge would help the students to fulfil the mission and vision of the Godfrey Okoye University which dictates itself to impart quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications.

Overview

There are different hybrids disciplines in chemistry that make it very interesting organometallic chemistry involves the study of compounds that contain both organic and different metals to form organometallic complexes. This is a bridge between organic and inorganic chemistry. Formation of bonds between organic compounds and metals is a trending area in chemistry because when compounds with such bonds are produced, they exhibit promising pharmacological properties.

This course is designed to expose students to the preparation, structures, reactions and application of some organometallics. The production and chemistry of Grignard's reagents as well as their use and applications. It also covers the generation and detection of free radicals from organometallic compounds as well as the structures, synthesis and reactions of ferrocene and other metallocenes. Furthermore, metal phthalocyanine dyes and pigments and their industrial uses will also be discussed.

Objectives: The objectives of the course are to:

- i. Define organometallic chemistry.
- ii. Define organometallic compounds.
- iii. State and explain examples of organometallic compounds.
- iv. Explain the preparation of organometallic compounds.
- v. Draw and explain the structures of organometallic compound.
- vi. Describe the chemical reactions of organometallic compounds.
- vii. Explain the meaning of organometallic free radicals.
- viii. Describe the synthesis and reactions of ferrocene and other metallocenes.
- ix. Describe the formation of metal phthalocyanine dyes and pigments and their uses.

Learning Outcome

On completion of this course, students should be able to:

- i. State and explain the meaning of organometallic chemistry.
- ii. Explain the meaning of organometallic compounds.
- iii. State and explain at least five examples of organometallic compounds.
- iv. Explain at least three methods of preparing organometallic compounds.
- v. Draw and explain at least ten chemical structures of organometallic compounds
- vi. Describe and explain five chemical reactions of organometallic compounds
- vii. State and explain the meaning of organometallic radicals and mention five examples
- viii. Describe two synthetic methods and reactions of ferrocene and other metallocenes
- ix. Describe the formation of three metal phthalocyanine dyes and pigments and their uses
- x.

Course Contents

The concept of organometallic chemistry. Organometallic compounds. Chemistry of organometallic compounds. Examples of organometallic compounds. Preparation of organometallic compounds. Structures and nomenclature of organometallic compounds. Reactions of organometallic compounds. Applications uses of organometallic compounds. Abnormal behaviors of some organometallics. Generation of free radicals from organometallic compound. Detection of free radicals from organometallic compounds. Ferrocene. Metallocenes. Synthesis of Ferrocene. Synthesis of other metallocenes. Reactions of ferrocene and other metallocenes. Metal phthalocyanine dyes and pigments and their industrial uses. Grignard's reagents. Types of Grignard's reagents. Chemistry of Grignard's reagents. Synthesis of Grignard's reagent. Applications of Grignard's reagents.

Minimum Academic Standard: As found in the 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 405: Environmental Chemistry and waste management (3 Units; Compulsory; LH = 45; PH = 0)

Senate – Approved Relevance

The study of our environment is very important for our survival. Activities carried out in our environment affect us directly or indirectly. Emissions discharged from industrial plants and effluence released by chemical and allied industries have adverse effect on the environment. To

prepare students that would be able to mitigate the problems of pollution in our environment through the knowledge and skill acquired as environmental chemists. They should be able to carry out impact assessment on the environment and solve problems of pollution caused by different factors using their knowledge of chemistry. The importance of this course lies in the fact that our environment is filled with a lot waste materials that need urgent attention, students via this course are equipped with adequate knowledge and skills to management these waste by chemical treatment, recycling of non- biodegradable waste or converting them to clean and renewable energy products. This is alignment with SDG 7 aimed at Ensuring access to affordable, reliable, sustainable and modern energy for all and also in agreement with the mission and vision of Godfrey Okoye University which dictates itself to impart quality education aims at inculcating in the students strong personality that will promote religions, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications.

Overview

The quality of life we live depends on the type of environment that surrounds us. A clean and healthy environment would lead to a healthier and wealthier live because health is wealth. A polluted and dirty environment would bring outbreak of sicknesses and diseases. Emphasis shall be laid in the teaching of this course on the concepts of elementary cycles and characteristics of the atmosphere, sources, types and effects of environmental pollution. It shall also touch aspect of heavy metal and pesticides as pollutants and mutagenic and other effects of pollutants. The composition of different domestic wastes shall also be treated. More importantly water chemistry and analysis shall be carried out one some of the water bodies around us and lastly the chemical and physical methods in environmental pollution analysis would also be dealt with.

Objectives: The objectives of the course are to:

- i. Explain the meaning of environment in the context of chemistry.
- ii. Explain the meaning of environmental chemistry.
- iii. Describe the concept of elementary cycles.
- iv. State the characteristics of atmosphere.
- v. Mention the sources, types and effect of environmental pollution.
- vi. Describe heavy metals and pesticides as pollutants.
- vii. Outline mutagenic and other effects of pollutants.
- viii. Identify the composition of domestic waste and their management.
- ix. Describe the chemistry of water and analyze water samples.
- x. Discuss the physical and chemical method of pollution analysis in our environment.
- xi. Explain industrial pollution.

Learning Outcome

On completion of this course, students should be able to:

- i. State the correct meaning of environment in the context of chemistry.
- ii. Explain correctly the meaning of environmental chemistry.
- iii. Describe with three examples the concept of elementary cycles.
- iv. State and explain five characteristics of atmosphere.
- v. Mention and explain three sources, three types and three effects of environmental pollution.
- vi. List and explain three examples of heavy metals and pesticides that could pollute the environment.
- vii. Describe three mutagenic effects of pollutants.

- viii. Identify and explain three components of domestic waste and three methods they could be managed.
- ix. Explain the analysis of three of water samples.
- x. List and explain three physical and three chemical methods of pollution analysis.
- xi. Mention and explain types of industrial pollutions.

Course Content

Meaning of environment and meaning of environmental chemistry. Concepts of elementary cycles. Characteristics of the atmosphere. Sources of environmental pollution. Types of environmental pollution. Effects of environmental pollution. Heavy metal as pollutants. Pesticides as pollutants. Mutagenic and other effects of pollutants. Composition of domestic wastes. Water chemistry. Water analysis. Chemical methods in environmental pollution analysis. Physical methods in environmental pollution analysis. Meaning of industrial pollution. Types of industries and their waste products (dust and gas emitting industries) e.g. Cement, Metallurgical, Automobile and Mining, Solid waste industries (such as sugar, paper, food and rubber). Liquid and gaseous chemical wastes from chemical industries. Gas and oil spillage from petrochemical industries. Effects of industrial wastes on the environment. Effects of pollution on soil and water, plants and animals. Emission control technology. Electrostatic precipitators and efficiency. Cyclones, filters and wet scrubbers etc. Emphasis on cement. Metallurgical and mining industries. Solid waste treatment. Water as a medium for transport and distribution of solid waste. Characteristics of industrial wastewater. Treatment of industrial wastewater including products from sewage sludge, oil spillages etc.

Minimum Academic Standard: As found in the 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 406: Organic Synthesis (2 Units; Compulsory; LH= 30; P = 0)

Senate – Approved Relevance

Some organic chemical compounds of domestic and industrial importance can be obtained from nature but the challenge is in quantity and quality of such compounds. To solve this challenge, the field of organic synthesis becomes very vital. This involves the production of organic compounds from simple commercially and readily available starting materials by a careful planning, following laid down synthetic procedures and processes. Drugs, detergents, soap, paints and pigments etc. are all produced through synthesis. Students in industrial chemistry programme will be equipped with the knowledge and skills to carry out the synthesis of chemical compounds and their characterization via this course. This will position them to be gainfully employed in chemical industries or set up their own industries and become employers of labour. Training students in the area of chemistry will make them better and profitable human beings that can contribute toward the growth and development of the economy which is in agreement with the mission and vision of the Godfrey Okoye University which is to impart quality education aimed at inculcating in the students strong personality that will promote religious, cultural and epistemological dialogue and to produce graduates who will be outstanding in learning, balanced in character and personality and ready to pursue epistemic unity in all ramifications.

Overview

The challenge of sourcing product of industrial importance from natural source has been a very serious issue due to the limited supply of such materials, however organic synthesis has been developed as a technique that can carry out mass production of materials that are short in supply. Though it is a very tedious process that needs careful planning and application of known organic reactions, chemists cannot do without it. Organic synthesis is all about the transformation of simple starting materials into more complex and useful organic compounds via simple organic reactions.

The courses will expose students to the fundamentals of organic reactions that are very important in the building up of chemical compounds of domestic and industrial importance. Discussions will include reduction methods, metal reductions, oxidation methods: The stereochemistry of chemical compounds would also be taught in addition to treatment of cyclic compounds, allenes and spiranes; optical activity of diphenyl and conformational analysis with emphasis on stabilities of isomers, rates and course of reaction in acyclic, cyclic and fused ring systems.

Objectives: The objectives of the course are to:

- i. Define organic synthesis and the steps involved.
- ii. Explain reduction processes used in organic synthesis.
- iii. Discuss metal reduction in organic synthesis.
- iv. Explain oxidation methods in organic synthesis.
- v. Describe the stereochemistry of organic compounds.
- vi. Highlight on the synthesis of cyclic compounds allene and spiranes.
- vii. Describe optical activity of diphenyl compounds.
- viii. Explain conformational analysis with emphasis on isomerism, rates and reaction courses.

Learning Outcome

On completion of this course, students should be able to:

- i. State the correct definition of organic synthesis and outline 4 steps involved in organic synthesis.
- ii. Explain four reduction processes in organic synthesis.
- iii. Discuss three metal reduction processes used in organic synthesis.
- iv. Explain four oxidation processes used in organic synthesis.
- v. Describe the stereochemistry of five named organic compounds.
- vi. Highlight on the synthesis of three cyclic, allenes and spirane compounds.
- vii. Explain the structures of five compounds using conformational analysis.

Course content

Reduction methods. Catalytic hydrogenation. Reduction with boron and aluminum hydrides and their analogues and derivatives. Metal reductions. Selective reduction in polyfunctional compounds. Oxidation methods: Epoxidation. Hydration and Hydroxylation of alkenes. Oxidative cleavage of glycol. Organoboranes. Hydroboration and its oxidative applications in organic chemistry. Stereochemistry. Treatment of cyclic compounds. Allenes and spiranes. Optical activity of diphenyl. Conformational analysis with emphasis on stabilities of isomers. Rates and course of reaction in acyclic, cyclic and fused ring systems.

Minimum academic standard: As found in the 70% CCMAS

Godfrey Okoye University Enugu
Faculty of Natural Sciences and Environmental Studies
Department of Chemical Sciences
Sciences: Industrial Chemistry
BSc. Industrial Chemistry

GOU-ICH 407: Chemo statistics (3 Unit, C; LH=15; PH = 45)

Senate Approved Relevance

The course aims to expose Chemistry students to the basic principles and methods of Biostatistics and to enable them to use different statistical and bio statistical analysis and packages for biological science and data interpretations and interference. Since the beginning of the century, the field of Biostatistics has become an indispensable tool in biological and medical sciences. The relevance of this course is seen in Industrial Chemistry graduates from Godfrey Okoye University being able to acquire knowledge and expertise which will enable them to effectively address various challenges encountered in biological and medical sciences as well as in public health practices. Chemostatics a field in information and communication tech ology – are crucial to achieving sustainable development and empowering our students (SDG 9).

Overview

Chemostatistics is the application of statistical techniques to scientific research in the health related fields, including public health, medical and chemical sciences. The purpose of this course is to teach Chemistry students the fundamental concepts and techniques of descriptive and inferential statistics with applications in chemical and medical sciences and public health.

The training of students in this field will enables them acquire knowledge and skills that will be needed to transform data into useful information. Knowledge of chemostatistics is essential for understanding and interpretation of modern scientific literatures and active participation in the global research enterprise. Data is so crucial in the research field and processing that data spurs innovations in new treatments and medicines. It also helps us better predict the outcomes of public health issues and could even teach us how to see the beginnings of problems before they become a public health crisis. Biostatisticians are at the forefront of using big data to the advantage of human health.

Objectives: The objectives of the course are to:

- i. State and explain the principles of Chemo statistics.
- ii. Explain the concepts of frequency distribution sampling and experimental design.
- iii. Determine the level of confidence in a given biological data.
- iv. Compute correlation and regression.
- v. Define analysis of variance (ANOVA) and test statistical hypothesis using ANOVA

- vi. Explain the application of statistical methods and tools in biological and medical sciences.

Learning Outcomes

On completion of the course, students should be able to:

- i. State and explain the appropriate application and limitations of hypothesis testing and regression methods.
- ii. Describe the appropriate graphical or tabular display for a given data set.
- iii. Explain which statistical methods is/are most appropriate to analyze a given data
- iv. Analyze a given data using fundamental statistical methods.
- v. Draw conclusions from statistical analysis and place them into the appropriate public health concepts.

Course Content

Introduction to statistical methods used in biological and medical research. Basic principles of Biostatistics. Frequency distribution and sampling. Experimental design. Analysis of variance. Estimation and hypothesis testing. Correlation and regression. Elementary probability theory. Basic concepts of statistical inference. Regression and correlation. Level of confidence in biological data. Methods and sample size estimation. Statistical methods most appropriate to analyze a given data. Graphical or tabular display for a given data set. Biostatistics applications to medical problems. Use of statistical packages. Conclusions from statistical analysis into the appropriate public health concepts.

Minimum academic standard: Classrooms, computer sets installed with SPSS applications, library collections.

Staffing

Academic Staff

To start any programme in science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel

There should be adequate number of qualified technical staff in the various cadres listed below, with a minimum of school certificate and National Diploma in Laboratory Technology or its equivalent:

Chief Technologist

Assistant Chief Technologist

Senior Technologist

Technologist I

Technologist II

There should also be adequate number of Laboratory Assistants with a minimum of school certificate

In addition, there should be supporting Office Staff: Secretary, Typist, Higher Executive Officer and Messenger

Library

Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the Faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

There should be a Departmental Library that can contain a minimum of 50 students and equipped with relevant books, journal articles and other relevant news articles particularly on Industrial chemistry.

The Department shall maintain both physical and electronic libraries that shall comprise of the following Units:

Conventional

Circulation Section

Reference/Reserve Section with core Subject textbooks.
 Serial/ Special journals
 E- library with Internet connectivities
 Reading area
 Learning common which shall include (Stationary laptops Wi-Fi, Sofa sitters, Smart boards).
 Story rooms (Stratified into levels) for specialised institutions.
 Computers (DESKTOPS AND LAPTOPS.)
 Internet connectivity (broad band)
 Workstation available in the library for at least 25% of the total students enrolled in each academic year/ programme.
 Wide screen projection facilities.
 Librarian with at least three staff.
 Space should be dependent on the population of students enrolled.
 Funding of the library's hold be in line with NUC guideline.

Classrooms, Laboratories, Workshops and Office

Space The NUC recommends the following physical space requirements:

Description		Size m²
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0