ADDITIONAL MINIMUM CHEMICAL ENGINEERING CORE CURRICULUM AND MINIMUM ACADEMIC STANDARDS FOR THE NIGERIAN UNIVERSITIES (CCMAS)

NIGERIAN SOCIETY OF CHEMICAL ENGINEERS (NSChE)

MARCH 2023

1.0 PREAMBLE

The National Universities Commission (NUC) launched a new document for minimum academic standards in Nigerian Universities on December 5, 2022. It is called Core Curriculum and Minimum Academic Standards (CCMAS). It contains 70% of the course requirements for graduation by any student in a particular programme in a Nigerian University, while the remaining 30% is expected to be developed by each programme to reflect their respective uniqueness. However, the development of this 30% CCMAS by the respective programme (such as B.Tech, B.Sc., B.Eng. Chemical Engineering) is to follow the format and process already sanctioned by the NUC.

In response to this demand by the NUC, the Council for the Regulation of Engineering in Nigeria (COREN) called a virtual meeting of all stakeholders in Engineering Education in Nigerian Universities on January 12, 2023. The meeting focussed on the appraisal of the content of CCMAS in relation to the recently launched programme accreditation instrument by COREN called Outcome Based Education Benchmark Minimum Academic Standards (OBE-BMAS). It was recommended from the meeting that each sub-sector of the Engineering profession in Nigeria should constitute a working group to review the 70% CCMAS already approved. The group should also come up with generally acceptable academic content for the 30% CCMAS to address the perceived gap in the 70% CCMAS bearing in mind the OBE-BMAS and NUC requirements for the 30% CCMAS.

Also, the Nigerian Society of Chemical Engineers, through its Education and Research Sectoral Group (E&RSG), constituted a seven-man Technical Working Group to appraise the content of the published 70% NUC CCMAS and the COREN response to the NUC 70% CCMAS.

2.0. REVIEW OF THE 70% CCMAS AND FINDINGS

The following are the findings of the E&RSG on the 70% CCMAS for the Chemical Engineering programme as contained on pages 193 -227:

i. that the concept of the CCMAS aimed at reducing the workload of students by reducing general courses, especially in humanities as well as creating niche areas for each programme based on the university mission is noble and laudable;
ii. that the graduation requirements for the award of an honours degree in Chemical Engineering are as follows:
    a. candidates admitted through the UTME mode shall have registered for a minimum of 150 and a maximum of 180 units of courses during the 5–year engineering degree programme. Such candidates shall have spent a minimum of ten academic semesters;
    b. candidates admitted through the Direct Entry mode shall have registered for a minimum of 120 and a maximum of 150 units of courses during a 4–year engineering degree programme. Such candidates shall have spent a minimum of eight academic semesters;
    c. the minimum and maximum credit load per semester is 15 and 24 credit units respectively;
    d. a student shall have completed and passed all the courses registered for, including all compulsory courses and such elective/optional courses as may be specified by the university/faculty or department; obtained a minimum Cumulative Grade Point Average (CGPA) specified by the university but not less than 1.00; and
    e. a student shall also have earned the 15 credit units of the Students Industrial Work Experience Scheme (SIWES), 8 credit units of University General Study courses and 4 credit units of Entrepreneurship courses.

iii. that the approved 70% CCMAS has a total of 120 units comprising 105 units (compulsory) and 15 units (Elective) leaving 45 units for the individual Universities;

iv. that the six(6) courses designated as **"ELECTIVES"** as pointed out in (iii) above are core Chemical Engineering courses whose status should be made "compulsory" and they include:

a. TCH202 – Material Science	3 units	Elective
b. TCH303 – Separation Processes I	2 units	Elective
c. TCH304 – Process Instrumentation	2 units	Elective
d. TCH402 – Chemical Reaction Engineering	3 units	Elective
e. TCH404 – Plant Design and Economics	3 units	Elective
f. TCH405 – Process Control	2 units	Elective

v. that some basic core courses in Chemical Engineering are not included in the 70% CCMAS and also that the credit loads have been reduced even with increased course contents where two or more courses have been totally or partly merged;

vi. that the course content of TCH206 (Statistics for Chemical Engineers) in terms of expected topics is not concisely spelt out in line with the outcome-based content that NUC is promoting;

vii. that the course codes assigned to three courses (i.e TCH402, TCH404 and TCH406) in the 400 level do not comply with the CCMAS rule of course coding as enumerated on page 27 (definition of course system). Since SIWES III (TCH499) is slated for 2nd semester, all the courses at this level should be odd numbers;

viii. that GET501 is tagged Engineering Management on the course structure (page 198) while in the content section on page 222, it is Engineering Project Management (the content confirms this);

3. REVIEW OF COREN RESPONSE ON THE 70% CCMAS

3.1 COREN Response to 70% CCMAS

To meet COREN BMAS requirements, the following courses were required by COREN to be added within the 30% CCMAS window for Chemical Engineering:

a. List of 100 level courses to be added from Science CCMAS of NUC

MTH 103 – Elementary Mathematics III (Vectors, Geometry and Dynamics) – 2 units
*PHY 102 – General Physic II (Electricity and Magnetism) – 2 units
PHY 104 – General Physic IV (Vibration, Waves and Optics) – 2 units
STA 112 – Probability I – 3 units

* *Note that the correct Course Code for the Physics Course titled "Behaviour of Matters" is PHY 103 and **NOT** PHY 102 as wrongly put in the NUC CCMAS for 28 out of the 29 Engineering degree programmes.*

b. List of 200 Level courses to be added from Engineering and Technology CCMAS of NUC

GET 201– Applied Electricity I – 3 units
GET 202– Engineering Materials – 3 units
GET 203– Engineering Graphics and solid modelling – 3 units

c. List of 300 Level courses to be added from COREN BMAS

GET 3xx – Engineering Economics – 3 units (LH 45)

d. List of 500 Level courses to be added from COREN BMAS

GET 5xx – Engineering Management – 2units (LH 30)

3.2 Observations on the COREN Response to 70% CCMAS

It is observed that:

i. some of the listed courses in Section 3.0 are already captured in some CCMAS courses while others are not considered necessary for Chemical Engineering programmes as already pointed out during the COREN virtual meeting on January 12, 2023. These include :
   a. STA 112 is already captured in TCH206
   b. GET 202 is already captured in TCH202
   c. GET203 is not considered necessary for Chemical Engineering students as all that is required is already included in GET102;
   d. GET3xx is already captured by TCH404
   e. GET5xx is already sorted by GET501

ii. based on (ii) above the following four (4) courses should be included as part of the 30% CCMAS: MTH103 (2 units), PHY102/PHY103(2 units), PHY104 (2 units), and GET201(3 units) units),

iii. from industry point of view, the following additional two (2) courses should be included: GET207 (3units), GET208 (3units);

iv. the total units would now be 15 units.

4.0 Chemical Engineering Minimum CCMAS

Chemical engineering finds commercial applications in diverse areas such as energy, food, water, medicine, and manufacturing. Hence, its curriculum must include some fundamental courses for the programme to produce graduates that meet the needs of today's and future process industries. Thus, in line with international best practices, the core chemical engineering courses listed in Table 1 must be offered by all chemical engineering departments in Nigeria. The course contents for these courses are given in Section 7.

Table 1: List of Additional Core Chemical Engineering Courses

Course Code	Course Title	Preq	Status	LH	PH	Units
	200 LEVEL					
TCH202	Material Science for Chem Engrs		CU	45	0	3
TCHxxx	Engineering Chemistry 1		CU	45	0	3
	300 LEVEL					
TCH303	Separation Processes I		CU	45	0	2
TCHxxx	Transfer Processes II		CU	30	0	2
TCHxxx	Particulate Systems		CU	30	0	2
TCHxxx	Chem. Engrng Lab II		CU	0	45	1
TCHxxx	Engineering Chemistry 2		CU	45	0	3
	400 LEVEL					
TCH402	Chemical Rxn Engrng		CU	45	0	3
TCH404	Process Design & Economics		CU	45	0	3
TCH405	Process Control		CU	30	0	2
TCHxxx	Separation Processes II		CU	30	0	2
TCHxxx	Chemical Engineering Laboratory III		CU	0	45	1
	500 LEVEL					
TCH304	Process Instrumentation		CU	30	0	2
TCHxxx	Process Safety & Loss Prevention		CU	30	0	2
TCHxxx	Environmental Pollution Control		CU	30	0	2
	TOTAL					**33**

5.0 University Specialty Courses

In view of the diverse nature of Chemical Engineering, NSChE recommends that each University should include four (4) university speciality core courses of 2 units each and two elective courses of 2 units each thus making the total of 12 units.

6.0 Summary

The course structure including the NUC 70%, COREN requirement and NSChE requirement is shown in Table 2. Thus, the minimum graduation requirement for chemical engineering programme shall be 165 units; the details are given in Table 3.

Table 2. Course structure for Chemical engineering

	COURSE CLASSIFICATIONS	100L	200L	300L	400L	500L	TOTAL
1	NUC Compulsory Course (CN)	27	26	19	5	13	90
2	COREN Required Courses (CR)	6	3	6	-		15
3	University Compulsory Courses(CU)	-	6	10	11	6	33
4	NUC SIWES Requirement (SN)	---	3	4	8	0	15
5	University Specialty Courses (US)	---	---	---	---	8	8
6	Electives	---	---	---	---	4	4
		33	**38**	**39**	**24**	**31**	**165**

Table 3: Course Structure Details

100 Level

GST111	Communication in English	CN	2
GST112	Nigerian People & Culture	CN	2
GET101	Engineer in Society	CN	1
GET102	Engineering Graphics	CN	2
GET204	Workshop Practice	CN	2
CHM101	General Chemistry I	CN	2
CHM102	General Chemistry II	CN	2
CHM107	Gen. Practical Chemistry I	CN	1
CHM108	Gen. Practical Chemistry II	CN	1
MTH101	Elem. Maths I	CN	2
MTH102	Elem. Maths II	CN	2
MTH103	Elem. Maths III	CR	2
PHY101	General Physics I	CN	2
PHY102	General Physics II	CN	2
PHY103	General Physics III	CR	2
PHY104	General Physics IV	CR	2
PHY107	Gen. Practical Physics I	CN	1
PHY108	Gen. Practical Physics II	CN	1
TCH101	Intro. To Chem Engrng	CN	2
			33

200Level

GST212	Philosophy, Logic & Human Existence	CN	2
ENT211	Entrepreneurship & Innovation	CN	2
GET201	Applied Electricity	CR	3
GET205	Fundamentals of Fluid Mechanics	CN	3
GET206	Fundamentals of Thermodynamics	CN	3
GET209	Engineering Mathematics I	CN	3
GET210	Engrng Mathematics II	CN	3
GET211	Computing & Software Engrng	CN	3
TCH201	ChemEngrng Fundamentals (Process Principles)	CN	3
TCH202	Material Sc for Chem Engrs	CU	3
TCH206	Statistics for Chem Engrs	CN	2
TCH301	Transfer Process I (Transfer Phenomenon I)	CN	2
TCHxxx	Engineering Chemistry 1 (Physical Chemistry)	CU	3
GET299	SIWES I	SN	3
			38

300Level

GST312	Peace & Conflict Resolution	CN	2
ENT312	Venture & Creation	CN	2
GET207	Applied Mechanics	CR	3
GET208	Strength of Materials	CR	3
GET304	Tech. Writing & Communication	CN	3
GET306	Renewable Energy Systems & Technologies	CN	3
GET307	Intro. To Art. Intelligence, Machine Learning & Convergent Technologies	CN	2
TCH302	ChemEngrng Thermodynamics	CN	2
TCH303	Separation Processes I	CU	2
TCH305	Chem. Engrng Lab I	CN	1
TCH307	Biochemical Engineering	CN	2
TCH308	Numerical Methods in Chem. Engrng	CN	2
TCHxxx	Transfer Processes II (Transfer Phenomena II)	CU	2
TCHxxx	Particulate Systems	CU	2
TCHxxx	Chem. Engrng Lab II	CU	1
TCHxxx	Engineering Chemistry 2 (Organic & Analytical Chemistry)	CU	3
GET399	SIWES II	SN	4

400Level

TCH401	Chemical Product Design	CN	3
TCH402	Chemical Rxn Engrng	CU	3
TCH404	Process Design & Economics	CU	3
TCH405	Process Control	CU	2
TCH406	Process Modelling & Simulation	CN	2
TCHxxx	Separation Processes II	CU	2
TCHxxx	Chem. Engrng Lab III	CU	1
GET499	SIWES III	SN	8
			24

500Level

GET501	Engineering Management	CN	3
GET502	Engineering Law	CN	2
TCH304	Process Instrumentation	CU	2
TCH501	Process/Plant Design	CN	4
TCHxxx	Process Safety & Loss Prevention	CU	2
TCHxxx	Environmental Pollution Control	CU	2
TCHxxx	University Course I	US	2
TCHxxx	University Course II	US	2
TCHxxx	Elective Course I	E	2
TCHxxx	University Course III	US	2
TCHxxx	University Course IV	US	2
TCHxxx	Elective Course II	E	2
TCH555	Chem. Engrng Research Project	CN	4
			31

Key

CN NUC Compulsory Course
CR COREN Required Courses
CU University Compulsory Courses
SN NUC SIWES Requirement
US University Courses
E Electives

7.0 Course Contents for Chemical Engineering Core Courses

TCH xxx: Engineering Chemistry I (3 Units; Compulsory; L = 45; P = 0)

Overview

This module introduces the fundamentals and principles of Physical Chemistry, Chemical Thermodynamics, Chemical Kinetics, and Surface Chemistry in order to provide students with a solid foundation in the fundamental principles of chemistry and their application to chemical engineering. In Physical Chemistry, students will study the fundamental concepts and principles that govern the behaviour of matter at the molecular and atomic levels. Chemical Thermodynamics will introduce students to the laws of thermodynamics and their application to chemical systems. Chemical Kinetics will focus on the rates of chemical reactions and the factors that influence them while Surface Chemistry will cover the physical and chemical properties of surfaces and interfaces and their relevance to chemical engineering applications.

Objectives

The objectives of the course are to:

1. To provide students with an understanding of the fundamental principles and concepts of physical chemistry, including gas laws, thermodynamics, and electrochemistry.
2. To develop students' ability to apply physical chemistry concepts to real-world engineering problems.
3. To introduce students to the principles and applications of chemical thermodynamics, including heat and work, internal energy, and entropy.
4. To enable students to apply chemical thermodynamics to problems related to phase equilibrium, reaction equilibrium, and chemical processes.
5. To introduce chemical kinetics and reaction mechanisms, including rate laws and reaction order.
6. To introduce students to the principles of surface chemistry, including adsorption, colloids, and surface tension.
7. To develop students' ability to apply surface chemistry principles to solve problems related to heterogeneous catalysis, material synthesis, and corrosion.

Learning outcomes

Having completed this course, students will be able to:

1. Describe the fundamental principles of atomic theory, chemical bonding, the physical states of matter and the main features of the periodic table.
2. Perform calculations regarding molar quantities, solutions, stoichiometry, reaction rates, and the equilibrium state.
3. Link fundamental concepts in chemistry with applications in the engineering sphere.
4. Understand the principles of physical chemistry and apply them to solve problems related to chemical systems.
5. Apply the laws of thermodynamics to calculate thermodynamic properties of chemical systems and analyze the behavior of chemical reactions.
6. Analyze chemical kinetics and reaction mechanisms, and design reactors for various chemical processes.
7. Understand the fundamental concepts of surface chemistry and their applications in various industrial processes.
8. Develop practical skills through laboratory experiments and analyze experimental data.

Course Contents

States of matter and their properties, Thermodynamics and its applications, Phase equilibria and phase diagrams, Chemical equilibria, Electrochemistry. First law of thermodynamics and its applications, Second law of thermodynamics and its applications, Third law of thermodynamics and its applications, Chemical potential and its applications, Fugacity and activity coefficients. Reaction rates and rate laws, Rate constants and temperature dependence, Reaction mechanisms and their determination, Catalysis and its types, Enzyme kinetics. Surface tension and interfacial phenomena, Adsorption and its types, Colloids and their properties, Emulsions and their stability, Surfactants and their applications

TCH xxx: Engineering Chemistry 2 (3 Units; Compulsory; L = 45; P = 0)

Overview

In this course students will have a solid understanding of the fundamental concepts and principles in analytical chemistry, organic chemistry, inorganic polymers, and electrochemistry, and how they apply to the field of chemical engineering. They will be able to apply this knowledge to solve problems related to the design, synthesis, and characterization of chemical systems, as well as the analysis of chemical processes and products. Analytical Chemistry focuses on the principles and techniques of chemical analysis, including quantitative and qualitative analysis, chromatography, spectroscopy, and electrochemical analysis. Organic Chemistry covers the basic principles of organic chemistry, including the structure and reactivity of organic compounds, reaction mechanisms, and functional group chemistry. It also includes an introduction to biochemistry and the chemistry of natural products. Inorganic Polymers focuses on the synthesis, properties, and applications of inorganic polymers, including their classification, characterization, and processing. Electrochemistry covers the principles and applications of electrochemistry, including electrochemical cells, electrode reactions, electrochemical thermodynamics, and electroanalytical techniques.

Objectives

The objectives of the course are to:

1. To provide students with an understanding of analytical chemistry and its applications in engineering and industry.
2. To introduce students to organic chemistry and its relevance to chemical engineering processes.
3. To provide students with an understanding of inorganic polymers and their properties and applications.
4. To provide students with an understanding of electrochemistry and its applications in chemical engineering.
5. To develop the ability of students to apply the concepts and principles learned to solve engineering problems and design chemical processes

Learning outcomes

Having completed this course, students will be able to:

1. Apply analytical techniques to solve complex problems in chemical engineering.
2. Understand the principles of organic chemistry and its applications in chemical engineering.
3. Analyze the properties and applications of inorganic polymers in chemical engineering.
4. Demonstrate a deep understanding of electrochemistry and its relevance in chemical engineering.
5. Apply knowledge of engineering chemistry to design and optimize chemical processes.
6. Carry out a range of selected laboratory experiments for measurement of different parameters using correct laboratory practice.

Course Contents

Introduction to analytical chemistry, Basic principles of chemical analysis, Chemical equilibria in analytical chemistry, Electroanalytical chemistry, Spectroscopic methods of analysis, Chromatographic methods of analysis, Sample preparation techniques. Structure, properties, and reactions of organic compounds, Organic reaction mechanisms, Stereochemistry of organic compounds. Introduction to organic synthesis, Applications of organic chemistry in industry. Introduction to inorganic polymers, Synthesis and properties of inorganic polymers, Applications of inorganic polymers in industry. Introduction to electrochemistry, Electrochemical cells and electrodes, Electrochemical thermodynamics, Electrochemical kinetics, Applications of electrochemistry in industry and technology.

TCH 311: **Particulate Technology** (2 Units; Compulsory; L = 30; P = 0)

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

Objectives

The objectives of the course are to:

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

Learning outcomes

Having completed this course, students will be able to:

9. list and describe four (4) particle characterisations in terms of size distribution ;
10. describe the effect of particle diameter on its motion in a fluid;
11. list at least four (4) particle size reduction techniques;
12. list and describe four (4) unit operations used in the separation of a fluid-solid system;
13. state the differences in the operations of at least five (5) unit operations in particle technology;
14. calculate the settling velocities of particles and bed heights etc;
15. estimate at least two (2) design parameters for each of the filtration and sedimentation processes;
16. 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 Nano-particles. Principles of developing nano-particles.

Minimum Academic Standards

Chemical Engineering laboratory with NUC-MAS requirement facilities.

TCH321: Chemical Kinetics and Catalysis (2 Units; Compulsory; L = 30; P = 0)

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.

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 non-catalytic 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.

TCH306: Chemical Engineering Laboratory II (1 Unit; Compulsory; L=0; 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.

Overview

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.

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

TCH431 Transfer Processes II (2 Units; Core; L = 30; P =0)

Senate-approved relevance

Training of high-quality chemical engineering graduates that will meet the demand of process industries entails of 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

The course which is designed as a continuation of transfer I which focus more on heat and mass transfer processes especially heat exchangers was designed to create in the undergraduate students additional critical thinking abilities in resolving problems in other transfer processes such as momentum transfer and other associated transport phenomena techniques discussed which will be discussed for any process.

In this course, students will be trained on how to incorporate any of the transport phenomena techniques learnt about any design project and other unit operations processes.

Objectives

The objectives of the course are to:

1. define the basic laws of momentum, mass and energy transfer;
2. describe the relationship between the three transfer laws ;
3. describe the transfer coefficients for each of the different transport mechanisms;
4. define viscosity as a mean of the mechanism of momentum transfer;
5. describe the 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;
6. describe the shell momentum balances and velocity distributions in laminar flow;
7. describe the relevance of dimensionless numbers in transport operations.

Learning outcomes

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

1. state the mathematical representations of the three (3) laws of transfer;
2. describe at least two (2) momentum transfer problems in their mathematical forms and solve them;
3. evaluate the transfer coefficient(s) from the equations for design purposes;
4. construct one (1) equation each for viscosity measurement using three (3) different states of matter;
5. list two (2) factors affecting velocity distributions;
6. list at least four(4) step used in the derivation of the equation of state and their application in flow calculation;
7. describe three (3) dimensionless numbers and their application in transport processes;

Course contents

Basic Laws of mass momentum and energy transfer process and their relationship. Measurement calculations and prediction of transport coefficients. Viscosity and the Mechanisms of Momentum. Transport, shell momentum balances and velocity distributions in laminar flow. Velocity distributions in a turbulent flow. The equations of change for isothermal systems. The equation of continuity. The equation of motion. The equation of mechanical energy. The equation of angular momentum. The equations of change in terms of the substantial derivative. Use of the equations of change to solve flow problems. Shell momentum balances and velocity distributions in laminar flow. Shell momentum balances and boundary. Flow through a circular tube. Pressure drop for creeping flow in a condition. The flow of a falling film. Simple problems involving dimensionless groups such as Re Sc Pr. Boundary layer theory and turbulence. Navier Stokes equation. Universal Velocity profile. Eddy diffusion. Theories of mass transfer. Mass transfer with chemical reaction. Interphase mass transfer.

Minimum Academic Standards

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

TCH407: Chemical Engineering Laboratory III (1 Unit ; Compulsory; L = 0; 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 analysed and compared to applicable theories. The objectives of the course, learning outcomes and contents are provided to address the need.

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 facilities

TCH511 : Separation Processes II (2 Units ; Compulsory ; L = 30 ; P = 0)

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.

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

TCH521: Chemical Reaction Engineering II (2 units, Compulsory, L = 30; P = 0)

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;

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;
6. describe the applications of numerical methods in modelling heterogeneous reactors;
7. 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 film diffusion resistances.

Deactivation and regeneration of catalysts. Porous catalyst particles: Deriving the global reaction rate expression. Determination of rate controlling step. Effectiveness factor for flat-plate, 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

TCH544:Process Safety and Loss Prevention in Industries (2 Units, Compulsory; L= 30; P =0)

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

Course Overview

This course covers the principles and knowledge of process safety and loss prevention in the industrial setting. It 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.

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 Fire and Explosion Index. Hazard and Operability studies (HAZOP). The layer of protection Analysis. Risk Assessment - Probability Theory. Interactions between units. Event Trees. Fault Trees. Accident Investigations. Process Safety Management – FMA, CIMAH, SEVESO Directives, PSM etc

Minimum Academic Standards

Same with NUC-CCMA requirement facilities.

TCH544: Environmental Pollution and Control (2 Units; Compulsory; L = 30; P = 0)

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.

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.

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

TCH 562: Petroleum Production Engineering and Technology (2 Units; Elective; L= 30; P=0)

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.

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.

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

TCH 562: **Petroleum Processing and Petrochemical**, (2 Units; Elective; L = 30; P = 0)

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.

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.

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 two (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.

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.

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 H_2S, NH_3, tar, and suspended particulate matter.

Minimum Academic Standards

Chemical Engineering laboratory with NUC-MAS requirement facilities

TCH564: Sugar Technology (2 Units; Elective; L= 30; P = 0)

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.

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

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

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.

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

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.

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

TCH567: Polymer Science and Engineering (2 Units; Elective; L= 30; P =0)

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.

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 and 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

TCH568: Fermentation Technology (2 units; Elective; L = 30;P = 0)

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.

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