**Bayero University, Kano (BUK) Engineering**

**Chemical and Petroleum Engineering**

**B.Eng Chemical Engineering Programme**

**30% Additional Courses to CCMAS**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 100 LEVEL | | | | | | |
| Course Code | Course Title | Pre | Units | Status | LH | PH |
| BUK-MTH103 | Elementary Mathematics III |  | 2 | C | 30 |  |
| BUK-PHY103 | General Physics III |  | 3 | C | 45 |  |
|  | **Total** |  | **5** |  |  |  |
| 200 LEVEL | | | | | | |
| BUK-GET201 | Applied Electricity I |  | 3 | C | 45 |  |
| BUK-CHM201 | Physical Chemistry |  | 2 | C | 30 |  |
|  | **Total** |  | **3** |  |  |  |
|  |  |  |  |  |  |  |
| 300 LEVEL | | | | | | |
| BUK-TCH311 | Particulate Technology |  | 3 | C | 30 | 0 |
| BUK-TCH321 | Chemical Reaction Kinetics |  | 2 | C | 30 | 0 |
| BUK-TCH306 | Chemical Engineering Laboratory II |  | 2 | C | 0 | 45 |
| BUK-TCH 309 | Transfer Processes II |  | 3 | C | 30 |  |
|  |  |  |  |  |  |  |
|  | **Total** |  | **10** |  |  |  |
|  |  |  |  |  |  |  |
| 400 LEVEL | | | | | | |
|  |  |  |  |  |  |  |
| BUK-TCH 407 | Chemical Engineering Laboratory III |  | 1 | C | 0 | 45 |
| BUK-ELE 403 | Engineering Mathematics IV |  | 3 | C | 45 |  |
| BUK-TCH409 | Separation Processes II |  | 3 | C | 45 |  |
|  | **Total** |  | **7** |  |  |  |
|  |  |  |  |  |  |  |
| 500 LEVEL | | | | | | |
| BUK-TCH521 | Chemical Reaction Engineering II |  | 2 | C | 30 |  |
| BUK-TCH541 | Process Optimisation |  | 3 | C | 45 |  |
| BUK-TCH543 | Chemical Process Technology |  | 2 | C | 30 |  |
| BUK-TCH542 | Process Safety and Loss Prevention in Industries |  | 2 | C | 30 |  |
| BUK-TCH544 | Environmental Pollution and Control |  | 2 | C | 30 |  |
| BUK-TCH571 | Biofuels and Biorefining |  | 2 | C | 30 |  |
| BUK-TCH573 | Biochemical Engineering II |  | 2 | C | 30 |  |
|  | Elective |  | 4 | E |  |  |
|  | **Total** |  | **22** |  |  |  |
| **LIST OF ELECTIVE COURSES** | | | | | | |
| BUK-TCH 562 | Petroleum Production Engineering and Technology |  | 2 | E | 30 |  |
| BUK-TCH 563 | Coal Processing |  | 2 | E | 30 |  |
| BUK-TCH 564 | Sugar Technology |  | 2 | E | 30 |  |
| BUK-TCH 565 | Pulp and Paper Technology |  | 2 | E | 30 |  |
| BUK-TCH 566 | Cement and Cement Technology |  | 2 | E | 30 |  |
| BUK-TCH 567 | Polymer Science and Engineering |  | 2 | E | 30 |  |
| BUK-TCH 568 | Fermentation Technology |  | 2 | E | 30 |  |
| BUK-TCH 569 | Fertilizer Science and Technology |  | 2 | E | 30 |  |
| BUK-TCH 570 | Introduction to Electrochemical Engineering |  | 2 | E | 30 |  |
|  |  |  |  |  |  |  |
|  | Total core units developed: | 42 |  |  |  |  |
|  | Total elective units developed: | 18 |  |  |  |  |
|  | **Total units developed:** | **60** |  |  |  |  |

**BUK-MTH 103 Elementary Mathematics III (Vectors, Geometry and Dynamics) (2 Units C: LH 30)**

**Senate-approved relevance**

Mathematics is the bedrock of any engineering course. Knowledge of Mathematics is essential skill required for any engineering student as it provides the basis on which the students can build their engineering skills on. Thus, it is fundamentally important that the students are equipped with the mathematics knowledge like the ones provided in this course. This is in line with BUK’s mission and vision of producing high-quality graduates that are well-skilled and knowledgeable.

**Overview**

Vectors coordinate, geometry and dynamic is a vital course that prepares the graduate in chemical engineering to be able to handle and improve on the infrastructural deficit for sustainable development. This highlights the importance of preparing students in chemical engineering with the knowledge and skills on how to solve problems that they will encounter during their training.

This course is designed to introduce students to the concept of Vectors, Geometry and Dynamics in its entirety as well as Vectors differentiation and integration. In addition, co-ordinate geometry, equations of lines, circles etc will also be covered. The importance of the course lies in meeting the need in achieving sustainable development goals (SDGs) numbers 1 and 2 in the areas of reducing poverty and zero hunger respectively. The objectives of the course, learning outcomes, and contents are provided to address this need.

**Course Objectives**

The objectives of the course are to:

1. introduce the concept of vectors and geometric representation of vectors
2. explain differentiation and integration of vectors
3. explain two-dimensional coordinate geometry
4. explain equations of straight lines, circles, parabola etc.
5. explain the concept of velocity and acceleration of a moving particle
6. explain the concept of forces, momentum and the laws of motion under gravity.
7. explain the principle behind elastic string and simple pendulum.
8. explain impulse and the impact of two smooth spheres and a sphere on a smooth surface.

**Learning Outcomes**

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

1. represent vectors in 1-3 dimensions
2. solve some vectors addition and multiplication
3. solve differentiation and integration of vectors
4. write the equation of a straight line, circles, parabola etc.
5. calculate the velocity and acceleration of a moving particle
6. calculate force and momentum of a moving particle

**Course Contents**

Geometric representation of vectors in 1-3 dimensions, components, direction cosines. Addition, scalar, multiplication of vectors, linear independence. Scalar and vector products of two vectors. Differentiation and integration of vectors with respect to a scalar variable. Two-dimensional co-ordinate geometry. Straight lines, circles, parabola, ellipse, hyperbola. Tangents, normal. Kinematics of a particle. Components of velocity and acceleration of a particle moving in a plane. Force, momentum, laws of motion under gravity, projectiles and resisted vertical motion. Elastic string and simple pendulum. Impulse, impact of two smooth spheres and a sphere on a smooth surface.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-PHY 103: General Physics III (Behaviour of Matter) (3 Units C: LH 45)**

**Senate Approved Relevance**

Physics just as mathematics are the bedrock of any engineering course. Knowledge of Physics is essential skill required for any engineering student as it provides the basis on which the students can build their engineering skills on. Thus, it is fundamentally important that the students are equipped with the knowledge Behaviour of Matter. This is in line with BUK’s mission and vision of producing high-quality graduates that are well-skilled and knowledgeable.

**Overview**

Behaviour of matter is a vital course that prepares the graduate in chemical engineering to be able to handle and improve on the infrastructural deficit for sustainable development. This highlights the importance of preparing students in chemical engineering with the knowledge and skills on how to solve problems that they will encounter during their training.

This course is designed to introduce students to the concept of laws of thermodynamics, thermal conductivity, and kinetic theory of gases. The use of Bernoulli’s equation to solve incompressible fluid flow problems will also be covered. The importance of the course lies in meeting the need in achieving sustainable development goals (SDGs) numbers 1 and 2 in the areas of reducing poverty and zero hunger respectively. The objectives of the course, learning outcomes, and contents are provided to address this need.

**Course Objectives**

The objectives of the course are to:

1. introduce the concepts of heat and temperature and relate the temperature scales;
2. explain the various gas laws, the general gas equation and its application
3. explain thermal conductivity
4. explain First Law of thermodynamics and Thermodynamic processes
5. explain Second law of thermodynamics
6. explain Zeroth law of thermodynamics.
7. know the Kinetic theory of gases and understand molecular collisions and mean free path.
8. explain the concepts of elasticity including Hooke's law, Young's modulus, shear and bulk moduli).
9. explain Archimedes' principles
10. use Bernoulli’s equation to solve incompressible fluid flow problems
11. explain the concepts of surface tension including adhesion, cohesion, viscosity etc.

**Learning Outcomes**

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

1. explain the concepts of heat and temperature and relate the temperature scales;
2. define, derive, and apply the fundamental thermodynamic relations to thermal systems;
3. describe and explain the first and second laws of thermodynamics, and the concept of entropy;
4. state the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;
5. deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
6. describe and determine the effect of forces and deformation of materials and surfaces.

**Course Contents**

Heat and temperature (temperature scales). Gas laws. General gas equation. Thermal conductivity. First Law of thermodynamics (heat, work and internal energy, reversibility). Thermodynamic processes (adiabatic, isothermal, isobaric). Second law of thermodynamics (heat engines and entropy). Zeroth law of thermodynamics. Kinetic theory of gases. Molecular collisions and mean free path. Elasticity (Hooke's law, Young's, shear and bulk moduli). Hydrostatics (Pressure, buoyancy, Archimedes' principles). Bernoulli’s equation and incompressible fluid flow. Surface tension (adhesion, cohesion, viscosity, capillarity, drops and bubbles).

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-PHY 104: Physical Chemistry (2 Units C: LH 30)**

**Senate-approved relevance**

Physical chemistry, like mathematics and physics, is fundamental to chemical engineering course. Knowledge of physical chemistry is an essential skill required for any chemical engineering student as it provides the basis on which the students can build their skills on. Thus, it is fundamentally important that the students are equipped with the knowledge provided in this course. This is in line with BUK’s mission and vision of producing high-quality graduates that are well-skilled and knowledgeable.

**Overview**

Physical chemistry exposes the aspiring chemical engineer to knowledge required in sizing a significant number of unit operations, such as liquid-liquid extraction, distillation, humidifcation and drying among others.

This course is designed to introduce students to the concept of laws of thermodynamics, kinetic theory of gases and science of real gases from a chemistry perspective and their implication to chemical systems. It also introduces the student to concept of solution chemistry, colligative properties, binary phase equilibria, surface tension and intermolecular forces in general.

**Course Objective**

The objectives of the course are to:

1. understand the kinetic theory of gases and science of real gases
2. understand the fundamental concepts of physical chemistry
3. discuss the concept of solution in chemistry
4. understand the colligative properties of real solution
5. discuss intermolecular forces
6. understand Nernst distribution law
7. understand phase diagram of binary systems

**Learning Outcomes**

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

1. state the kinetic theory of gases and solve problems related to ideal and real gases;

2. derive the formula for molecular velocity of gases and use the derived formula to solve

problems;

3. describe and explain the fundamental concepts of physical chemistry including those of statistical mechanics, chemical kinetics, quantum mechanics and spectroscopy;

4. define and state type of solutions; define different concentration terms which include molarity, normality etc.

5. describe vapour pressure lowering of the solvent, boiling point elevation of

solutions, freezing point depression of solution and measurement of osmotic pressure;

6. describe the intermolecular forces;

7. describe surface tension;

8. state the different types of mixture and associated phase diagram

9. apply Nernst distribution law to solve a problem

10. states the Faraday’s Law and Conductance Law of solution and calculation.

**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; Solution. Colligative properties. Intermolecular force. Surface tension. Mixture and binary phase diagram. Basic electrochemistry.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-GET 201: Applied Electricity I (3 Units C: LH 45)**

**Senate Approved Relevance**

One of the main branches of engineering is electrical engineering. Knowledge of applied electricity is essential skill required for any engineering student as it provides the basis on which the students can build their engineering skills on. Thus, it is fundamentally important that the students are equipped with the knowledge of applied electricity. This is in line with BUK’s mission and vision of producing high-quality graduates that are well-skilled and knowledgeable.

**Overview**

Applied electricity is a vital course that prepares the graduate in chemical engineering to be able to handle and improve on the infrastructural deficit for sustainable development. This highlights the importance of preparing students in chemical engineering with the knowledge and skills on how to solve problems that they will encounter during their training.

This course is designed to introduce students to the concept of electrical circuit as well as the application of Kirchoff’s law and Thevenin’s theorem. The importance of the course lies in meeting the need in achieving sustainable development goals (SDGs) numbers 1 and 2 in the areas of reducing poverty and zero hunger respectively. The objectives of the course, learning outcomes, and contents are provided to address this need.

**Course Objectives**

The objectives of the course are to:

1. understand the fundamental concepts of electricity and electric fields

2. know Kirchhoff’s laws and its application

3. use superposition Thevenin and Norton theorems to solve circuit problems

4. understand RL, RC, RLC circuits

5. measure resistance, capacitance and inductance of circuits.

6. understand single phase circuits,

7. use complex j – notation

**Learning Outcomes**

Students will be able to:

1. discuss the fundamental concepts of electricity and electrical d.c. circuits;

2. state, explain and apply the basic d.c. circuit theorems;

3. explain the basic a.c. circuit theory and

4. apply to solution of simple circuits.

5. explain the basic principle of impedance, admittance and susceptance.

**Course Contents**

Fundamental concepts: Electric fields, charges, magnetic fields. current, B-H curves Kirchhoff’s laws, superposition. Thevenin, Norton theorems, Reciprocity, RL, RC, RLC circuits. DC, AC bridges, Resistance, Capacitance, Inductance measurement, Transducers, Single phase circuits, Complex j - notation, AC circuits, impedance, admittance, susceptance.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH311: Particulate Technology (3 Units C: LH 45)**

**Senate-approved relevance**

Particle Science is becoming recognized as an enabling technology that helps in creating new energy sources, cleaning the air and water and building stronger and lighter materials. Training of high-quality graduates who are highly skilled and knowledgeable in the design, construction, and maintenance of processes and systems that use particles, converts raw materials to finish products or clean the environment in the arid and semi-arid areas of Nigeria agree with the mission to address African developmental challenges in producing chemical engineering graduates.

**Overview**

The study of Particulate Technology is vital to the design of the system and process where particles are involved. This highlights the importance of preparing students in chemical engineering with the knowledge and skills on how to design systems with different particles and sizes. This course is designed to expose students to various techniques involved in particle science and technology. Also, to build the capacity of students in the area of nanoparticles and their uses.

It involves the application of particle science and technology principles to the design and optimization of process units such as fluidization, sedimentation and flocculation, filtration, screening, classification and grinding. The importance of the course lies in meeting the need for the conversion of raw materials to end products that consist of particles. The objectives of the course, learning outcomes, and contents are provided to address this need.

**Course Objectives**

The objectives of the course are to:

1. explain particle size analysis for determining size distribution;
2. describe various properties of particles and their behaviours in different media;
3. describe various particle size reduction methods;
4. describe various fluid-solid separation techniques;
5. describe features of various unit operations used in particle technology;
6. develop models for evaluating key performance parameters in particulate processing;
7. apply the information in (6) for designing key equipment for particulate;
8. explain the term nano-particles and the principles of developing nano-materials

**Learning Outcomes**

Having completed this course, students will be able to:

1. list and describe four (4) particle characterisations in terms of size distribution ;
2. describe the effect of particle diameter on its motion in a fluid;
3. list at least four (4) particle size reduction techniques;
4. list and describe four (4) unit operations used in the separation of a fluid-solid system;
5. state the differences in the operations of at least five (5) unit operations in particle technology;
6. calculate the settling velocities of particles and bed heights etc;
7. estimate at least two (2) design parameters for each of the filtration and sedimentation processes;
8. describe two (2) methods used to synthesize and characterize nanomaterials.

**Course Contents**

Particle properties. Stroke’s and Newton’s Laws. Flow through packed beds. Characteristics of packed columns. Estimation of fluidization point and bed expansion. Regions of fluidisation pressure drop. Heat and mass transfer in fluidized beds. Sedimentation. Flocculation. Filtration. Screening. Classification. Grinding. Centrifugation. Precipitation. Definition of Nanoparticles. Principles of developing nanoparticles.

**Minimum Academic Standards**

Chemical Engineering laboratory with NUC-MAS requirement facilities.

**BUK-TCH321: Chemical Kinetics and Catalysis (2 Units C: LH = 30)**

**Senate-Approved Relevance**

Graduates that are versatile in understanding the rates of chemical reactions; conditions that influence the rates of chemical reactions and yields; identify the mechanism of reactions as well as the construction of mathematical models that will serve as a backbone of transforming the outcomes of studying chemical kinetics and catalysis in the university into visible products that run on oiled hinges.

**Overview**

Chemical Kinetics and catalysis are an integral part of chemical engineering production processes. It deals with the conditions that influence the rate of chemical reactions and yield (products). It is used to identify the mechanism of reactions as well as the construction of mathematical models that can be used to describe the characteristics of a chemical reaction and the influence of catalysis on the rate of both homogenous and heterogeneous reactions.

The students are expected to be able to navigate from the theory to develop mathematical models that can be employed for predictions for chemical reactions. The importance of the course lies in preparing predictive tools that can be employed for the industrialization of the nation. The objectives of the course, learning outcomes and contents are provided to address the need.

**Course Objectives**

The objectives of the course are to:

1. state the importance of chemical kinetics and classify reactions
2. state the relevance of catalysis in the homogenous and heterogenous production process
3. describe the kinetics of homogenous non-catalytic reactions
4. describe the kinetics of heterogenous non-catalytic reactions
5. describe the kinetics of homogenous catalytic reactions
6. discuss kinetics of heterogeneous catalytic reactions
7. construct mathematical models for the identified reaction types

**Learning Outcomes**

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

1. identify at least four types of reactions

2. compare the advantages and disadvantages of 3 reaction types

3. determine the effects of specific variables on the rate of reaction

4. state at least five factors affecting rates of reaction

5. compare the effect of at least three reaction types on yield/product

6. identify the effect of catalysis on at least three reaction types

7. construct at least three mathematical models representing different reaction types

**Course Contents**

Introduction to chemical reactions. Classifications of chemical reactions. Definition of rates of a chemical reaction. Factors affecting the rate of chemical reactions. Identification of rate equations and constants. Arrhenius relationships in chemical reactions. Orders of chemical reactions. Activation energy and chemical reactions. Frequency factors and determinations in chemical reactions. Introduction to catalysis. Determination of the mechanism of reactions. Kinetics of homogenous noncatalytic reactions. Kinetics of heterogeneous non-catalytic reactions. Kinetics of catalytic homogenous reactions. Kinetics of catalytic heterogenous reactions. Deactivation of catalysts. Physicochemical characterization of catalyst deactivation. Construction of mathematical models.

**Minimum Academic Standards**

Chemical Engineering laboratory with NUC-MAS requirement facilities.

**BUK-TCH306: Chemical Engineering Laboratory II (1 Units C: PH 45)**

**Senate-Approved Relevance**

Virtually all activities in chemical process industries are practical oriented, thus any graduate of Chemical Engineering who wishes to actively participate in the industry must exhibit clear knowledge of interfacing with process units. This course provides the basic knowledge of handling process units using laboratory rigs that are modelled after the real industrial process. This course enhances competence and assimilation when scientific theories are illustrated with hands-on activities in form of experiments. Thus, it contributes to the making of Chemical Engineers with the requisite safety and industrial capabilities for the emerging industrial revolution.

In this second course in the chemical engineering laboratory, experiments are conducted in the areas of mass transfer, separations, reaction engineering, and process dynamics and control. Bench and pilot-scale equipment are used. Data collected are analysed and compared to applicable theories.

Written reports are prepared by the students. A safety session is given at the commencement of the course. Safe practices are strictly adhered to throughout the course. The importance of the course lies in practical applications of known theories whose knowledge can be employed for industrial-scale practices. The objectives of the course, learning outcomes and contents are provided to address the need.

**Course Objectives**

The objectives of the course are to:

1. demonstrate the start-up and shutdown of experimental rigs;
2. illustrate basic health and safety rules in the laboratory
3. illustrate the use of relevant literature sources to support/contradict theoretical arguments, and to source data;
4. demonstrate theoretical principles by means of experiments;
5. describe the use of theoretical models to explain experimental data;
6. demonstrate how to validate experimental data with theoretical models; and
7. describe technical information and arguments in a professional manner.

**Learning outcomes**

Having completed this course, students will be able to:

1. demonstrate the start-up and shutdown of the experimental rig in each of the experiments;
2. list at least two (2) safety and environmental hazards present in the laboratory and specific steps to deal with the risks responsibly;
3. identify at least one (1) theory from the literature to explain the scheduled experiment and support the measured data;
4. collect data from the process of the scheduled experiment;
5. evaluate the parameter(s) representing the objective(s) of the scheduled experiment from the measured data;
6. evaluate the accuracy of the determined parameter based on the prescribed theory from the literature;
7. write a technical report on the scheduled experiment.

**Course Contents**

Laboratory experiments in separation processes and heat transfer operations.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH 309: Momentum Transfer (3 Units C: LH 45)**

**Senate-Approved Relevance**

Training of high-quality chemical engineering graduates that will meet the demand of process industries entails development of skills in different transfer processes as exemplified in many transport phenomena operation, especially momentum transport. The operation of many process industries requires good skill in the understanding of the design of many equipment where different transfers of materials are taking place to get the final output which solves engineering problems.

**Overview**

Momentum transfer is a branch of the Transport phenomena. This course is designed to teach students the importance of Momentum Transfer and their applications from the viewpoint of chemical engineering. This course includes studying the principles of momentum transfer and general molecular transport equation.

Students are helped to appreciate pipe flow problems such as head loses, boundary layer theory, loses due to friction and fittings. They are also introduced to pump and their characteristics, gas moving equipment, design equation for laminar and turbulent flows in pipes.

**Course Objectives**

The objectives of this course are to:

1. know fluids and how they behave with change in temperature.
2. know how to determine the nature of flow and how to calculate the boundary layer thickness.
3. know fluid flow classifications.
4. know how to apply Bernoulli’s equation with and without friction.
5. size different agitation devices.
6. be able to perform basic pump selection operations.
7. identify different fluid moving machinery and how to size them.

**Learning Outcomes**

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

1. explain the principles of static and dynamic behavior of fluids.
2. enumerate the rheological properties of fluids using newton law of viscosity with its generalization to understand the pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density and convective momentum transport.
3. identify and analyze incompressible and compressible fluid flows.
4. apply Bernoulli’s theorem to solve incompressible and compressible fluid flow problems.
5. calculate friction factor for different types of flow through pipes and fittings.
6. select suitable fittings and valves for a given flow problem.
7. identify different agitation and mixing equipment and how to size them.
8. draw characteristic curve for pumps.
9. size pump and compressors.

**Course Content**

Fluid and fluid properties. Incompressible and Compressible fluid flow. Boundary layer theory. Flow through pipes. Valves and fittings. Head losses. Pump and gas moving equipment. Agitation, mixing of fluid and power requirement. Design equation for laminar and turbulent flows in pipes.

**Minimum Academic Standards**

Transport phenomena laboratory with facilities meeting the NUC-CCMAS requirement.

**BUK-TCH407: Chemical Engineering Laboratory III (1 Unit; C: PH =45)**

**Senate-Approved Relevance**

With the rising sophistication in technology and its attendant consequences on chemical process industries, a graduate of Chemical Engineering with skills and competence in process units management for environmental sustainability and market competitiveness is required. This course provides the basic knowledge of handling process units using laboratory rigs that are modelled after the real industrial process.

**Overview**

This laboratory emphasizes concepts presented in heat transfer, thermodynamics, chemical reaction engineering, biochemical engineering, process dynamics and control course. A safety session is given at the commencement of the course. Safe practices are strictly adhered to throughout the course. Students carry out selected experiments in heat transfer, process control and biochemical engineering. Data collected are analyzed and compared to applicable theories. The objectives of the course, learning outcomes and contents are provided to address the need.

**Course Objectives**

The objectives of the course are to:

1. demonstrate the start-up and shutdown of experimental rigs;
2. illustrate basic health and safety rules in the laboratory
3. illustrate the use of relevant literature sources to support/contradict theoretical arguments, and to source data;
4. demonstrate theoretical principles by means of experiments;
5. describe the use of theoretical models to explain experimental data;
6. demonstrate how to validate experimental data with theoretical models; and
7. describe technical information and arguments in a professional manner.

**Learning Outcomes**

Having completed this course, students will be able to:

1. demonstrate the start-up and shutdown of the experimental rig in each of the experiments;
2. list at least two (2) safety and environmental hazards present in the laboratory and specific steps to deal with the risks responsibly;
3. identify at least one (1) theory from the literature to explain the scheduled experiment and support the measured data;
4. collect data from the process of the scheduled experiment;
5. evaluate the parameter(s) representing the objective(s) of the scheduled experiment from the measured data;
6. evaluate the accuracy of the determined parameter based on the prescribed theory from the literature;
7. write a technical report on the scheduled experiment.

**Course Contents**

Selected experiments in Heat Transfer. Thermodynamics. Chemical Reaction Engineering. Biochemical Engineering. Process Dynamics and control.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilitie

**BUK-ELE 403: Engineering Mathematics IV (3 Units C: LH 45)**

**Senate-Approved relevance**

Mathematics is the bedrock of any engineering course. Knowledge of Mathematics is essential skill required for any engineering student as it provides the basis on which the students can build their engineering skills on. Thus, it is fundamentally important that the students are equipped with the mathematics knowledge like the ones provided in this course. This is in line with BUK’s mission and vision of producing high-quality graduates that are well-skilled and knowledgeable.

**Overview**

Differential equation and numerical analysis is a vital course that prepares the graduate in chemical engineering to be able to handle and improve on the infrastructural deficit for sustainable development. This highlights the importance of preparing students in chemical engineering with the knowledge and skills on how to solve problems that they will encounter during their training.

This course is designed to introduce students to the concept of both partial and total differential equations and transforms, relate the integral transforms to solution of differential and integral equations, also apply the knowledge of numerical solution to solving chemical engineering problem etc. The objectives of the course, learning outcomes, and contents are provided to highlight the importance of the course.

**Learning Outcomes**

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

1. solve second order differential equations;
2. solve partial differential equations;
3. solve linear integral equations;
4. relate integral transforms to solution of differential and integral equations;
5. explain and apply interpolation formulas; and
6. apply Runge-Kutta and other similar methods in solving ODE and PDEs.

**Course Contents**

Series solution of second order linear differential equations with variable coefficients. Bessel and Legendre equations. Equations with variable coefficients. Sturn-Louville boundary value problems. Solutions of equations in two and three dimensions by separation of variables. Eigen value problems. Use of operations in the solution of partial differential equations and Linear integral equations. Integral transforms and their inverse including Fourier, Laplace, Mellin and Handel Transforms. Convolution integrals and Hilbert Transforms. Calculus of finite differences. Interpolation formulae. Finite difference equations. Runge-Kutta and other methods in the solutions of ODE and PDEs. Numerical integration and differentiation. MATLAB functions for numeric solution of linear and non-linear ODEs.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH409 : Separation Processes II (3 Units C: LH = 45)**

**Senate-Approved Relevance**

Highly skilled and versatile Chemical Engineering graduates are highly sourced for by the chemical manufacturing industry. Separation processes are key to high-purity and quality products in the chemical industries. This is pertinent to the survival of industries in this highly competitive economy and therefore paramount to national industrial development.

**Overview**

Separation processes deal with purification methods for reaction products in chemical industries. It forms an important aspect in the anatomy of manufacturing plants taking cognizance of feed pre-treatment and product separation/purification. This course is intended to equip chemical engineering graduates with good knowledge and skill requisite in process/chemical industries for corporate profitability.

The goal of the course is to familiarize the students with the industrial separation processes essential in the chemical, petroleum refining and other material processing industries. It is important to graduates who desire to take job opportunities in the chemical industries. The objectives of the course, learning outcomes and contents are provided to address the need.

**Course Objectives**

The objectives of the course are to:

1. describe the drying operations, its mechanism and the design of the drying equipment;
2. determine the drying rate for different periods;
3. explain the physical absorption process, chemical absorption, and stripping;
4. describe the evaporation process, identifying the influence of the effects on performance;
5. describe the two key components of multicomponent distillation;
6. estimate the equilibrium stages and distribution of non-key components;
7. describe the problems associated with multicomponent mixtures;
8. explain the various methods of multi-component system separation analysis;
9. describe the procedure for determining equilibrium stage, stage and column efficiency.
10. explain membrane processes in terms of the membrane, feed, sweep, retentate, permeate, and solute-membrane interactions.

**Learning Outcomes**

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

1. describe at least two (2) phases in the drying process and list two modes of drying;
2. state two (2) factors affecting drying rate;
3. state at least two (2) features of chemical and physical adsorption;
4. list five(5) parameters for the design of multiple-effect evaporation systems;
5. identify the two key components for multicomponent distillation;
6. calculate the number of equilibrium stages;
7. list at least two (2) methods of solving countercurrent multistage problems;
8. evaluate the number of equilibrium stages for multicomponent absorption, distillation and extraction operations using the Kremser equation;
9. construct a model each for distillation and absorption operations in a counter-current cascade equilibrium stages;
10. identify the two (2) common types of membranes and their significance.

**Course Contents**

Drying mechanism. Rate of drying and estimation of drying periods. Industrial dryer design. Solvent extraction. Introduction to gas absorption. Evaporation. Evaporation equipment and operation methods. Multiple effect evaporation. Evaporator performance and efficiency. General problems of multicomponent systems. Approximate method for multicomponent multistage operation. Fenske Underwood and Gilliland's method for multistage, multicomponent separation. Kremser Method.

Multicomponent gas absorption. Distillation of multicomponent mixtures. Introduction to membrane separation technology. Types of membrane separation processes. Gas permeation, pervaporation and various models for gas separation membrane process. Design of selected multicomponent separation equipment.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH521: Chemical Reaction Engineering II (2 units C: LH = 30)**

**Senate-Approved Relevance**

Chemical Reaction Engineering (CRE) deals with the design of Chemical Reactors to produce chemicals. The design of Chemical Reactors is based on a few simple and useful concepts. This course seeks to equip would-be chemical engineering graduates with adequate knowledge in the area of heterogeneous reactions for both catalysed and non-catalysed cases as it is mostly found in most real-life chemical processes. This course is highly relevant to chemical engineering graduates who seek an internship or job placement in the vast chemical processing industries. The course prepares students to be able to design and analyse reactors to achieve chemical conversion of raw chemical materials into chemical products

**Overview**

The first Chemical Reaction Engineering Course focuses on reactions occurring in one phase and is generally based on the assumption of ideality. However, most processes in Chemical plants and petrochemical industries involve multiphase systems. Most times, solid catalysts are introduced into the system to improve its performance and so, models of homogenous systems do not apply. This current course focuses on the analysis of a heterogeneous system of reaction. It consists of topics that introduce principles of heterogeneous reaction systems and the basic steps in a solid-catalysed or non–catalysed reaction system; rate laws and mechanism of reaction; how to develop pore models for analysing diffusion and reaction, and the design steps for various types of heterogeneous and multiphase reactors;

**Course Objectives**

The objectives of the course are to:

1. describe the basic features of a heterogeneous reaction and the factors influencing them;
2. describe the roles of catalysts as a vital part of heterogeneous reactions;
3. derive the rate laws and mechanisms for solid-catalysed reaction systems
4. describe how to develop mathematical expressions for the behaviour of different types of heterogeneous and multiphase reactors;
5. describe the influence of kinetics, mass and heat transfer on the performance of

heterogeneous and multiphase reactors;

1. describe the applications of numerical methods in modelling heterogeneous reactors;
2. describe the design steps for heterogeneous and multiphase chemical reactors;

**Learning Outcomes**

Having completed this course, students will be able to:

1. list four (4) features of a heterogeneous reaction;
2. describe at least two (2) effects of the catalyst in a reaction;
3. describe the rate steps and overall rate equation for heterogeneous reaction systems;
4. develop a mathematical expression to describe each of the behaviour of catalytic packed bed reactor, fluidized bed reactor, and slurry reactor;
5. describe at least one (1) effect of each of kinetics, mass and heat transfer on the performance of heterogeneous and multiphase reactors;
6. estimate the percentage conversion in a heterogeneous reactor using at least one (1) numerical mathematical method;
7. list at least four (4) design steps for a heterogeneous and multiphase chemical reactor.

**Course Content**

Non-catalytic Heterogeneous Reactions: Selection of model. Progressive Conversion model. Unreacted core model. Determination of controlling step. Design application. Catalysis and Catalytic Reactors: Overview of solid catalysed reactions. Rate equations for surface kinetics. Mass transfer between the bulk fluid phase and external catalyst surface in isothermal reactors. Pore and filmdiffusion resistances. Deactivation and regeneration of catalysts. Porous catalyst particles: Deriving theglobal reaction rate expression. Determination of rate controlling step. Effectiveness factor for flatplate, cylindrical and spherical catalyst pellets. Performance equation for catalytic reactors with porous catalysts. Pressure drops in packed bed catalytic reactors. Heat effects in catalytic reactors. Adiabatic packed bed catalytic reactors.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH541: Process Optimisation ( 3 Units CL LH=45)**

**Senate-Approved Relevance**

The Chemical Engineering programme in the Universities is approved by the senate to train highquality graduates that can navigate the emerging dynamic, economic-volatile and technology-driven world through competence, creativity, competitiveness and character. This course, process optimisation becomes relevant to the programme's philosophy as it equips graduates with skills to design and run a process plant based on systematic decision-making that leads to such benefits as high profit, minimum cost, least energy usage, reduced maintenance costs, less equipment wear, better staff utilization, faster and more reliable troubleshooting, which ultimately guarantee market competitiveness and environmental sustainability through minimization of industrial wastes.

**Course Overview**

This course is intended to harness various principles and theories from chemical engineering analyses to real-life applications in the management of resources for maximum benefit or minimum losses as thecase may be. It lays a foundation for relevant information and skills that can be repeatedly employed insubsequent professional endeavours. The industrialisation has been identified as a panacea to some of the economic and developmental challenges of Nigeria that are imported dependent. However, market competitiveness is a key virtue for survival against all import-driven aggression. Hence, the need for process optimisation. That consists of systematic problem-solving skills, to determine the most cost-effective and efficient solution

to a problem or design of a process. These techniques are vital quantitative tools in industrial decision making. A wide variety of problems in the design, construction, operation, and analysis of chemical plants (as well as many other industrial processes) can be resolved by optimization. It illustrates the basic characteristics of optimization problems and their solution techniques and describes some typical benefits and applications in the chemical and petroleum industries.

**Course Objectives**

The objectives of the course are to:

1. describe the concept of process optimisation and its importance;
2. describe various types of mathematical models, their development and features;
3. describe steps involved in building models of chemical process systems;
4. describe the basic features of a model that can be optimised;
5. describe the features of constrained and unconstrained optimisation problems;
6. describe steps involved in formulating both objectives and constraints for a chemical process;
7. solve examples with various features using different types of optimisation techniques;
8. demonstrate the application of the Matlab optimisation toolbox in solving problems.

**Learning Outcomes**

Having completed this course, students will be able to:

1. list four (4) economic importance of process optimisation to chemical industries;
2. identify at least one (1) feature each for a variable and a parameter in a mathematical model;
3. construct a mathematical model for at least one (1) chemical process system and identify the variable and parameter in it;
4. list two (2) differences between continuous and non – continuous functions;
5. state at least two (2) differences between constrained and unconstrained optimisation problems;
6. construct an optimisation problem statement for at least two (2) chemical processes;
7. identify appropriate optimisation solution techniques for at least two (2) types of

optimisation problems;

1. use Matlab software to solve a numerical process optimisation problem.

**Course Contents**

Nature and organization of optimisation problems: Definition of optimisation, scope and hierarchy of optimisation. Examples of chemical Engineering applications of optimisation. Essential features of optimisation problems. General procedure for solving optimisation problems. Developing models for optimisation: Classification of models. How to build a model. Selecting functions to fit empirical. Formulation of the objective function: Economic objective functions. Time value of money in objective functions and measures of profitability. Basic concepts of optimisation theory: Continuity of functions. Convexity, concavity and their applications. Necessary and sufficient conditions for an extremum of an unconstrained function. Optimisation of unconstrained functions: One-Dimensional Search Methods. Unconstrained multivariable optimization techniques. Linear programming. Quadratic programming. Successive quadratic programming. Using Non-linear programming software: Matlab optimisation toolbox. Dynamics programming: optimization of the staged system. Network analysis and queuing theory. Numerical optimization techniques. Applications in heat transfer and energy conservation, separation processes, fluid flow systems, chemical reactor design and operation.

**Minimum Academic Standards**

Modelling and Simulation laboratory with NUC-CCMA requirement facilities

**BUK-TCH543: Chemical Process Technology (2 Units; C: LH = 30)**

**Senate-Approved Relevance**

This course seeks to train ready-made functional graduates who can meet the emerging needs of modern agro-industries, chemical industries, petroleum refineries, and petrochemical industries. The course aims at preparing chemical engineering graduates for careers in chemical process industries and also equipping them with the capability to facilitate the development of new and modern chemical/petroleum/petrochemical complexes.

**Course Overview**

This course provides a comprehensive view of the evolution of the chemical industry, emphasizing major technology changes and sustainability issues. It surveys four (4) key sectors of the chemical processing industries (oil and fat, soap and detergent, essential oil and fragrance, cosmetics industries). It discusses the structure of the industries, the historical development of keystone technologies, and the common flowsheet elements that have proven to be commercially successful.

It draws examples from production scales, chemistries, and enabling technologies. It examines the industry in light of the factors that have most influenced its development, including raw materials of choice, energy availability, and the development of new unit operations, as well as those that will influence its future courses in Nigeria, such as advances in science and technology, environmental impact minimization, water availability, and sustainability concerns.

**Course Objectives**

The objectives of the course are to:

1. describes the economic relevance of the four industries in Nigeria;
2. describe various types of products from the industries;
3. describe various raw materials used in the industries ;
4. describe the processing technologies of manufacturing in these industries;
5. describe major equipment used in the operations of these industries;
6. describe the environmental and safety aspects of the operations of these four chemical industries;
7. describe some emerging Nigerian government policies for sustainable industrial growth.

**Learning Outcomes**

Having completed this course, students will be able to:

1. list at least four (4) of the economic importance of these industries in Nigeria;
2. describe at least one (1) type of product from each of these industries in Nigeria;
3. describe at least four (4) raw materials used in products and their importance in production;
4. describe two (2) methods of production for various types of products in these industries;
5. list at least three (3) major equipment used in manufacturing and their functions;
6. describe two (2) environmental impacts and two (2) safety precautions obtainable from any two (2) of these industries;
7. describe at least one (1) government policy on industrial revitalisation and its relevance to each of these industries.

**Course Contents:**

Oils, Fats and Waxes: Extraction and reforming of vegetable oils. Animal fats and oils. Hydrogenation. Inter-esterification. Waxes.

Soaps and Detergents: Splitting of fats. Fatty alcohols manufacture. Raw materials. Types and manufacture of soap and detergent. The cleansing action of soap and detergents. Manufacture, properties and uses of glycerine.

Essential Oils, Fragrances and Flavours: Vehicle. Fixative. Essential oil. Recovery of volatile oils. Synthetic and semi-synthetic essential oils use. Natural fruit concentrates. Perfumes: Definition. Classification. Synthesis and uses.

Cosmetics: A general study including the preparation of cosmetics and perfumes in terms of raw materials such as emulsifiers (natural, synthetic and finely dispersed solids). Lipid components (oils, waxes, fats). Humectants, colours (dyes and pigments). Preservatives and antioxidants. Essential oils and their importance in cosmetic industries. Cosmetics for skin (Types and problems of skin). Key ingredients of skin cleansing: Toners. Moisturizers, Nourishing. Protectives. Talcum powder. Bleaching products. Hair care: Classification. Special additives for conditioning and scalp health. Hair colourants. The plant materials (herbs) used in hair cosmetics.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH542: Process Safety and Loss Prevention in Industries (2 Units C: LH= 30)**

**Senate-Approved Relevance**

Topics on Safety and Loss Prevention in Chemical Process industries are concerned primarily with the identification of potential hazards and hazardous conditions associated with the processes and equipment utilized in chemical process industries. It includes methods of predicting the possible severity of the associated hazards and preventing, controlling or mitigating them. The course will prepare the would-be chemical engineers with techniques for performing process hazard analysis, risk assessment, and accident investigations chemical processing industry

**Overview**

This course covers the principles and knowledge of process safety and loss prevention in the industrial setting. It will acquaint would be chemical engineering graduates with advanced safety matters such as process safety management systems, hazard identification, risk assessment, risk management, hazard analysis, and safety audit. This will afford them the skill to identify potential hazards and hazardous conditions associated with the processes and equipment involved in the chemical process industries.

It describes the elements of a modern approach to process safety. It provides the basis for how process safety should be approached and implemented across the lifecycle of a project. The interaction between process design and hazard identification is explored. Some hazard study techniques are introduced and the concepts underlying risk and risk criteria are analysed.

**Course Objectives**

The objectives of the course are to:

1. identify the potential hazards in chemical process industries;
2. review the major fatal accident in the chemical industries;
3. discuss key factors influencing process safety;
4. evaluate the safety performance of a chemical plant using relevant techniques;
5. analyse and evaluate the consequences of safety failure on immediate surroundings and economy;
6. evaluate ways of mitigating fire and explosion in chemical plants;
7. evaluate the adequateness of the layer of protection and select suitable safety features;
8. conduct hazard control plans in chemical industries;
9. describe the common legislation in managing process safety.

**Learning Outcomes**

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

1. list four (4) potential hazards in chemical process industries;
2. describe five (5) records of a fatal accident in the chemical industries;
3. enumerate the six (6) factors affecting process safety;
4. evaluate the safety performance of a chemical plant using two (2) techniques;
5. list four (4) consequences of safety failure on immediate surroundings and economy;
6. list five (5) ways of mitigating fire and explosion in chemical plants;
7. apply a layer of protection analysis for quantitative analysis and assessment of risk to at least one(1) scenario;
8. identify and evaluate at least two (2) options for controlling hazards using the hierarchy of control
9. mention at least 4 common legislation in managing process safety

**Course Contents**

Review of some major accidents in process industries. Hazard Identification. Hazard types. Assessment and Control. Introduction to Process Safety Engineering. Loss Prevention. Toxic Materials. Dose and Response Curves. Threshold Limit Values and Permissible Exposure Levels

MSDS's. Monitoring of Volatile Toxicants. Toxic Release and Dispersion Models -Pasquill-Gifford Plume and Puff Models. Fires and Explosions: Flammability of liquids and vapours. Explosions - Detonations and Deflagrations. Fire and Explosion Protection and Prevention-Inerting, Purging Static Electricity. Explosion Proof. Equipment Ventilation. Sprinklers. Hazard Identification Checklists. DOW

**BUK-TCH545: Environmental Pollution and Control (2 Units; C: LH = 30)**

**Senate-Approved Relevance**

For every chemical process, pollution of the environment is almost inevitable though the gravity of pollution may differ based on the mode of operation and control of produced pollutants. To have graduates that will know appropriate pollution control to reduce loss of biodiversity, global warming and be able to project and understand the impact of chemical processes on the environment, in general, will emerge. The role of regulatory agencies in ensuring environmental pollution is controlled.

**Course Overview**

Environmental pollution control promotes the efficient use of raw materials, equipment and water and this will eventually lead to a safer environment and promotes the health of workers and residents in the environment. The importance of the course lies in preparing an Environmental Impact Assessment (EIA) and Environmental audit that will be used as predictive tools that can be employed for the siting of industrial and residential layouts.

**Course Objectives**

The objectives of the course are to:

1. identify and discuss sources of environmental pollution;
2. discuss environmental pollutants in (air, water, and land);
3. identify and discuss methods of remediating identified pollutants;
4. identify and discuss the functions of environmental regulatory bodies in general;
5. state functions of regulatory bodies in Nigeria;
6. discuss the dispersion of pollutants in water;
7. discuss principles and practices related to engineering control of emissions from different sources;

**Learning Outcomes**

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

1. identify 3 sources of pollution each for air, water and land ;
2. list 3 pollutants each for air, water and land and suggest remediation for each ;
3. describe 3 functions of each of any 2 regulatory bodies in Nigeria in environmental pollution control
4. describe at least 2 roles of regulatory bodies in environmental pollution control;
5. develop at least 1 mathematical model for atmospheric pollutant dispersal;
6. describe the analysis of dispersed pollutants in water;
7. identify the theory and any 2 principles related to engineering control of particulate and gaseous emissions from different sources.

**Course Contents**

Sources of water. Introduction to water pollution. Types of water pollution. Sources of water pollution. Analysis of dispersed pollutants in water. Effects of water pollutants on the environment. Streams and effluent standards. Water treatment processes for domestic uses. Water treatment for industrial uses. Introduction to air pollution. Types of air pollution. Theory, principles and practices related to engineering control of particulate and gaseous emissions from natural, industrial, agricultural, commercial and municipal sources of atmospheric pollution. Effect of atmospheric pollution on the various forms of life. Atmospheric pollutant dispersal modelling. Solid waste collection. Solid waste management. Refuse processing, recovery and conversion to useful products. Functions of environmental regulatory bodies.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities.

**BUK-CEE-573: Biochemical Engineering II (3 Units; Core; LH = 60)**

**Senate-approved relevance**

The relevance of this course will be seen in its context of dealing with major elements of the global significance of biotechnology and key developments and technologies such as fermentation.

**Overview**

This course will advance the application of biological, biochemical, and engineering fundamentals in the area of bioprocess engineering. It will discuss microbial growth and product formation kinetics, process scale up and design, bioreactor operation consideration, design and control the bioprocess parameters.

**Course Objectives**

The objectives of the course are to:

1. Provide knowledge of cell growth and kinetics in batch and continuous processes.
2. Provide the basic knowledge of the mathematical models of batch, semi-continuous and continuous processes
3. Provide an understanding of the effect of environmental and process parameters on batch and continuous processes.
4. Provide the knowledge of mass and heat transfer and their importance in aerobic fermentation.
5. Provide the understanding of bioreactor design and selection as well as scale up and scale down of bioprocesses.
6. Provide students with the information on production methods of various products from aerobic and anaerobic processes.

**Learning Outcomes**

Upon successful completion of this course, students should be able to:

1. Explain the complexity of microbes and yet be able to use Monod and other types of growth patterns to describe their growth.
2. Describe the kinetics of substrate utilization and product formation during fermentation.
3. Model the growth of microorganisms in batch, fed-batch, and continuous flow processes
4. Describe the concept of mass and heat transfer in aerobic processes and their importance.
5. Explain different types of bioreactors, appropriate conditions for their use, and considerations in reactor scale-up.
6. Explain the production methods of various bioproducts from aerobic and anaerobic processes

**Course Contents**

How cells grow. Batch growth and patterns. Factors affecting growth. Kinetics of growth. Cell growth in continuous culture. Fermentation processes: batch, fed-batch and continuous processes. Material and energy balances for bioprocessing operations. Kinetics of fermentation processes. Ideal chemostat. Stoichiometry and kinetics of substrate utilisation and product formation. Nutrient requirements for microbial growth. Transfer phenomena in fermentation: oxygen and heat transfer. Practical aspects of bioreactor operation, monitoring and control. Bioreactor design and selection. Bioreactors scale-up and its difficulties. Examples of anaerobic processes: ethanol, lactic acid productions. Aerobic processes: Bakers’s yeast, penicillin production.

**Minimum Academic Standards**

NUC-MAS requirement facilities

**BUK-CEE-571: Biofuel and Biorefining (3 Units; Core; LH = 45)**

**Senate-approved relevance**

The relevance will be seen in students from BUK being able to critically analyze new technologies arising from emerging biotechnology solutions for a changing climate and drivers behind the current interest in biofuels and bio-based energy sources.

**Overview**

This course will focus on production and purification of biofuels and biochemicals as a sustainable, environmentally friendly and low cost route. Characteristics of biomass as potential feedstock, bioproduction of fuel and chemicals, waste utilisation and value recovery from wastes, types of biorefineries, conversion processes and existing technologies will be covered.

**Course Objectives**

The objectives of the course are to:

1. Provide students with understanding of the role of biomass as a sustainable energy resource and fuel.
2. Provide students with knowledge of the main sources of biomass, and the framework within which biomass is considered as a renewable energy source.
3. Provide the principles of calculation of the energy generating potential of biomass as an energy source used in different system design choices.
4. Provide students with understanding of the different biomass conversion processes in terms of operating conditions, useful products and by-products for biofuels and biochemical production
5. Provide knowledge of pyrolysis/gasification technologies applied to wastes and biomass in power generation.
6. Provide knowledge on biorefining schemes and evaluation of various technologies available for biofuels production from biomass.
7. Provide knowledge on the drivers of increased use of waste and biomass resources and associated legislative and environmental issues.

**Learning Outcomes**

Upon successful completion of this course, students should be able to:

1. Explain biofuels and biorefinery and their roles in sustainable bioeconomy,
2. Identify the range of biomass resources available for bioenergy and biochemicals production,
3. Critically evaluate a range of technologies for biofuels production and biorefining
4. analyse the potential for future reduction in costs through technological development,
5. Identify the high-value products that can be obtained from biomass feedstock,
6. Construct simple biorefining schemes and critically evaluate the potential of biorefining processes.
7. Analyze the economic, social and environmental impacts of biorefining

**Course Contents**

Concept of biofuel and refining. Biomass availability. Physicochemical properties of biomass. First, second and third generation biofuel production. Biofuel use. Conversion technologies for biochemicals (biomethanol, bioethanol, levulunic acid, bioacetic acid, bioformaldehyde, etc.). Economic, social and environmental impacts of biorefining.

**Minimum Academic Standards**

NUC-MAS requirement facilities

**BUK-TCH 562: Petroleum Production Engineering and Technology (2 Units; Elective; L= 30)**

**Senate-Approved Relevance**

Graduates who are highly skilled with knowledge in petroleum Production and refining Technology and are able to apply the knowledge in the rapidly growing petroleum industry are in line with the vision to be the university that is innovative and a solution provider to the industrial need of the country.

**Course Overview**

This course provides a detailed understanding of the methodologies and relevant engineering science and technology for the efficient and safe production of oil and gas. It introduces students to the design and implementation of the systems used in the extraction of oil and gas, including terminology and basic calculations in drilling engineering, geology, production, reservoir, and facilities engineering.

The course will give an overview of the responsibilities of the production engineer in oil and gas exploration. It describes the conventional extraction activities around the well.

**Course Objectives**

The objectives of the course are to:

1. describe various operations and equipment used in subsurface completion;
2. explain the inflow-outflow relationship and implications on the life of the well;
3. enumerate various basic concepts in the artificial lifting of oil;
4. explain the concept of formation damage, and identify its sources, implications and remedies;
5. explain the use of Nodal Analysis software in petroleum production;
6. explain the various methods for treating oil and gas;
7. demonstrate how to solve metering problems and identify various problems associated with flow measurement;
8. demonstrate how to calculate the size of vertical and horizontal separators;

**Learning Outcomes**

Having completed this course, students will be able to:

1. list at least three (3) operations and equipment required for subsurface completion;
2. describe the effect of the inflow-outflow relationship on the life of the well;
3. identify at least four (4) basic concepts in the artificial lifting of oil;
4. identify types of formation damage, their sources, implications and remedies;
5. solve vertical lift performance problems in at least two (2) types of well using Nodal Analysis software;
6. list at least three (3) methods for treating oil and gas;
7. describe at least two (2) problems associated with flow measurement and their solutions;
8. calculate the size of a vertical and horizontal separator;

**Course Contents**

Subsurface operations: Operational functions and output of subsurface production engineer. Nodal analysis in flow and outflow performances: Governing equations. Inflow performance relationship (IPR). Productivity index. Formation damage. Fines migration and skin effect. Vertical lift wellhead equipment performance and pressure losses. Choke performance. Problems in wells analysis: Sand. Water. Hydrate. Scale. Unstable flow. Surge. Waxy crude production. Surface operation: Gas treatment: Acid gas sweetening. Dehydration. Glycol dehydration. Oil treating: Dehydration. Water/oil emulsion resolution. Emulsion and demulsification. Metering of oil and gas: Meter proving. Storage facilities. Strainers. Deaerator. Lease Automatic Custody Transfer (LACT). Multi-stage-separation: Separator classification. Separator sizing. Flash calculation. Produced water management. Oil treating considerations. Water treating considerations.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH 562: Petroleum Processing and Petrochemical, (2 Units; Elective; L = 30)**

**Senate-Approved Relevance**

Petroleum products include transportation fuels, fuel oils for heating and electricity generation, asphalt and road oil, and feedstocks for making the chemicals, plastics, and synthetic materials that are in nearly everything we use. Petroleum is a part of many chemicals and medicines and is used to make crucial items such as heart valves, contact lenses, and bandages. Oil reserves attract outside investment and are important for improving countries' overall income. So, it is the mission of the university to train high-quality graduates who are highly skilled and knowledgeable in the design, construction, and maintenance of processes and systems of petroleum refining and the by-products referred to as petrochemicals and agree with the mission to address energy challenges in producing chemical engineering, graduates, that will be able to explore and process petroleum.

**Course Overview**

Petroleum Processing and Petrochemical are vital to meeting the energy demands of our country. The design of the system and process where petroleum products are produced is important to a chemical engineer. The petroleum industry, also known as the oil industry or the oil patch, includes the global processes of exploration, extraction, refining, transportation (often by oil tankers and pipelines), and marketing of petroleum products. The largest volume products of the industry are fuel oil and gasoline (petrol). The heavy by-products are also important. This highlights the importance of preparing students in chemical engineering with the knowledge and skills on how to design systems and processes of petroleum refining and petrochemicals.

This course is designed to expose students to various techniques involved in Petroleum Processing and Petrochemical production. The importance of the course lies in meeting the need for conversion of crude oil to end products that consist of the different products obtainable from crude oil. The objectives of the course, learning outcomes, and contents are provided to address this need.

**Course Objectives**

The objectives of the course are to:

1. explain the geologic processes and conditions that lead to the formation of oil and gas deposits;
2. explain the chemistry of petroleum and the differences between various types of crude oil;
3. describe the Nigeria sweet crude petroleum assay (bonny light and Kolmani crude);
4. describe the process of crude oil distillation and primary refining, including the separation of different fractions of oil;
5. describe the process of heavy oil processing and oil blending, and their impact on the properties of oil;
6. describe the petrochemical processes used to produce specific products such as Adipic acid, nylon, PVC, Polypropylene, polyethene, and insecticides;
7. enumerate the challenges and strategies for planning a petrochemical industry for a developing country;
8. explain the economic and environmental impact of the petrochemical industry and the challenges related to sustainable development;

**Learning Outcomes**

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

1. list at least two (2) tools and techniques used in each of the processes of oil exploration, drilling and production;
2. describe at least 2 effects of catalytic and thermal cracking on the properties of oil;
3. describe at least two (2) petrochemical feedstocks and their uses in the production of different chemical products;
4. list at least four (4) relevance of non-oil fossil fuels to the petrochemical industry;
5. describe at least three (3) stages of development of oil and gas production;
6. draw a process flow diagram for the production of polypropylene;
7. list at least four (4) challenges to establishing a petrochemical industry in a developing nation;
8. list two (2) environmental impact of the petrochemical industry and their challenges related to sustainable development;

**Course Contents**

Origin of oil and gas. Oil exploration drilling and production. Chemistry of petroleum. Crude oil distillation and primary refining. Catalytic and thermal cracking. Heavy oil processing. Oil Blending. Petrochemical feedstocks. Products specification. Petrochemical process: Adipic acid, nylon, nylon-6-6. PVC. Polypropylene, polyethene, insecticides etc. The non-oil fossil fuel and their relevance to the petrochemical industry. Models of crude oil distillation. Refining. Planning the petrochemical industry for a developing country. Design and simulation of modular refinery. Economic and environmental impact of the petrochemical industry. Mitigation plans for environmental pollution

**Minimum Academic Standards**

Chemical Engineering laboratory with NUC-MAS requirement facilities.

**BUK-TCH563: Coal Processing (2 Units; Elective; L = 30; P = 0)**

**Senate-Approved Relevance**

This course seeks to train high-quality graduates who are drivers of sustainable consumption and production policy of the United Nation Policy on Environment as it relates to coal processing in Nigeria. The relevance of this course is seen in chemical engineering students who seek an internship or job placement in the coal processing industries. The course prepares students to be able to develop strategies/approaches/systems that guarantee a cleaner environment during coal processing.

**Overview**

Environmental issues related to coal processing are multifaceted and are threatening the sustainability of the use of coal for power generation and gasification in Nigeria. This course highlights the importance of preparing students in Chemical Engineering with the knowledge and skills on how to appraise the quality of coal based on its rank, origin and property. Furthermore, this course is designed to provide future chemical engineers with the ability to analyse and evaluate the environmental issues associated with the various methods of coal processing. In addition, this course will build the competency of students to proffer solutions to minimizing the negative environmental impact caused by coal processing. Finally, this course will contribute to the realization of the United Nation Sustainable Development Goal 5 which seeks to promote sustainable consumption and production patterns.

**Course Objectives**

The objectives of the course are to:

1. describe the process of a coal formation;
2. distinguish between the different ranks/types of coal;
3. explain the commonly used unit operations for coal processing;
4. describe the effect of the quality of coals based on its physical and chemical properties;
5. enumerate the possible utilizations of products (solid, liquid and gas) of coal processing;
6. describe the environmental issues associated with coal processing;
7. explain strategies/approaches to guarantee a cleaner environment during coal processing.

**Learning Outcomes**

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

1. list two (2) constituents and four (4) properties of coal;
2. list differences between any three (3) types of coal;
3. describe five (5) commonly used unit operations in coal processing;
4. list four (4) qualities of each of three (3)types of coals based on their physical and chemical properties;
5. list the three (3) common products from coal processing and their uses;
6. describe five (5) environmental issues associated with coal processing;
7. describe at least four (4) strategies to guarantee a cleaner environment during coal processing.

**Course Contents**

Origin and formation of coal. Constituents of coal. Important properties of coals. Classification of coal. Rank of coal. Coal processing: Fundamentals of coal carbonization. Combustion. Pyrolysis. Co- pyrolysis with biochar. Gasification and liquefaction. Separation. Catalyst/catalytic reactions. Coal utilization: Products from carbonization (solid and volatile products). Chemicals and fertilizers from coal. Environmental aspects: Fly ash, SOx and NOx control strategies during combustion and after combustion. Product gas cleaning and energy utilization. Removal of H2S, NH3, tar, and suspended particulate matter.

**Minimum Academic Standards**

Chemical Engineering laboratory with NUC-MAS requirement facilities

**BUK-TCH564: Sugar Technology (2 Units; Elective; LH= 30)**

**Senate-Approval Relevance**

Sugar technology is a course that is designed to focus on the production, refinement and packaging of sugar from sugar cane and sugar beet and create skill manpower that can drive the technology of sugar production in Nigeria. This course is designed to familiarize the students with the chemical and physical properties of sugar and to give concepts of sugar production technology, its quality and by- products.

**Course Overview**

Sugars are caloric, sweet-tasting compounds that occur widely in nature, including fruits, vegetables, honey, and human and dairy milk. Humans are born with the desire or preference for sweet taste. The presence of lactose (a type of naturally occurring sugar in milk) in breast milk helps ensure that this primary source of nutrition for infants is palatable and acceptable. Chemically and with respect to foods, sugars are monosaccharide or disaccharide carbohydrates, which impart a sweet taste.

This course intends to focus on the principle of technology for the production of sugar from its various sources

**Course Objectives**

The objectives of the course are to:

1. describe the basic processes flow charts in the production of sugar;
2. describe all the detailed sugar manufacturing process and refining;
3. describe how the ascertain the quality of sugar;
4. describe the basic chemistry of sugar including types of sugar, structure and their properties
5. describe the raw materials, intermediate and final products of sugar production;
6. describe the sugar production by-products and management strategies;
7. explain the economic challenges to the growth of the sugar industry in Nigeria;

**Learning Outcomes**

Having completed this course, students will be able to:

1. describe five (5) unit operations in raw sugar manufacturing;
2. describe four (4) basic unit operations in sugar refining;
3. list four(4) quality properties of sugar;
4. describe the sugar structures, types and their properties;
5. list at least two (2) raw materials, intermediate and final products of sugar production;
6. describe two (2) economic applications of sugar by-products;
7. describe two (2) economic challenges in the sugar industry in Nigeria;

**Course Content**

Sugar industry in Nigeria. Sugar worldwide view. Sugarcane and Sugar Beet: Production quality. Indigenous Technology for Small-Scale Sugar Production. Raw Sugar Manufacturing: Unit operations. Juice extraction. Purification. Heating. Evaporation. Crystallization, crystallization in motion. Refining: Affination. Clarification. Decolourisation. Crystallization. Centrifugation. Drying. Bagging, Storage. Factors affecting sugar processing. Quality criteria: Raw and refined sugar. Specialty Sugar Products: Brown or soft sugar. Liquid sugar. Sugar industry by-products and their uses. Sugar Chemistry, Sucrose: Structure, physical & chemical properties. Uses of sucrose. Food applications. Feedstock for chemical synthesis. Fermentation feedstock. Pharmaceutical applications, nutrition & health aspects and metabolism of sucrose. Sugar Analysis: standards & definitions. Physical methods of sugar analysis. Polarimetry. Refractive index. Colourimetric methods. Enzymatic methods. Chromatographic methods. NIR, determination of other components. Moisture, ash & inorganic constituents. Particle size distribution, insoluble matter

**Minimum Academic Standard**

Standard laboratory for sugar production and analytical lab for testing and property determination following CCMAS

**BUK-TCH565: Pulp and Paper Technology ( 2 Units; Elective; L = 30; P =0)**

**Senate-Approved Relevance**

The pulp and Paper Technology course enables students to understand the process of manufacturing paper. Knowledge of pulp and paper technology is applied to various fields. Publishing houses, newspaper agencies and many others employ people from this field in their companies. Pulp and Paper Technology is not as simple as it is made to believe. Hence the students are given a strong foundation in chemical engineering and the basic sciences. As the pulp and paper technology course is industry oriented, the students are given sufficient exposure. The course, pulp and paper technology also ensure that the students are up to date with the technology.

**Overview**

Pulp and paper mills are highly complex and integrate many different process areas including wood preparation, pulping, chemical recovery, bleaching, and papermaking to convert wood to the final product. Processing options and the type of wood processed are often determined by the final product.

Pulp-making can be done mechanically or chemically. The pulp is then bleached and further processed, depending on the type and grade of paper that is to be produced. In the paper factory, the pulp is dried and pressed to produce paper sheets. Post-use, an increasing fraction of paper and paper products is recycled.

The pulp and paper industry is very diversified, using many types of raw materials to produce very different kinds of paper by different methods in mills of all sizes. Pulp and paper are manufactured from raw materials containing cellulose fibres, generally wood, recycled paper, and agricultural residues.

**Course Objectives**

The objectives of the course are to:

1. describe the fundamentals of pulp and paper manufacturing;
2. describe the basic raw materials in pulp and paper making and their preparation;
3. describe the basic chemical recovery processes in pulp and paper production;
4. describe the unit operations of the pulping process;
5. describe the basic techniques involved in pulp treatment;
6. describe the unit operations involved in paper making;
7. describe various types of paper finishing operations;
8. describe various quality characteristics of the paper.

**Learning Outcomes**

Having completed this course, students will be able to:

1. list at least four (4) important constituents of wood;
2. list and describe at least three (3) operations involved in wood handling;
3. describe the following: bagasse handling, recovery of secondary fibre and de-inking of secondary fibre;
4. list and describe at least four (4) operations involved in pulping processes;
5. describe these two terms: pulp bleaching and pulp washing;
6. draw a flow diagram of paper making process;
7. describe at least three (3) processes involved in paper finishing;
8. list at least two (2) each of the physical and chemical properties of paper.

**Course Contents**

Introduction: Present status of pulp and paper manufacture. Fibrous raw materials. Wood composition. Fibre chemistry. Overview of paper manufacturing. Paper Properties: Physical (optical, strength, and resistance). Chemical and electrical properties. Paper defects. Variables affecting paper properties. Raw Material Preparation: Debarking. Chipping. Chip screening. Storage. Pulping: Chemical, Semi- chemical. Mechanical, Chemi-mechanical. Non-conventional, Secondary fibre pulping. Advances and recent trends in pulping. Chemical Recovery: Composition and properties of black liquor. Oxidation and desilication. Concentration of black liquor and its incineration. Causticizing and clarification. Sludge washing and burning. Bleaching: Objectives of bleaching. Bleachability measurement. Bleaching chemicals and their production. Single and multi-stage bleaching processes. Bleaching of chemical and mechanical pulp. Colour reversion of bleached pulp. Control procedures in bleaching. Biobleaching. Recent trends in bleaching technology. Water reuse and recycle in bleaching. Pulp Processing: Deknotting. Defibering. Brown stock washing. Screening. Cleaning. Thickening. Blending. Beating and refining. Specific edge load concept in refining. Papermaking: Approach flow system. Wire part. Sheet-forming process. Sheet transfer mechanism. Press part. Theory of pressing. Dryer part. Paper drying process. Calendaring. Cylinder mould machine. Finishing. Fibre recovery systems. Recent developments in paper making. Coating and lamination. Biotechnology Applications in Pulp and Paper Making: Use of enzymes in debarking. Pulping. Bleaching. Pulp refining. Fibre modification. Improving fibre drainage. Biopulping. Effluent treatment for xenobiotic compounds.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH 566: Cement and Cement Technology, (2 Units; Elective; L = 30; P = 0)**

**Senate-Approved Relevance**

Cement is mainly used as a binder in concrete, which is a basic material for all types of construction, including housing, roads, schools, hospitals, dams and ports, as well as for decorative applications (for patios, floors, staircases, driveways, pool decks) and items like tables, sculptures or bookcases. Cement provides support for housing, highway infrastructure, medical centres, hospitals, buildings and roadways. So far as the growth and survival of human societies are concerned, concrete is an essential component. Training of high-quality graduates who are highly skilled and knowledgeable in the design, construction, and maintenance of processes and systems that produces cement in Nigeria is in agreement with the mission of the University in addressing the housing deficit in Nigeria.

**Overview**

The study of Cement and Cement technology is vital to every housing development. Construction project uses concrete in one form or another. It keeps us warm and safe; it allows us to get to work safely; it beautifies our homes and yards. Our environment matters. Concrete is produced from some of the world's most abundant resources and without toxic by-products. This highlights the importance of preparing students in chemical engineering with the knowledge and skills on how to design systems for producing cement.

This course is designed to expose students to various techniques involved in cement production. The importance of the course lies in meeting the need of the building industry. The objectives of the course, learning outcomes, and contents are provided to address this need.

**Course Objectives**

The objectives of the course are to:

1. explain the chemical engineering principles used in cement processing;
2. describe the raw materials used in cement production;
3. describe the production of clinker and cement;
4. describe the environmental impacts associated with cement production;
5. explain the mitigation processes of the environmental pollution associated with production;
6. explain the role of cement in carbon sequestration;
7. describe the bagging and storage of cement.

**Learning Outcome**

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

1. list five (5) chemical engineering principles used in cement processing;
2. list four (4) raw materials used in cement production;
3. describe the difference between clinker and cement;
4. describe two (2) environmental impacts associated with cement production;
5. describe (two) the mitigation processes for the environmental pollution associated with production;
6. list three (3) roles of cement in carbon sequestration;
7. describe four (4) stages in the bagging and storage of cement.

**Course Contents**

Introduction to Cement chemistry. Raw materials for cement production. Composition of cement raw mix. Sintering and chemistry of sintering. Transport, Separation, thermodynamics and reaction processes in Cement production. Technology of production of clinker and cement. Process Flow diagrams. Types of cement. Hydration of cement. Reactions of cement with gases, liquids and solids. Production of blended cement. Areas of utilization. Role of cement in carbon sequestration. Environmental impact of cement production. Mitigation processes and strategies. Design of equipment used in cement production. Bagging of cement. Storage of cement.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH567: Polymer Science and Engineering (2 Units; ELE LH= 30)**

**Senate-Approved Relevance**

In the 21st century, we are surrounded by different types of things or structures that are made by different types of polymer products such as plastic, moulded material, synthetic fibres, rubbers, etc. The use of all these polymer products is increasing day by day. The requirement for eco-friendly and recyclable plastic and proper management of polymer products is also rising at the same time. This job is done by Chemical/ Polymer Engineers. They use the principles of plant design, process design, thermodynamics, and transport phenomena to develop new products. Consequently, the importance of Chemical Engineering or Polymer Engineering as a viable career option has increased many times. So the need for graduates with requisite educational qualifications and other necessary skills is in line with the senate-approved goal of training high-quality graduates that can navigate the emerging dynamic, economic-volatile and technology-driven world through competence, creativity, competitiveness and character.

**Overview**

Polymer Engineering is a broad concept and its applications can be observed in industries such as Petrochemical, Packaging, Sports, Pharmaceuticals, Perfumes and Preservatives, Plastic Materials etc. This field of Engineering is likely to grow in the future days.

This course describes major polymers, the structures of different polymers, the relations between their properties, and their applications.

**Course Objectives**

The objectives of the course are to:

1. describe the meaning of polymer engineering and its scope;
2. describe various types of polymers, properties and structures;
3. describe various forms of polymer processing and their end products;
4. explain how various forms of processing impact the polymer properties;
5. describe various methods used in the characterization of polymer products;
6. explain the various forms of application of polymer products;
7. Identify various forms of polymer modification to enhance properties.

**Learning Outcomes**

Having completed this course, students will be able to:

1. describe two (2) techniques of polymer synthesis;
2. list at least two (2) types of polymer and their properties;
3. describe at least five (5) unit operations used in polymer processing;
4. describe at least two (2) effects of polymer structures on its properties;
5. describe two (2) effects of rheology on the performance of a polymer;
6. list five (5) applications of polymer products;
7. describe two (2) importance of blends and composite materials

**Course Contents**

Application of engineering fundamentals to the preparation and processing of polymers with emphasis on the relationship between polymer structure and properties. Polymer synthesis techniques. Characterization of molecular weight. Crystallinity. Glass transition. Phase behaviour. Mechanical properties. Visco-elasticity. Survey of polymer processing operations with emphasis on the application of polymer rheology and transport phenomena to predict performance, including polymer rheology a nd constitutive equations, mixing, extrusion, injection moulding, coating flows, fibre spinning, film blowing, blow moulding, compression moulding, thermoforming and composites processing

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH568: Fermentation Technology (2 units; Elective; L = 30)**

**Senate-Approved Relevance**

Fermentation is the natural way of salvaging waste food and improving vitamins, essential amino acids, anti-nutrients, proteins, food appearance, flavours and enhanced aroma. This increases the range of raw materials available as food. Fermentation also helps in the reduction of the energy needed for cooking as well as making a safer product. This course shall equip the students in the area of processing via the fermentation process.

**Overview**

This Fermentation Technology course is designed for students interested in learning about biological processes and fermented products. The course will equip students with the principles of fermentation technology (e.g. the processes of fermentation, fermentation types and fermentation design), microbial growth kinetics and selection of potential microbes used in industry and principles of major methods for industrial fermentation product recovery and purification. A part of the course will also introduce some products (biofuels, food and pharmaceutical substances) produced by using fermentation technology.

**Course Objectives**

The objectives of the course are to:

1. explain the processes of fermentation;
2. describe various types and characteristics of industrial microorganisms used for fermentation;
3. explain the advantages and disadvantages of the common methods used for microbial growth measurements;
4. explain the advantages and disadvantages of different fermentation modes ;
5. describe the factors affecting fermentation processes;
6. describe the major methods used for product recovery and purification in industrial fermentation;
7. explain the limitations of the applications of fermentation technology in various fields.

**Learning Outcomes**

Having completed this course, students will be able to:

1. describe the purpose and step-by-step processes of fermentation;
2. list four (4) types of industrial microorganisms and their characteristics;
3. list two (2) advantages and disadvantages of the two (2) methods used for microbial growth measurements;
4. list two (2) advantages of batch fermentation over continuous modes;
5. Identify four (4) factors affecting fermentation processes and propose a strategy for product enhancement;
6. list two (2) major methods used for product recovery and purification in industrial fermentation;
7. describe two (2) limitations on the applications of fermentation technology pharmaceutical science.

**Course Content**

Introduction: Fermentation. Types of fermentations. Role of microorganisms and other conditions on fermentation. Raw Materials for fermentative production of alcohol: Molasses- Composition. Storage. Spontaneous combustion. Grades and classification of molasses. Clarification of molasses. Other Saccharine Materials: Cane juice. Beet juice. Sweet sorghum. Manhua flowers. Fruits’ juices. Starchy and Cellulosic Materials. Isolation and purification of cultures. Outline of alcohol production by batch fermentation process. Alcohol production by continuous fermentation process. Modern Techniques of Fermentation: Batch. Semi-continuous. Continuous (Biostil, Multicont or Cascade, Encillium). Melle- Bionet process of yeast Cell Recycling. Bacterial Fermentation & immobilised Cell Technique. etc. Production of industrial and power alcohol by azeotropic distillation. Membrane technology and molecular sieves. Production of grain spirit. Chemical control. Theoretical Yield. Fermentation & Distillation. Efficiency, etc. including calculation.

**Minimum Academic Standards**

Same with NUC-CCMA requirement facilities

**BUK-TCH 569: Fertilizer Science and Technology (3 Units Elective: LH 45)**

**Senate-approved relevance**

Northern Nigeria is blessed with arable land and most of its population are farmers. Knowledge of fertilizer technology is essential for any engineering student who would like to contribute to this sector of the Nigerian economics. This course is set to ginger young engineers to knowing the basic sciences and technology of fertilizer production. This is in line with BUK’s mission and vision of producing high-quality graduates that are well-skilled and knowledgeable.

**Overview**

The importance of fertilizer in agriculture cannot be over emphasized. The course aims to provide good understanding of the basics of macro-and micronutrient, types of fertilizers in agriculture, calculation and application, manufacture, as well as chemical and physical methods of assessing the quality of fertilizer materials.

**Learning Objectives**

The objectives of this course are to:

1. understand the history of fertilizer consumption.
2. appreciate the importance of fertilizers in agriculture
3. introduce the science of fertilizer production
4. know the compositions of the different macro-and micro-nutrient fertilizer sources
5. explain the various methods of fertilizer application to crops.
6. get the principle of fertilizers production/manufacture.

**Learning Outcomes**

1. At the end of the course, student should be able to:
2. define basic fertilizer terminologies and explain their meaning.
3. state the importance of fertilizers in agriculture.
4. give an elaborate history of fertilizer consumption.
5. state the compositions of the different macro-and micro-nutrient fertilizer sources
6. calculate fertilizer requirement of different crops.
7. state and explain the various methods of fertilizer application to crops.
8. describe process of fertilizers production/manufacture.
9. ascertain the quality of fertilizers using chemical and physical methods.

**Course Content**

History of fertilizer consumption. Types of fertilizers and sources. Role of fertilizers in integrated soil fertility management. Fertilizer content calculations. Factors effecting fertilizer use. Methods of fertilizer application. Fertilizer production processes.

**BUK-TCH 570: Introduction to Electrochemical Engineering (3 Units Elective: LH 45)**

**Senate-approved relevance**

As the world begins to transits from fossil fuel to a low carbon-intensive energy source, driven by the need to reduce global warming and other catastrophic climate change, chemical engineering graduates most be adequately prepared to proffer effective solutions to the anticipated challenges. This course is set provide the fundamentals of the requirement of decarbonizing the chemical industry. This is in line with BUK’s mission and vision of producing high-quality graduates that are well-skilled and knowledgeable.

**Overview**

The purpose of this course is to introduce students to knowledge required of a modern chemical engineering graduate, where climate change action recommends electrification of chemical processes so as to reduce carbon emission.

Production of ozone, chlorine, caustic soda and hydrogen have already been electrified. Other carbon-heavy processes are yet to be. It is therefore intended that, this course will spark interest in students to go into research & development of electrolytic reactors/cells, design of electrochemical process plant and battery technology.

**Objectives**

The objectives of the module are to ensure understanding of

1. Electrochemical systems fundamentals
2. The application of thermodynamics and transport phenomena to electrochemical systems
3. The working principles of fuel cells, electrolytic cells and batteries
4. Application of electrochemical systems to renewable energy and chemical transition

**Learning Outcomes**

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

1. describe basic concept of the electrochemical systems
2. solve mass transfer and energy balances problems of electrochemical systems
3. describe the working principles and fundamental characteristics of fuel cells, electrolytic cells and batteries
4. describe the importance of electrochemical systems to energy transition

**Content**

Basic concept: Electrolytic cell vs galvanic cell, Faraday’s law. Current density, electrode potential and current efficiency, cell voltage. Nernst equation, thermodynamic principles of electrochemical cells, polarization, electrochemical reactions and series etc. Introduction to mass transfer and energy balances of electrochemical systems. Introduction to electrochemical reaction systems: Fuel cell (working principle) and electrolytic cells (working principle). Introduction to electrolytic reactor design and selection. Introduction to batteries: Working principles, types (primary, secondary) fundamentals of charge-discharge system. Electrochemical systems and climate change