NIGER DELTA UNIVERSITY

WILBERFORCE ISLAND, AMASSOMA,
BAYELSA STATE.

DEPARTMENT OF CHEMICAL ENGINEERING

FACULTY OF ENGINEERING

HAND BOOK

SEPTEMBER, 2023.

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Vision

To become one of the leading institutions for the training of Chemical Engineers.

Mission

To produce modern high-tech Chemical Engineers for the analysis and determination of solution to problems for both national and global development.

Foreword

The Department of Chemical Engineering is one of the departments that commenced academic activity in the faculty of engineering, Niger Delta University of Bayelsa state in the 2001/2002 academic session, with 15 students. Dr. Humphrey A. Ogoni, now Professor, was the pioneer Ag. Head of Department, with five other teaching staff from the Rivers State University of Science and Technology (RSUST), now Rivers State University (RSU); who are Bayelsa state origin and therefore transferred their services to the new university.

Over the years, the Department has experienced growth in staff strength, student population, competence, qualification of staff, improvement in the quality of curriculum, enhanced academic development of students and commendable performance of students in external competitions.

This prospectus is intended to give an over-view of the programme leading to the award of bachelor's degree (B.Eng.) in Chemical Engineering.

ENG. DR. REWARD K. DOUGLAS
Head of Department
April 2023

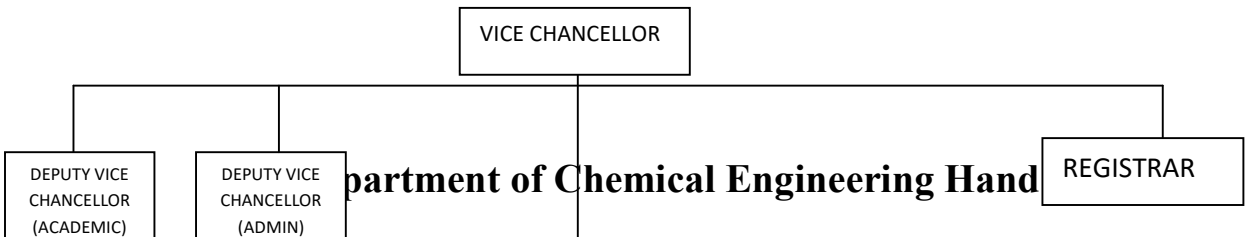
PHILOSOPHY:

To produce chemical engineering graduates who are well-versed in the latest advances in the field, with the ability to adapt to a rapidly changing world. Graduates will have a strong foundation in both theory and practical applications, as well as an understanding of the ethical and social responsibilities of engineers. They will be prepared to take on challenging roles in industry and government, making a positive impact on the world through their work.

OBJECTIVES:

- To give a balanced engineering training suitable for developing a country.
- To enable the student to master the basics in engineering analysis and design.
- To have close association with industries in the region and enhance practical application of engineering principles.
- To take full advantage of the global information network through the internet, and using the concept of "virtual" university.
- To impart sound knowledge to students in the art of application of the related principles in designing equipment and manufacture of products for national economy.
- To impart relevant knowledge to students in oil field operations and their development.

GENERAL ADMINISTRATION OF PROGRAMME



partment of Chemical Engineering Hand

ADMISSION REQUIREMENTS

University Requirement

Joint Matriculation Examination (JME) (Year I), SSCE/GCE, O'level/NECO with passes in 5 appropriate subjects including English Language and Mathematics, obtained in not more than two (2) sittings.

Faculty/Department Requirements

(i) **J.M.E Entry Requirements:** Five (5) SSCE/NECO/ O'level credit passes including English Language, Chemistry, Physics, Mathematics or Further Mathematics, any other science subject.

(ii) **Direct Entry Requirements:** At least three (3) 'A' level passes at GCE or its equivalent including Physics, Chemistry and Mathematics or Further Mathematics. Candidates must also have two (2) credit level passes at SSCE/NECO/GCE O'level including English Language and Further Mathematics.

General Guidelines

Students in any of the Engineering programmes are expected to take and pass at D-Level, the NUC required ten (10) units of Mathematics, ten (10) units of Physics and ten (10) units of Chemistry to qualify to register for courses in the 300 level. Deficient students at the close of 200-level are no longer engineering students of this University and would be advised to withdraw from the Faculty of Engineering.

Probation, Expulsion, and Withdrawals

Probation is applied to 100 level students who fail to maintain a CGPA of 1.50 at the end of the academic session. The probation status of the student is reversed if the student maintains a CPGA of 1.50 at the end of the next session.

A student shall face expulsion if he/she has committed an offence and has been tried and found guilty by the student disciplinary Committee. Expulsion will be given to the student in line with policy of the University.

A student shall be withdrawn for academic failure if he/she fails to obtain a CGPA of 1.50. However, the rule does not apply to 100 level students. Secondly, students who failed to pass 40% of the courses registered for the session shall also be withdrawn from the University for Academic Failure. A student in final year of student who fails to pass 40% of the courses registered in the session shall be allowed to register for the next session. However, he he/she fails to pass 40% of the registered course for the concessional year shall be asked to withdraw from the University.

Duration of Programme

The B.Eng. programme in Chemical Engineering runs for five years (10 semesters), comprising of classroom studies, workshop/laboratory, fieldwork and supervised industrial work experienced (SIWE) attachment as follows:

- Year I, II and III classroom, workshop/laboratory work
- Year II long vacation 3 months SIWES
- Year III long vacation 3 months SIWES
- First semester of Year IV classroom, workshop/laboratory
- Second semester and long vacation of Year IV 6 months SIWES
- Year V classroom, workshop/laboratory work and final year project

Examination-Related Offence

S/N	Offence	Remark
1	Possession of mobile phones, lecture notes, storage devices, electronic programmable calculators etc, in the examination hall	Action according to the University Policy on Exam malpractice

2	Receiving or attempting to assist either in writing from another student during the examination or communicating verbally	Same
3	Possession and admittance of usage of relevant material in the examination hall	Same
4	Coming to the examination hall with prepared university answer booklet	Same
5	Impersonation-exchange of student matriculation number; alteration of student ID card number etc	Same

Graduation Requirements for Bachelor's Degree

In order to qualify for Bachelor's degree of the Niger Delta University, student must:

i. Earn a pass grade in supervised industrial work experience (SIWES) where applicable;
ii. Earn a minimum CGPA of 1.00 or 1.50 (for student admitted into the university from 2013/2014)
iii. Earn a minimum of 150 units including SIWES for a five year programme or 120 units for a four year programme.
iv. A transfer student must earn a minimum of 60 units for a four year programme in Niger Delta University
v. A passing grade is required in all compulsory course of a programme
vi. A minimum score of 30% must be obtained in required courses, and
vii. A student may take some elective courses to meet graduation requirements in which pass grades must be obtained.

Final Classification of Degrees

For the purpose of final classification of degrees, a student should have achieved one of the following CGPAs:

CGPA		CLASS OF DEGREE
4.50-5 .00	-	First Class
3.50-40.49	-	Second Class (upper division)
2. 40-3. 49	-	Second class (lower division)
1. 50-2. 39	-	Third class
1. 00-1. 49	-	Pass

For students admitted into the University from the 2013/2014 academic session the CGPAs are as follows:

CGPA		CLASS OF DEGREE
4.50-5 .000	-	First Class
3. 50-4. 49	-	Second Class (upper division)
2. 40-3. 49	-	Second Class (lower division)
1. 50-2. 39	-	Third class

Format for Course Numbering

Faculty Courses

The faculty courses are numbered according to the Senate Curriculum and Instruction Committee (SCIC) recommendation on course numeration. The course number starts with FCE followed by a three-digit number.

The first letter (F) represents **Faculty**

The second letter (C) represents **Course**

The third letter (E) represents **Engineering**

The first digit indicates the course level where

1 - 100 level
2 - 200 level
3 - 300 level
4 - 400 level
5 - 500 level

The second digit indicates the department where the course is domiciled or run:

0 - Faculty of Engineering General Course
1 - Agric & Environmental Engineering
2 - Chemical Engineering
3 - Civil Engineering
4 - Electrical/Electronic Engineering
5 - Marine Engineering
6 - Mechanical Engineering
7 - Petroleum Engineering

The third digit indicates the semester in which the course is offered:

Odd number – first semester

Even number – second semester

Course Domiciliation

Faculty courses are domiciled in the various departments that makes up the Faculty of Engineering as indicated below:

In the Department of Agricultural and environmental Engineering

FCE 212 – Strength of materials I

FCE 411 – Engineering Practice and Research Presentation

In the Department of Chemical Engineering

FCE221 – Material Science

In the Department of Civil Engineering

FCE 131- Engineering Graphics I

FCE 132- Engineering Graphics II

FCE 232 – Fundamentals of Fluid Mechanics

FCE 532 – Entrepreneurship, industry and Engineering law

In the department of Electrical/Electronic Engineering

FCE 244 – Fundamentals of Electrical Engineering

In the Department of Mechanical Engineering

FCE 261 – Engineering Graphics III

FCE 263 – Workshop/Manufacturing Technology

FCE 265 – Engineering Statics

FCE 267 – Engineering Thermodynamics

FCE 262 – Engineering Dynamics

In the Department of Petroleum Engineering

FCE 571- Engineering Economics Management

In the Faculty as General Courses

- All year one courses, all General Studies courses and any other course serviced from sister faculties/departments
- FCE 201 – Engineering Analysis I
- FCE 202 – Engineering Analysis II

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- FCE 302 – Engineering Analysis IV
- FCE 200 – SIWE I
- FCE 300 – SIWE II
- FCE 402 – SIWE III

Programmme Structure- Chemical Engineering (Year One and Two)

Year 1 Semester 1

S/N	Course Code	Course Title	L	T	P	Units
1	GST 101	Use of English I	2	3	0	3
2	MTH 105	Engineering Mathematics I	3	3	0	5
3	PHY 105	General Physics I	2	3	2	5
4	CHM 101	General Chemistry I	2	3	2	5
5	FCE 131	Engineering Graphics I	2	0	2	2
6	GST 100	Fundamentals of Computer Science	3	0	0	2
			14	**12**	**6**	**22**

Year 1 Semester 2

S/N	Course Code	Course Title	L	T	P	Units
1	GST 102	Use of English II	2	3	0	3
2	GST110	Nigerian People and Culture	3	0	0	3
3	FCE132	Engineering Graphics II	2	0	2	2
4	MTH 106	General Mathematics II	3	3	0	5
5	PHY 106	General Physics II	2	3	3	5
6	CHM 102	General Chemistry II	2	3	2	5
			14	**12**	**7**	**23**

Year 2 Semester 2

S/N	Course Code	Course Title	L	T	P	Units
1	FCE 201	Engineering Analysis I	2	3	0	4
2	FCE 261	Engineering Graphics III	2	0	2	2
3	FCE 263	Work/Manufacturing Technology	3	0	2	3
4	FCE 265	Engineering Statics	3	3	0	3
5	FCE 221	Material Science	3	0	2	3
6	FCE 267	Engineering Thermodynamics	3	3	0	3
			16	**6**	**6**	**18**

YEAR 1, FIRST SEMESTER

GST 101: Use of English 1 (3 Units) C

An overview of the concept of language, importance of the English Language in Nigeria. The sentence, the phrase/clause, parts of speech, rule of concord, direct and indirect speech. The paragraph, punctuation, figure of speech, oral communication (Vowels and Consonants).

MTH 105: Basic functions and Series (5 units) C

Sets, mapping, functions inequalities, graphs, quadratic equations, Remainder theorem, surds and indices, AP, GP, logarithmic and exponential functions, permutations and combinations and binomial theorem. Trigonometry: Trigonometric and hyperbolic functions, solution of trigonometric equations in three unknowns. Complex numbers. Analytical. Geometry: Equations of lines, circles, conic sections, generalized to three-dimensional space lines, planes, spheres. Review of Calculus: Limit of a sequence derivations and differentials, L'hospital rule, methods of integration, definite integrals. Infinite series: Infinite series Taylor's and Maclaurin's series.

PHY 105: Physics 1 (5 Units) C

Physical quantities: units, vectors, particle. Kinematics and dynamics. Oscillations. Work, Energy, Momentum, Angular Momentum. Motion of rigid bodies. Collisions. Hooke's Law, Sound waves, Calorimetric. Gas laws and kinetic Theory. Heat and work. Laws of thermodynamics and applications. Surface tensions.

CHM 101: General Chemistry 1 (5 Units) C

Atomic and molecular structure. Electronic configuration and periodicity. Metals and non-metals. Chemical bonding. The Mole concept. Chemical equations and stoichiometry. Acids, bases and salts. Chemical equilibrium. Ionization of water. Indicators etc. the pH scale, Buffer solutions. Hydrolysis of salts. Redox reactions. Electro-chemical cells and electrode potentials. Electrolysis. Chemical Energy. Thermodynamics. Chemical kinetics-chemical reaction rates; homogeneous and heterogeneous catalysis.

FCE 131 Engineering Graphics I (2 Units) C

Use of draughting instruments, lettering, dimensioning, layouts. Constructions of geometrical figures, conics, etc. Graphical calculus and applications. Development, intersection of curves and solids, tangents, etc. Projections; orthographic and isometric, sectional views.

GST 100 Fundamentals of Computer Science (3 Units) C

Introduction to Computers, Computers and uses; Computer logic softwares and hardwares. Basics of computer language; FORTRAN, BASIC, COBOL, etc. Basic computer appreciation; MS word MS DOS, etc. Flow Charting and computer algorithm design. Extensive exercises in solution to engineering problems using computer algorithms, flow charts and/or other pseudo codes. Introduction to advanced programming languages. Application of computer BASICS, FORTRAN. Flow charting/pseudo codes to simple engineering problems. Basic computer appreciation and overview in MS WORD, Excel, CorelDraw.

YEAR 1, SECOND SEMESTER

GST 102: Use of English II (3 Units) C

Vocabulary, root and affixes; idioms, figures of speech (part II); summary. Essay writing, minute writing, speech writing

GST 110: Nigerian Peoples and Culture (3 Units) C

Introduction to man and society, history of Nigerian society and people (Hausa/Fulani, Yoruba, Ibos, Niger Delta, etc). Structural components of Nigerian people and culture. Cultural similarities and variations of the Nigerian people. Culture, environment and health practices in Nigeria. Nigerian heritage, nature and culture of traditional religion, rites of passage, systems of marriage, decent, kinship and family. Systems of social stratification. The evolution of Nigeria; politics and democracy. Ethnic relations, prejudice, discrimination and inter-ethnic conflicts and resolution. Traditional economics system and sustaining the economic profile in Nigeria.

FCE 132 Engineering Graphics II (2 Units) C

Pictoral/Freehand Sketching, conventional practices. Architectural drawing. Advanced topics in auxiliary and sectional views, developments, intersections of surfaces, projections.

MTH 106: Linear Algebra and Ordinary Differential Equation (5 units) C

Scalars and Vectors, vector algebra, vector calculus differentiation and integration. The gradient of scalar field, the divergence and curl of a vector field, application to co-ordinate system. Eigen values & Eigen vectors. More Matrices: Adjoins and inverse, elementary transformations. The rank of a metric, system of linear equations. Differential Equation: First order differential equations and its geometric interpretation. Second order differential equations with constant coefficients. Exact equations, separable variables, Homogenous integrating, Fadol improper integrals, Gamma, Delta, Seta, and Errol and

other functions, geometric and physical applications. Linear programming: Problem formulation, method of solution.

PHY 106 Physics II (5 Units) C

Electrostatics. Electric intensity. Coulomb's and Gauss' laws. Capacitors. D.C. current circuit, Electrolytic cells. Magnetic fields of currents, Electro-magnetic induction generations. Induction. Electric motors. A.C. circuit theory-theories of magnetism. Optical instruments. Quantum theory. Photoelectric effect. Bohr's atom model of Energy levels and lines spectra. Matter waves and spectra. Semi-conductors.

CHM 102: General Chemistry II (5 Units) C

Colligative properties. Ideal solution.Osmotic pressure and determination ofmolecular mass. Raoult's law. Henry's law.Phase rule and phase diagrams. Emulsions and suspensions.Transport phenomena; diffusion and viscosity.Sources of organic compounds.Aliphatic and aromatic hydrocarbons nomenclature. Homologous series, isomerism, functional groups; alcohols, carbonyls, carboxlic acids, esters and ethers, Introduction to spectroscopy-basic principles.

YEAR 2, FIRST SEMESTER

FCE 201 Engineering Analysis 1 (4 Units) Pre-requisite: MTH 105 & MTH 106 C

General engineering systems, Rate systems and their relationships, General principles of optimization, Use of functions of several variables, partial derivatives, total differentials in components design and optimization. Taylor's formula and its extension to functions of several variables, maxima and minima, LaGrange multipliers and their engineering applications. Functions of complex variables, analytic functions, integration in the complex plane and phase systems, infinite series in the complex plane and mapping. Taylor's and Laurent's expansions, the theory of residues, conformal mappings and application of Fourier series integrals, Laplace transform. Method for solving linear differential equations with structural illustrations. Convolution and Duhamel formulae and application.

FCE 261 Engineering Graphics III (2 Units) Pre-requisite: FCE 162 C

Introduction to limits, fits and tolerance. Surface roughness determinations. Drawing methods for Cam-profiles. Presentation and drawing of various types of gears. Assembly and sub-assembly drawing of elements, workshop, drawings, correction and modification of drawings, general engineering drawing symbols. Reading of blueprints.

FCE 263 Workshop/Manufacturing Technology (2 Units) C

Safety and safe working practices in the workshop. Carpentry and joinery process.Forging furnace and forging operations. Fitting and plumbing; hand-drilling and tapping, measuring instruments such as mictrometers, venier, height gauges, bevel protector, sinebar, gauage blocks etc. Checking surface for flatness, squareness etc. Types of patterns and pattern main, moldings sand, molding process: machine molding. Ferrous and no-ferous castings, various casting methods and casting defects. Arc and gas welding processes, soldering and brazing. Introduction to the later; milling shaping and drilling machines. Cutting fluid types and applications.

FCE 265 Engineering Statics (Pre-requisite: MTH 106) (3 Units) C

Basic Concepts; Newton's Laws of Motion, mathematical modeling and analysis. Statistics; force systems, resultant of coplanar and spatial force systems, equilibrium conditions. Shear forces and bending moments in beams and shafts, analysis of trusses and frames. Friction between dry surfaces. Moment of Inertia, plane figures and composite bodies.

FCE 221 Material Science (Pre-requisite: CHM 102) (2 Units) R

The atomic structure. Crystal structure and material bonding-Physical properties of materials. Dislocation theory. Metals-ferrous and non-ferrous. Polymers, thermosetting and thermoplastic materials. Wood- natural and modified. Rubber. Ceramics and composite materials.

FCE 267 Engineering Thermodynamics (3 Units) (Pre-requisite: MTH 105) C

Fundamentals concepts; systems properties and process, Heat and work. First law; closed system, open systems, model applications. Working fluids, liquid, vapour and perfect gases. Steam tables and charges. Second law, cycle efficiency. Reversibility. Entropy simple cycles; Carnot, Rankine, air standard.

GST 221: Peace and Conflict Resolutions (3 Units) C

Basic Concepts of peace and conflicts, types, sources and causes of conflict and violence. Conflict management strategies; traditional approaches, alternative dispute resolution and third window in judiciary. Case studies and group discussions, comparative study of ethnic militia and youth insurgency in Nigeria. Models of conflict resolution and peace building. Peace keeping efforts. Excursion visits and group empirical studies.

YEAR 2, SECOND SEMESTER

GST 212: Introduction to Philosophy and Logic (3 Units) C

The nature and scope of philosophy; Misconceptions, popular notions, etymological definition of philosophy, branches of philosophy-metaphysics, epistemology, ethics, logic, aesthetics. Ancient, medieval modern and contemporary periods of philosophy. The problems of knowledge, appearance, reality, mind and body, freedom and necessity. Distinction between logic and other disciplines. Argument and its components (preposition, premise, conclusion), detailed discussion on proposition and its features, disjunctive and hypothetical propositions.

FCE 202 Engineering Analysis II (3 Units) C

The concept of uncertainties and in engineering productions. Basic system engineering minimization, maximizations principles, simplex and queuing principles. Engineering experimentations, field surveys, predictions and reports. Probability models: frequency distribution, central tendency and dispersion, moments, discrete random variables, binomial distribution, Poisson normal distribution, sampling and sampling distributions,

estimation of population parameters, hypothesis testing, correlation and regression, analysis of variance, experimental design.Statistical quality control.

FCE 246 COMPUTER ENGINEERING II (3 Units) C

Further programming in C++/Java: Selection and iteration, the 'if' statement, the 'if-else' statement, compound statements, logical operators, switch statements, etc. The while, do-while, and for-statements: Arrays and structures, strings and functions, objects and classes, pointers and operator overloading. Introduction to the Java programming language.

FCE 244 Fundamentals of Electrical Engineering (3 Units) R

The electric circuit. DC and AC analysis technique. Measurement of basic electrical quantities. Electrical machines. Alternating voltage and electric devices. Installation techniques.

FCE 262 Engineering Dynamics (Pre-requisite: MTH 106) (3 Units) C

Plane kinematics and kinetics of particles. Kinetics of particle: Newton's second law. Work and energy, conservation of energy and momentum, fields of forces, impact coefficient of restitution. Kinetics of system of particles. Generalized Newton's second law, steady mass flow and variable mass rocket motion. Plane kinematics and kinetics of rigid bodies. 3D dynamics of rigid bodies, gyroscopic motion and gyroscopic stabilization.

FCE 232 Fundamental of Fluid Mechanics (3 Units) C

Fundamentals concepts: Characteristics of fluids, fluid properties, dimensions and units. Nature of fluid flow. Newtonian and Non-Newtonian fluids. Fluid statics: pressure, buoyancy, force on submerged body, stability of bodies in fluids. Fundamentals of fluid motion. Conservation laws of mass, momentum and energy. Euler's equation; Bernoulli's equation; applications; incompressible viscous flow; ideal and real fluids.Friction loss,

laminar flow in pipes and between parallel plates. Flow measurements, pressure, velocity, rate measurement techniques.

FCE 212 Strength of Material (3 Units) C

Force equilibrium free body and force diagrams; concept of stress and strain, generalized stress-strain relationship, Young's Modulus and other strength factors, Tensile test; Biaxial and Triaxia states of stresses and strains, axially loaded bars, composite bars, temperature stresses and simple indeterminate problems; hoop stress; cylinders and rings. Bending moment, shear force and axial force diagrams; torsion and applications. Stress transformations, failure theories and the Mohr's circle. Theories of bending of beams, symmetrical and unsymmetrical bending and the concept of shear center.Strain energy and applications.

FCE 200 SIWE I (0 Unit) R

Introduction to practices and skills in general engineering through engineering instructions in the operation of hand tools, power tools for wood and metal works. Safety practices and other hands on experience in safe usage tools and machine. Statement of experience in any selected practical task (Course to be taken during vacation following 200 level).

Department Courses – Chemical Engineering (Year Three to Year Five)

Groups of Departmental Courses

Group	Group Title/Course	Year Semester
1. Chemical/Petroleum Engineering Technology/Petro-Chemical & Organic & Organic Synthesis		

CHE 311 – Fundamentals of Petroleum Engineering	III	1
CHE 312 – Petroleum Processing I	III	2
CHE 415 - Petroleum Processing II	IV	2
CHE 511 – Chemical Technology I	V	1
CHE 513 –Petrochemicals Technology I	V	1

CHE 514 – Chemicals Technology II	V	2
CHE 516 - Petrochemical Technology II	V	2
CHE 517 – Biochemical Engineering	V	1
CHE 413 – Polymer Technology	IV	1

2. Industrial Chemistry and Thermodynamics

CHE 321 – Chemical Thermodynamics	III	1
CHE 322 – Industrial Analytical Chemistry	III	2
CHE 323 – Organic Processes	III	1

3. Process Modeling, Control and Dynamics

CHE 431 – Process Analysis and Optimization	IV	1
CHE 433 – Instrumentation and Process Control	IV	1
CHE 532 – Process Dynamics	V	2
CHE 533-Modeling of Chemical Engineering Processes	V	1

4. Chemical Reaction Engineering and Catalysis

CHE 342 – Catalysis and Chemical Reaction Kinetics	III	2
CHE 441 – Chemical Reaction Engineering I	IV	1
CHE 542 – Chemical Reaction Engineering II	V	1

5. Separation and Process Design

6. General Engineering

CHE 360-Corrosion Engineering	III	2
CHE 362- Metallurgy	III	2
CHE 461-Computer Application in Chemical Engineering	IV	1
CHE 562- Engineering Management and Process Economics	V	2
CHE 564-Environmental Pollution, Control and Safety	V	2
CHE 566- Fuel Technology and Energy Resources	V	2
CHE 572 Entrepreneurship and Industry	V	1
CHE 568 – Project	V	1&2
CHE 566 – Seminary	V	2

Programme Structure

YEAR 3-SEMESTER I

S/N	Course Code	Course Title	L	T	P	U
1	FCE 301	Engineering Analysis III	3	3	-	3
2	CHE 311	Fundamentals of Petroleum Engineering	3	0	0	3
3	CHE 321	Chemical Thermodynamics	3	2	0	4
4	CHE 351	Process Calculation	2	2	0	3
5	CHE 353	Fluid Particle Technology	2	0	3	3
6	CHE 323	Organic Process	2	0	0	2
7	CHE 361	Metallurgy	2	0	0	2
			19	**9**	**6**	**20**

YEAR 3-SEMESTER II

S/N	Course Code	Course Title	L	T	P	U
1	FCE 302	Engineering Analysis IV	3	3	0	3
2	CHE 312	Petroleum Processing I	3	0	3	3
3	CHE 322	Industrial Analytical Chemistry	2	0	3	3
4	CHE 342	Chemical Reaction Kinetics	2	2	0	3
5	CHE 352	Transport Phenomena	2	2	3	4
6	CHE 362	Corrosion Engineering	2	0	0	2
7	CHE 314	Separation Process I	2	0	2	3
8	GST 300	Entrepreneurship Studies	2	0	0	2
			16	**7**	**11**	**23**

YEAR 4-SEMESTER I

S/N	Course Code	Course Title	L	T	P	U
1	FCE 415	Petroleum Processing II	3	-	3	3
2	CHE 413	Polymer Technology	2	0	0	2
3	CHE 430	Chemical Engineering Process Analysis, Optimization	3	2	0	3
4	CHE 433	Instrumentation and Process Control	3	0	3	3

5	CHE 441	Chemical Reaction Engineering I	3	2	0	3
6	CHE 453	Separation Process II	3	0	3	3
7	CHE 451	Process Design I	2	2	0	3
8	GST 461	Computer Application in Chemical Engineering	2	0	3	2
9	FCE 411	Engineering Practice & Research Presentation	1	3	0	2
			22	9	12	**24**

YEAR 5–SEMESTER I

S/N	Course Code	Course Title	L	T	P	U
1	FCE 511	Chemical Technology I	3	0	3	3
2	CHE 513	Petrochemical Technology I	3	0	3	3
3	CHE 517	Biochemical Engineering	3	0	0	3
4	CHE 533	Modeling of Chemical Engineering Processes	3	2	0	3
5	CHE 541	Chemical Reaction Engineering II	3	2	0	3
6	CHE 555	Process Design II	3	2	0	4
7	CHE 571	Engineering Economics and Management	2	0	0	2
8	CHE 563	Fuel Technology	2	0	0	2
			22	6	6	**23**

YEAR 5 – SEMESTER 2

S/N	Course Code	Course Title	L	T	P	U
1	LAW 430	Industrial Law and Relations	2	0	0	2
2	CHE 514	Chemical Technology II	3	0	3	3
3	CHE 532	Process Dynamics	3	2	0	3
4	CHE 562	Engineering Management Process Economics	3	2	0	3
5	CHE 566	Pollution Control and safety	2	0	0	2

6	CHE 572	Entrepreneurship and Industry	2	0	0	2
7	CHE 516	Petrochemical Technology II	3	0	3	3
			18	4	6	**18**

Project carries a total of 6 Units spread through the two semesters of Year V.

Description of courses – Chemical Engineering

(Year Three to Year Five)

YEAR 3, FIRST SEMESTER

FCE 301 Engineering Analysis III (3 Units) (Pre-requisites: MTH 105 & MTH 106, FCE 201) C

Overview of general engineering responses to mathematical applications in problem solving. General second order differential equations, systems of linear differential equations and applications in theories of failure. Partial differential equations and applications in theories of failure. Partial differential equations, Laplace's equation, the wave equation, the heat equation, Bessel functions and Legendre polynomials. The line integral, surface integrals. Double and triple integrals, simply and multiply connected domains and applications. Green's stokes and divergence theorems with applications. Laplacian operator: Co-ordinate transformation. The line integral, surface integrals, double and triple integrals, simply and multiply connected domains and applications. Green's, Stoke's and divergence theorems with diverse engineering applications.

CHE 311 – Fundamental of Petroleum Engineering (3 Units)

Origin and occurrence of petroleum and gas, oil exploration methods; Drilling and drilling bits; Blowout preventers and drilling fluids, fishing techniques, Offshore drilling; well completion, Logging, petroleum production; Stabilization of petroleum–Oil, gas and water separation. Basic tests on petroleum quality; Petroleum transport and storage.

CHE 321 – Chemical Engineering Thermodynamics (4 Units).

First law and the enervation of chemical reactions. Second law and calculation of entropy changes. Definitions of thermodynamics potentials. Free energy and function. Chemical potentials and affinity of reactions. Equilibrium in chemical reaction systems. Equilibrium constant of a reaction. Third law. Thermal data. Thermodynamics of

electrochemical cells. Work production from chemically reacting systems. Phase relations and thermodynamics of solutions. Equilibrium in heterogeneous reactions.

CHE 351 – Process Calculations (3 Units)

Basic definitions: Chemical equations and stoichiometry. Combustion. Ideal gas laws. Real gas relationships. Vapour pressure, saturation and humidity. Material balances. Steady state processes involving chemical reaction, stepwise counter-current process, recycle, bypass and purge calculations, condensation and abeling. Energy balances. Heat capacity. Calculation of phase transitions. Heat of reaction. Combined material and energy balances for steady state and unsteady state processes.

CHE 353 – Fluid Particle Technology (Pre-requisite: CHE 351) 3 Units.

Particle classification/drag forces on rigid bodies, drag coefficients, settling velocity and stoke's law. Classification of solids. Centrifugal separation. Cyclones and centrifuges. Electrical separation. Mixing of solids and fluids. Filtration, packed and abeling bed systems; their applications. Drying and humidification.

CHE 323 – Organic processes (2 Units)

Nomenclature and conformation properties of hydrocarbons, Aromatic and heterocyclic compounds. Mechanism and stereochemistry of hydrocarbon reactions. Aromatic substitution rearrangements. Characteristic reactions of functional groups–Alcohols, carbonyl, etc. Optical, geometric, chain and disaster osomerism. Basic principles of electrochemistry, chemical kinetics and nuclear chemistry.

CHE 361 – Metallurgy (3 Units)

Geology of metals. Ore concentration. Ore processing. Iron and steel production. Manufacture of aluminium, copper, zinc, tin and silver. Metallurgical slag. Testing of metals crystallography. Coal carbonization.

YEAR 3, SECOND SEMESTER

FCE 302 Engineering Analysis IV (3Units)(Pre-requisites:FCE 201 and FCE 202) C

The recovery techniques, mathematical applications in system discretization processes, the finite difference, interpolation formulae, numerical integration and integration, their uses in the system analysis and discretization. The numerical solution of linear and non-linear equation, differential equations and applications to engineering problems. Finite element method and boundary element and its applications.

CHE 312 – Petroleum Processing I (3 Units)

Chemical composition of petroleum, Desalination processes, Atmospheric and vacuum distillation of petroleum, true boiling point and equilibrium flash vaporization curves for petroleum and petroleum fractions. Gasoline stabilization and sweetening. Properties of fuels–octane number, cetane number, etc. Hydrocarbon gas purification and separation, LPG production. Gas processing–alkylation and polymerization. Chemistry, thermodynamics and kinetics of thermal and catalytic processes in the petroleum business. Thermal processes–coking, thermal cracking and pyrolysis. Catalytic cracking and isomerization.

CHE 322 –Industrial Analytical Chemistry (Pre-requisite: CHM 101 & 102) 3 Units.

Technical and analytical weighing. Sampling. Preparation of reagents. Types of glass and assembly of gas apparatus. Filtration, decantation, evaporation and crystallization. Water purification. Volumetric and gravimetric analysis. Conductimetric and potentiometric titrations. Instrumental techniques. Calorimetric, absorptiometry and spectrophotometry. X-ray analysis and microscopy. Gas chromatography.

CHEM 342 – Chemical Reaction Kinetics and Catalysis (3 Units)

Rate expressions for the chemical reactions, law of mass action. Constant volume, reversible, irreversible, paralleled, and consecutive reactions.Reaction order and its determination. Variable volume reactions, Arrhenius equation and activation energy. The theories of reaction rates, especially the collision theory and the theory of absolute

reaction rates. Homogeneous and heterogeneous catalytic reactions and their kinetics. Kinetics of electrochemical processes. Equilibriums in ionic solutions.

CHE 352 – Transport Phenomena (4 Units)

Dimensional analysis and dimensionless groups, Boundary-layer theory, Navier-Stokes equation and applications in chemical engineering, laminar and turbulent flow of incompressible viscous fluids (isothermal flow over a flat plate, in tubes; non-isothermal flow); Introduction to rheology, flow in non-circular tubes, Non-Newtonian fluids, Turbulent flow in pipes and channels, one-dimensional compression flow. Energy equation, free and forced convective heat transfer (over a flat plate, in a tube and sphere). Introduction to multiphase phenomena (bubble dynamics, cavitation, fundamentals of two phase flow), Definition of the friction factor, macro-scopic mass, momentum and mechanical energy balances (Bernoulli's equation), metering of fluids. Diffusion through spherical and cylindrical coordinates. Diffusion with homogeneous and heterogeneous reactions. Interphase and multiphase transfer.

CHE 362 – Corrosion (2 Units)

Basic concepts of corrosion. Classification of corrosion processes. Nature of films, scales and corrosion products of metals. Effects of metallurgical structure on corrosion. Corrosion in aqueous solutions. Effect of environment on corrosivity, effect of mechanical factors. Corrosion control: cathodic and anodic protection, metallic and paint coatings. Corrosion testing, monitoring and inspection.

CHE 314 Separation Process I (3 Units).

General concepts of the unit operations in the chemical industry. Diffusion separation process, isothermal gas absorption, membrane separation, reverses osmosis and dialysis. Vapour-liquid equlibra, steam stripping. Hydrodynamics of packed beds and plate columns. Types of packages, pressure drop calculations including Argon's equation for pressure drop. Introduction to drying and humidification.

YEAR 4, FIRST SEMESTER

CHE 411 – Petroleum Processing II (3 Units) (Pre-requisite: CHE 311)

Catalytic cracking and hydro-cracking. Lubricating oil properties. Manufacture of lubricating oils. Deasphalting, phenol and furfural extraction, de-waxing, clay treatment and hydro-finishing processes. Grease production. Refinery layout. Safety rules. Environmental protection in the petroleum refinery. Manufacture of bitumen.

CHE 430 – Chemical Engineering Process Analysis, and Optimization (3 Units)

Review of elementary theorems and operations on vectors and matrices. Application to chemical engineering stage processes. Formation of simple and complex chemical engineering problems and their solution. Numerical methods for solving linear and non-linear equations, ordinary and partial differential equations. Introduction to optimization, general optimization problems, basic steps of solving optimization problems and methods. Linear programming. Numerical optimization techniques. Optimization of stage systems.

CHE 433 – Instrumentation and Process Control (4 Units)

Process measurement. Pressure, force, level, flow, temperature, humidity, density, viscosity. Primary element calibration. Signals nozzles, baffle and relay principles, Balancing principles. Transmitters. Controller and valves actions and mechanisms. Control responses: on-off, proportional, automatic, reset, pre-act, 3-ter, gap control. Automatic controllers and inter-linked instruments. Concept of control loops. Ratio, Cascade, spilt range, override, and point, time cycle and forward feed controllers. Instrument error and recognition of faults.

CHE 441 – Chemical Reaction Engineering II (3 Unit)

Classification of reactors. Chemical kinetics as applied to batch and continuous reactors, single ideal reactors. Steady state, mixed, and plug flow reactors. Holding time and space for flow systems. Design equations for single reactors. Batch reactor, mixed versus plug

flow reactors. Reactors in series and in parallel. Recycle reactors, concepts of residue time distribution.

CHE 453 – Separation Process II (3 Units)

Vapor-liquid equilibrium and distillation. Distillation equipment. Multicomponent distillation. Vacuum distillation and steam stripping. Azeotropic and extraction distillation. Molecular distillation. Leaching of solids. Liquid-liquid extraction. Theory of crystallization in mono-and multi-systems. Crystal growth. Dialysis. Reverse osmosis. Electro-dialysis.

CHE 451 – Process Design I (3 Units)

General scope of design. Factors influencing cost of product. Process evaluation. Block diagrams. Mass and energy balances. Process flow-sheets, flow-sheet symbols, engineering flow-sheets, mechanical flow diagram, utility flow-sheets. Presentation and discussion of real design problems. Selection between packed and plate towers and column internals. Detailed design procedures for distillation and absorption. Applicability of these methods to vacuum and high pressure operation. Mechanical design of columns including foundation and supporting structures.

CHE 461 – Computer Application of Chemical Engineering (3 Units)

Application of computer system to process dynamics, chemical engineering design and plant layout and flow sheeting, use of AutoCAD.

FCE 411 Engineering Practice and Research Presentation (2 Units) C

Philosophy of science and engineering. History of engineering and technology. The engineering profession, engineering literacy professional bodies and engineering societies' code of conduct and ethics. Safety in engineering. Professional use of English language for letters, specification distributions, presentation of charts, graphs, tables,

writing of proposals and case studies, etc. Research methodology and presentation, use of MS, PowerPoint, etc.

YEAR 4, SECOND SEMESTER

FCE 402 SIWES III (6 units) C

On the job training to acquire industrial experience and acts of responsibility to be obtained from the industry relevant to the student's chosen field/specialization. This is to be taken in semester 2 in the 400 level.

YEAR 5, FIRST SEMESTER

FCE 571 Engineering Economics and Managements (3 Units) R

The nature and scope of economics. Basic concepts in engineering economics. The interest formulae, discounted cash flow, present worth, equivalent annual growth and rate of return comparisons. Break even analysis, Replacement analysis, cost benefit analysis, concept of management tasks. Leadership patterns. The concept motivation, control and delegation of authority. Organization theories and concepts. Industrial relations. Operational research-history, definitions, theories, structure; Models, art of modeling and simulations, linear programming (graphical solution), basics of the simplex method, sensitivity analysis, decision theory and queuing models. Applications in engineering practice.

CHE 511 – Chemical Technology I (3 Units)

Chemical industry in Nigeria. Raw material resources and utilization. Basic principles of chemical technology. Technology of industrial acids-sulphuric, phosphoric, etc. Fertilizers. The silicate industry: ceramics, glass and cement manufacture. Electrolysis and the production of sodium hydroxide, chlorine and hydrochloric acid.

CHE 513 – Petrochemical Technology I (Optional) (3 Units)

Raw materials and their processing techniques ethylene, acetylene, synthesis gas and liquid hydrocarbons; properties of olefins, thermodynamic stability of hydrocarbons olefin production; use of polymerization reactions, raw materials from aromatic hydrocarbons: sulphonation, chlorination, nitration, oxidation, hydrogenation, aromatization, nomerization reactions, synthesis on bases of acetylene, carbon monoxide and synthesis gas.

CHE 515 – Fundamentals of Biochemical Engineering (Optional) (3 Units)

Introduction to microbiology–cells, cell structure and physiology. Metabolic pathways and bioenergetics, kinetics of enzyme. Catalyzed reactions. Bio-reactors, substrates and products batch, CSTP, plug flow reactors, airlift type of fermentor and ponds. Control and systems management, pH, temperature, abeling cultures and their isolation.

CHE 541-Chemical Reaction Engineering II (Pre-requisite: CHE 441) 3 Units.

Design for multiple reactions: reactions in parallel and in series. Extensions and applications of series and parallel reactions. Temperature and pressure effects. Design of fluid particle reactors. Chemical reactions control and gas film diffusion control processes. Fluidized bed reactors. Slurry reaction kinetics. Design of fluid reactors. Solid catalyzed reactors. Design of stage dadiabatic packed bed reactors, and abeling bed reactors.

CHE 555 Process Design II (4 Units)

Reasons for scale up and basic principles. Heat exchange system. Design and scale up of jacketed vessels and shell-and-tube heat exchangers. Fluid flow systems: scale up of pumps and pipe networks for laminar and turbulent flow. Liquid mixing systems: general principles of scale-up and the use of pilot plant data. Optimization of plant dimensions, operating condition and the economics of alternatives. Plant layout.

YEAR 5, SECOND SEMESTER

FCE 532 Engineering law, Entrepreneurship and Industry, Introduction and Sources of Law.(2/0/0, 2 Units)

Industrial/Engineering law and practices, liabilities intorts: assaults, negligence and strict liability. Law of contract: independent contractors, work men compensation. Property law: partnerships, intellectual property copyright, trademarks, design patents. Incorporation of company and registration. Arbitration. Organizational structure of manufacturing outfits. Definition of and starting a small and medium scale enterprise (SME). Market surveys, feasibility studies, projects and contract documentation and handling, BOQs, specifications, planning and scheduling, funding and fund sourcing, product, quality control, safety procedures.

CHE 514-Chemical Technology II (3 Units)

Fermentation. Manufacture of industrial alcohols, malt beverages and beer. Sugar from cane and beer. Processing of cassava and its derivatives. Palm oil and soap production. Detergents-natural and synthetic types; manufacture and biodegradability. Pulp and paper manufacture, specialty papers. Processing of vegetable oils and animal fats. Surface coatings and paint processing technology. Printing inks, polishes and adhesives.

CHE 516-Petrochemical Technology II (Optional)(3 Units)

Halogenation of paraffins- methane. Ethane, olefins, ethylene-liquid and gaseous phase halogenations processes. Chlorination products of olefins: methylchloride, synthetic fibres, glue and plastics, vinyl chloride from acetylene, Freon and antifreezes; hydrolysis,hydration, dehydration. Esterification processes in theproduction of solvents, plastificators, syntheticlubricants, and complex organic ethers. Monomers forabelingtion reactions, oxidation of paraffins and olefins; ethylene oxide and some higher oxides of hydrocarbons.Synthesis of amides; condensation of aldehyde witholefins: synthesis of isoprene, synthesis of rubber.

CHE 532 - Process Dynamics (3 Units) (Pre-requisite: FCE 301,302)

Components of a control system; operation and design. Basic control actions, valves. Transfer functions. Derivation of dynamic equations for simple instruments-thermometers, liquid level and manometer. Dynamic equations for simple models. Mixing vessels, single CSTR and CSTR in series. Use of block diagrams. Systems response to impulse. Step and sinusoidal inputs. Frequency response.

CHE 566 Environmental Pollution Control and Safety (2 Units)

Air and water pollution control legislation. Air and water quality standards, toxicity of pollutants to the natural environment. Air pollution control by particulates and gas removal. Filtration, cyclones, adsorption, combustion and dispersion. Water pollution control by biodegradation. Filtration, ion exchange, chemical treatment and coagulation. Noise pollution and sonic booms. Pollution monitoring and pollution control in petroleum industries. Treatment of refinery effluents.

CHE 564-Fuel Technology (2 Units)

Solid Fuel: Wood, peat and coal- their origin, classification and mechanical preparation, combustion of coal: low and high temperature cokes. Solid fuel for specific purposes: liquid fuels. Oil products derived fromcoal. The Fisher-Tropsch process. The oil fuels. Gaseous fuels: natural gas, coal gas. Fuel gas cleaning and Purification. Choice of fuels and fuel economics. Techno-economic aspects of renewable energies- the future and the present. Techno-economic aspects of non-renewable energies-the present and the foreseeable.

Status of Courses

All courses in the various degree programmes of the Niger Delta University are classified as follow:

i) Compulsory Courses
ii) Required Courses
iii) Elective Courses

i. Compulsory Courses:

These are course that must be registered for in a given programme of study and for which the student must earn a pass grade to meet graduation requirements.

ii. Required Courses:

These are prescribed and specific courses that students in specific disciplines must register for and may not have to earn a pass grade but must earn a minimum score of 30% to meet graduation requirements.

iii. Elective Courses:

Elective courses are usually optional in nature. These are courses that broaden the students' understanding in particular aspects of specific disciplines. These course also enable students to make up graduation requirements in term of credit unit and pass grade must be earned in them.

List of academic staff in the department

Name Of Staff	Rank/Designation/Salary Scale/Date of First Appointment	Tenured	Qualification Date Obtained Membershi Professional Association No of Publicatio
Dr. Reward K. Douglas	Senior Lecturer 5/3 2018	Tenured	B. Eng., 2007, NDU M.Sc 2014, Cranfield PhD. 2018, Cranfield
Engr. Prof. Ogoni A. Humphrey	Professor 7/10 LT/RUST 1983	Tenured	MSc. 1981, PhD 1998 Member. AIChE, NSE, NSChE COREN
Engr. Prof . Zekieni Robert Yelebe	Professor 7/2 LT/RSUST 2002	Tenured	B.Tech 2000, M.Tech 2004, PhD 2010. COREN, MNSE
Engr. Dr. Salome T. Torubeli	Professor 7/3 2000	Tenured	B.Tech 1998, RSUST; MRes 2002, universi Nottingham, UK; PhD 2013, University Nottingham, UK. MNSE, SPE; RCOREN (R. 260) 38 Publications
Engr.Woyengi-Ebinipre Burubai	Professor 7/3		B.Tech 2000, RSUST; M.Tech.2005RUST; 2010, RUST; ASABE, COREN
Engr. Dr Yousuo Digieneni	Associate Professor 5/4 2004	Tenured	B.Tech 1997, RSUST M.Eng. 2004 Uniport PhD 2014, Uniben COREN
Engr. Dr. Ketebu Orlando	Associate Professor 5/6 2002	Tenured	B.Eng 1999, Uniport M.Tech, 2006 RUST PhD 2014 Univ. of Newcastle

			UK. COREN registered R.16.25 9 25 publications
Dr. Kenneth P. Kelvin	Senior Lecturer 5/3 2008	Tenured	B.Eng. 2006 NDU, M.Sc 2010 University Nottingham UK; PhD 2019 University of Sussex; MNSE, COREN
Dr. Keneth Preye Aina	Senior Lecturer 5/3 2010	Tenured	B.Eng, 2006 NDU; M.Sc 2010 University Nottingham UK; Ph.D 2018, University o Town South Africa; RCORE; Several Publications.
Dr. Abraham Tomvie	Senior Lecturer 5/3 2002		B.Eng1998, RUST; M.Sc.2003Coventry U 2016, Coventry UK.
Engr. Dr. Matthew D. Castro	Senior Lecturer, 5/3 2004		B.Tech,2000 RUST; MSc 2005 Cranfield UK; Ph.D 2014 Cranfield Univ. UK
Engr. Dr. David W Ebregbe	Senior Lecturer 5/3 2002		B.Eng1987 RUST; M.Sc.2002, Loughboro UK. PhD 2013, Harbin Instituet of Tech.,
Engr. Dr. Olisa Yemi Philip	Senior Lecturer 5/3 2006		B.Eng1997, FUTY; M.Sc.2002UNILAG; Ph 2016, UNIBEN
Engr. Dr. Ebizimor A. Kiridi	Senior Lecturer 5/3		B.Sc (1999), M.Sc. (2006), Ph.D (2013) COREN
Engr. Dr. Kotingo Kelvin	Senior Lecturer 5/3		B.Sc. (2000), M.Sc. (2006). Ph.D (2022)
Engr. Dr.T. J. Ajoko	Senior Lecturer 5/3, 2010		B.Eng. (2007),M.Sc (2010), PhD (2020), RCOREN
Engr.Dr. Igbani Sunday	Senior Lecturer 5/4 2006		B. Tech (RUST) 2002 MSc (Coventry) , PhD (NDU) 2022
Dr. R.T Samuel	Lecturer I 4/8 2000	Tenured	B.Tech 1998 RUST; MRes 2002 University Nottingham, UK PhD Cranfield University 2016, UKMNSE,
Dr. Komonibo Ebuindu	Lecturer I 4/8 2018	Tenured	B.EngM.Sc PhDMNSE COREN
Dr. DudunaWilliam-Porbeni	Lecturer I 4/2	Tenured	B.Eng 2006, NDU; M.Sc. 2013, Surrey, UK RCOREN

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	2010		
Engr. Nelson A. Osaribie	Lecturer II 4/2 2010	Tenured	B.Eng. 2006 NDU M.Sc. 2013, Ahmadu Bello Uni. Zaria. RC
Engr. Dr. Ann A. J.O	Lecturer I 4/3, 2019		BSc. 2006, Univ. Of Cal; MSc 2015 Londo Bank Univ; Ph.D 2019, Univ. Of Port Harc
Mr. Ogbereyo Sunny	Lecturer II 2018 3/3 2018	Tenured	B.Eng. 2015, NDU MSc, 2018
Engr. Joseph Alah	Lecturer II 3/6 2010		B.Eng. 2008 NDU; M.Sc. 2015, Uni. RCO
Engr. Ifidi Wonyengitari-elado	Lecturer II 2018 3/3 2018	Tenured	B.Eng. 2009, NDU M.Sc 2014
Mr. Fetepigi Seigha	Lecturer II 3/5	Contract	B. Eng 1985, USA M.Sc 1987, USA
OTHERS			
Mr. ThankGod A. Atukpa	Graduate Assistant 1/2; 2023		B.Eng. 2021, NDU
Mr. Edoumiekumo O. Precious	Graduate Assistant 1/2; 2023		B.Eng. 2021, NDU
SUMMARY: Male = 25; Female = 3			

100 LEVEL ENGINEERING COURSES

ENGINEERING GRAPHICS I (FCE 131)

Course Time table				
Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:
Engineering Graphics	Engr. Prof. E. A. Ogbonnaya,	100 Level	First Semester	November, 2022 – March, 2023

I/FCE 131	Engr. Dr. B. E. Yabefa Engr. B. J. Jonathan			
Credit Unit: 2	Credit hours: 8	Class Timing: Tuesdays 12pm – 4pm Wednesdays 2pm – 6pm		

Course Description/Objectives

Drawing in general is an art of picturing an imagination. Thus, engineering drawing is the scientific representation of an object according to standardized requirement. The engineering graphics language had its existence when it became necessary to build new structures and create new machines. The absence of graphics language, the ideas on technical matters have to be conveyed by speech or writing, both are unreliable and difficult to understand in the manufacturing and production industries. It is also may produce lots of manufacturing errors hence, the engineering graphics as a course is aimed to cover these limitations. The importance of engineering drawing cannot be over emphasized, without engineering drawing, it would have been impossible to produce objects like automobiles, machines components, etc. Therefore, the objectives of the course is to hence students with the knowledge of object construction with lay-down engineering principles.

Course Outlines

Use of draughting instruments

Lettering dimensioning layouts.

Constructions of geometrical figures, comics, etc.

Graphical calculus and applications.

Development, intersection of curves and solids, tangents etc.

Projections – Orthographic and Isometrics, sectional views.

Recommended textbooks

"Technical Drawing", by B. A. Ozogu. Sadah Printing and Publishing, Port-Harcourt, Rivers State, Nigeria

"Engineering Drawing (Plane and Solid Geometry)", by N. D. Bhatt and V. M. Panchal. Charotas Publishing House PVT.LTD, Gujurat, India

"Machine Drawing", by K. L. Narayana, P. Kannaiah and K. V. Reddy. New Age International Publishers, New Deilhi, India

Course Learning Outcomes (CLOs)					
S/N	CLO	Domain	Taxonomy Level	PEO	Assessment
1	Recognize the fundamental concepts of engineering drawing and graphics	Cognitive	2	1	Classwork + Assignment + Test + Attendance
2	Have good knowledge of design and application in solving simple and complex engineering problems	Cognitive	3	2	Classwork + Assignment + Test + Attendance
3	Analyze engineering models for strength and cost production	Cognitive	4	3	Classwork + Assignment + Test + Attendance
4	Show skills of engineering objects in actionable solid models for simulation analyses	Cognitive	5	2	Classwork + Assignment + Test + Attendance

DETAILED LECTURE PLAN			
Week No	Lecture	Course Content to be Covered	References
1	1 – 2	Use of draughting instruments	"Technical Drawing", by B. A. Ozogu. Sadah Printing

2 – 3	3 - 4	Lettering dimensioning layouts	and Publishing, Port-Harcourt, Rivers State, Nigeria "Engineering Drawing (Plane and Solid Geometry)", by N. D. Bhatt and V. M. Panchal. Charotas Publishing House PVT.LTD, Gujurat, India "Machine Drawing", by K. L. Narayana, P. Kannaiah and K. V. Reddy. New Age International Publishers, New Deilhi, India
4 – 5	5 – 7	Constructions of geometrical figures, comics, etc	
6 – 8	8 – 10	Graphical calculus and applications	
9 – 11	11 – 12	Development, intersection of curves and solids, tangents etc.	
12 – 14	13 – 15	Projections – Orthographic and Isometrics, sectional views	
15	16 – 17	Revision	
16	Final Semester Examination		

ENGINEERING GRAPHICS II (FCE 132)

Course Time table				
Course Title/Code: Engineering Graphics II/FCE 132	Name of Lecturers: Engr. Prof. E. A. Ogbonnaya, Engr. Dr. B. E. Yabefa Engr. B. J. Jonathan	Class Level: 100 Level	Semester: Second Semester	Duration: November, 2022 – March, 2023
Credit Unit: 2	Credit hours: 8	Class Timing: Tuesdays 12pm – 4pm Wednesdays 2pm – 6pm		

Course Description/Objectives

Engineering graphics is a drawing course which enables an effective communication medium in engineering industries to furnish all needed information required for the manufacture and assembly of machine components and parts. It is understood by all with the knowledge of basic engineering principles of drawing. Thus, by this means, the shape, size, finish, colour and the construction of any object is described accurately, corrected and clearly. Hence, engineering graphics II is to enhance students the ability to use pictorial and freehand sketching, architectural drawing, etc.

Course Outlines

Pictorial/Freehand sketching

Conventional practices.

Architectural drawing.

Advance topics in auxiliary and sectional views

Developments, intersection of surfaces, projections, etc.

Recommended textbooks

"Technical Drawing", by B. A. Ozogu. Sadah Printing and Publishing, Port-Harcourt, Rivers State, Nigeria

"Engineering Drawing (Plane and Solid Geometry)", by N. D. Bhatt and V. M. Panchal. Charotas Publishing House PVT.LTD, Gujurat, India

"Machine Drawing", by K. L. Narayana, P. Kannaiah and K. V. Reddy. New Age International Publishers, New Deilhi, India

Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEO	Assessment
1	Understanding the basic language of engineering drawing and graphics	Cognitive	2	1	Classwork + Assignment + Test + Attendance
2	Design simple architectural drawings	Cognitive	6	2	Classwork + Assignment + Test + Attendance
3	Analyze engineering drawings using	Cognitive	4	3	Classwork + Assignment + Test + Attendance

	various views				

DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1 – 2	Pictorial/Freehand sketching	"Technical Drawing", by B. A. Ozogu. Sadah Printing and Publishing, Port-Harcourt, Rivers State, Nigeria "Engineering Drawing (Plane and Solid Geometry)", by N. D. Bhatt and V. M. Panchal. Charotas Publishing House PVT.LTD, Gujurat, Indi "Machine Drawing", by K. L. Narayana, P. Kannaiah and K. V. Reddy. New Age International Publishers, New Deilhi, India
2 – 3	3 - 4	Conventional practices	
4 – 5	5 – 8	Architectural drawing Plans Views (front, back and sides) Structural drawings Mechanical and Electrical drawings	
6 – 7	9 – 10	Advance topics in auxiliary and sectional views Introduction of sectional views Full sectioning Half sectioning Auxiliary sections	
8 – 10	11 – 13	Developments Introduction Development of objects Cylinder, square prism, polygons Cone, oblique hexagonal pyramid, truncated cone, etc	
11	14	Intersection of surfaces	
12 – 14	15 – 18	Projections Orthographic Projections – Introduction First angle projection Third angle projection Axonometric Projections – Introduction Axonometric representation	

		Conventional isometric projections Circles and curves drawn in Isometric views Oblique Projections – Introduction The axes, chice of angles,	
15	19 – 20	Revision	
16	**Final Semester Examination**		

200 LEVEL ENGINEERING COURSES

ENGINEERING GRAPHICS III (FCE 261)

Course Time table				
Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:
Engineering Graphics III/FCE 261	Engr. Prof. E. A. Ogbonnaya Engr. Dr. B. E. Yabefa Engr. B. J. Jonathan	200 Level	First Semester	November, 2022 – March, 2023
Credit Unit: 2	Credit hours: 4	Class Timing: Tuesdays 12pm – 2pm Thursday 12pm – 2pm		

Course Description/Objectives
Engineering drawing is a critical aspect of mechanical engineering, as it is the fundamental need to develop the design and assembly of a machine. While the interpretation of a component in terms of sketching can be done in various methods related to descriptive Geometry. The focus of this course is to hence students on presentation drawings of various kinds such as gears, cam profiles, etc. It also enables students on different engineering design drawings.

Course Outlines
Introduction to limits. Fits and tolerance. Surface roughness determinations. Drawing methods for cam profiles.

Presentation of types of gears. Drawing of various types of gears.

Assembly drawing of elements. Sub-assembly drawing of elements.

Workshop drawing correction. Modification of drawings symbols.

Reading of blueprints. Geometrical Constructions. Principles of Tangency. Orthographic Projections. Sectional views. Dimensioning.

Recommended textbooks

"Technical Drawing", by B. A. Ozogu. Sadah Printing and Publishing, Port-Harcourt, Rivers State, Nigeria

"Engineering Drawing (Plane and Solid Geometry)", by N. D. Bhatt and V. M. Panchal. Charotas Publishing House PVT.LTD, Gujurat, India

"Machine Drawing", by K. L. Narayana, P. Kannaiah and K. V. Reddy. New Age International Publishers, New Deilhi, India.

Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEO	Assessment
1	Define the basis of limits, fits and tolerance	Cognitive	1	2	Classwork + Assignment + Test + Attendance
2	Draw the various methods of cam profiles	Cognitive	6	4	Classwork + Assignment + Test + Attendance
3	Describe the various types of gears and their drawing techniques.	Cognitive	4	4	Classwork + Assignment + Test + Attendance
4	Explain drawing elements and apply CAD in engineering drawing	Cognitive	3	4	Classwork + Assignment + Test + Attendance

DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Introduction to limits	"Technical Drawing", by B. A. Ozogu. Sadah Printing and Publishing, Port-Harcourt, Rivers State, Nigeria "Engineering Drawing (Plane and Solid Geometry)", by N. D. Bhatt and V. M. Panchal. Charotas Publishing House PVT.LTD, Gujurat, India "Machine Drawing", by K. L. Narayana, P. Kannaiah and K. V. Reddy. New Age International Publishers, New Deilhi, India
2	2 - 3	Fits and tolerance	
3 – 4	4 – 5	Surface roughness determinations	
5 –6	6 – 11	Drawing methods for cam profiles	
7 – 8	12 – 14	Presentation of types of gears. Drawing of various types of gears	
9 – 10	15 – 17	Assembly drawing of elements. Sub-assembly drawing of elements	
11	18	Workshop drawing correction. Modification of drawings symbols	
12	19	Reading of blueprints. Geometrical Constructions. Principles of Tangency	
13	20 – 21	Orthographic Projections.	
14		Sectional views. Dimensioning	
15	22 – 23	Revision	
16	**Final Semester Examination**		

ENGINEERING STATICS (FCE 265)

Course Time table				
Course Title/Code: Engineering Statics/FCE 265	Name of Lecturers: Engr. Prof. A. N. Okpala, Engr. Dr. T. J. Ajoko, Engr. G. Banje	Class Level: 200 Level	Semester: First Semester	Duration: November, 2022 – March, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 12pm – 2pm		

		Wednesdays 12pm – 2pm

Course Description/Objectives

The course teaches students the concept of engineering statics. The student will be introduced to ideas of applied loads in different static engineering materials and the behaviour of the materials under the load application. It teaches load application in equilibrium condition, different kind of force systems on structures like frames, trusses, etc. It also describes the action of shear forces and bending moment on engineering components. This course familiarizes students with the principles of static equilibrium by applying Newton's laws of motion to solve engineering problems. Emphasis is placed on drawing free body diagrams and self-checking strategies.

Course Outlines

Apply Newton's laws of motion on problems of engineering statics.
Identify the different force action on engineering components.
Analyse different force systems, their resultant, magnitude and direction.
Determine shear force and bending moment analysis with their corresponding diagrams.
Solve simple problems involving friction between surfaces and moment of inertia on plane figure, composite bodies, etc

Recommended textbooks

"Engineering Mechanics", by D.S. Kumar. S.K Kataria & Sons Publishers of Engineering and Computer Books, New Delhi, India

"Engineering Mechanics – Statics", by E.W. Nelson, C.L. Best, W.G. McLean, M.C. Potter. Tata McGraw Hill Education Private Limited, New Delhi, India

Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEO	Assessment
1	Apply Newton's laws of motion on problems of engineering statics.	Cognitive	3	1	Classwork + Assignment + Test + Attendance

2	Describe the concept of mathematical modelling to Engineering problems.	Cognitive	2	1	Classwork + Assignment + Test + Attendance
3	Analyse forces to vertical and horizontal components, define and classify force systems.	Cognitive	4	1	Classwork + Assignment + Test + Attendance
4	Differentiate between shear force and bending moments, the types of friction and their application to engineering equipment.	Cognitive	2	1	Classwork + Assignment + Test + Attendance
5	Calculate problems in moment of inertia for plane figures and composite bodies.	Cognitive	5	1	Classwork + Assignment + Test + Attendance

DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1 – 2	Basic Concepts – Newton's Law of Motion First Law Law of Inertia	Engineering Mechanics by D.S. Kumar. S.K Kataria & Sons Publishers of

		Second Law Third Law Mathematical Modelling	Engineering and Computer Books, New Delhi, India
2 – 3	3 - 5	Force Systems Colinear force system Coplanar and spatial force system, Non-coplanar force system Parallel and Non-parallel, Like and unlike force systems, etc. Equilibrium Condition and Resultant of forces.	Engineering Mechanics – Statics by E.W. Nelson, C.L. Best, W.G. McLean, M.C. Potter. Tata McGraw Hill Education Private Limited, New Delhi, India
4 – 5	6 – 8	Shear Forces and bending moments in beams and shafts	
6 – 8	9 – 11	Trusses and Frames	
9 – 11	12 – 14	Friction between dry surfaces	
12 – 14	15 – 18	Moment of Inertia, plane figures and composite bodies.	
15	19 – 20	Revision	
16	**Final Semester Examination**		

ENGINEERING DYNAMICS (FCE 262)

Course Time table				
Course Title/Code: Engineering Dynamics/FCE 262	Name of Lecturers: Engr. Dr. Agonga Oyinbonogha Fred Engr. Dr. Otuami Obiga	Class Level: 200 Level	Semester: Second Semester	Duration: April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 12am – 2pm Wednesdays 2pm – 4pm		

Course Description/Objectives

Dynamics is a branch of mechanics that deals with the motion of bodies under the action of forces. The two distinct aspects of dynamics are kinematics and kinetics. In this course the focus will be on 2D dynamics, hence students are expected to learn 2D kinematics and kinematics with adequate attention given to real life application.

Course Outlines

1. Plane kinematics and kinetics of particles.
2. Kinetics of particle; Newton's laws of motion.
3. Work and Energy, conservation of energy and momentum, fields of forces,
4. Impact coefficient of restitution.
5. Kinetics of system of particles.
6. Generalized Newton's second law, steady mass flow and variable mass rocket motion.
7. Plane kinematics and kinetics of rigid bodies.
8. 3D dynamics of rigid bodies, gyroscopic motion and gyroscopic stabilization.

RECOMMENDED TEXTBOOKS

1 Engineering Mechanics Dynamics J.L. Meriam and L.G. Kraige (6th edition)

2 Engineering Dynamics A comprehensive introduction, N. Jeremy Kasdin and Derek A. Paley

Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEO	Assessment
1	To understand and analyze 2D kinematics and kinetics dynamics systems.	Cognitive	3	1	Classwork + Assignment + Test + Attendance
2	Application of knowledge of vectors in solving 2D kinematics and kinetics dynamics problems.	Cognitive	2	1	Classwork + Assignment + Test + Attendance

3	To understand the different types of motion, impact and collision	Cognitive	2	1	Classwork + Assignment + Test + Attendance
4	Application of Newton's 2nd Law in solving dynamics problems.	Cognitive	4	1	Classwork + Assignment + Test + Attendance
5	Use of energy method in solving dynamics problems.	Cognitive	5	1	Classwork + Assignment + Test + Attendance

DETAILED LECTURE PLAN			
Week No	Lecture	Course Content to be Covered	References
1	1 – 2	BASIC CONCEPTS OF ENGINEERING DYNAMICS • Introduction to engineering dynamic • Define and evaluate basic terms associated with Engineering Dynamics • Kinematics of a particle • Kinetics of a particl • Newton's Laws of motion	1 Engineering Mechanics Dynamics J.L. Meriam and L.G. Kraige (6th edition) 2. Engineering Dynamics A comprehensive introduction, N. Jeremy Kasdin and Derek A.
2 – 3	3 - 5	RECTILINEAR AND CURVILINEAR MOTION Displacement, velocity and acceleration Graphical representation Rectilinear and curvilinear motion Equations of rectilinear motion Motion under gravity Curvilinear motion	

4 – 5	6 – 8	PROJECTILES Projectile motion Equations of projectile path Projection on an inclined plane	
6 – 8	9 – 11	COLLISION OF ELASTIC BODIES Collision of Elastic Bodies Types of impact Elastic and Inelastic impact Conservation of momentum Newton's Law of Collision: Coefficient of restitution Loss of Kinetic energy during impact Oblique-Central Impact	
9 – 11	12 – 14	KINETICS: IMPULSE MOMENTUM, WORK AND ENERGY	
12 – 14	15 – 18	KINETICS OF ROTARY MOTION	
15	19 – 20	Revision	
16	Final Semester Examination		

FLUID MECHANICS I (FCE 232)

Course Time table				
Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:
Fluid Mechanics I/FCE 232	Engr. Dr. Y. P. Olisa Engr. Dr. A. E. Amos Engr. Goodnews Arobe	200 Level	Second Semester	April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Wednesday 8am – 10am Thursday 10am – 12pm		
Course Description/Objectives				

Fundamentals of fluid mechanics introduces students to the basic concept of fluid mechanics such as fluid characteristics, fluid properties, dimensional analysis and unit. It gives the basic principles and theories of fluid static condition and fluid motion. For fluid static, students will understand the pressure, buoyancy forces in submerged bodies and stability of bodies in fluid. Fluid in motion, students are taught the basic laws of conservation of mass, energy and momentum. Bernoulli's equations and momentum equations as application to compressible and incompressible flows. Students will be able to describe and differentiate between a Newtonian and Non-Newtonain fluids, ideal/real friction losses. Students will be introduced to types of flow measurements. Also introduced to analytical application of solving different types of engineering problems.

Course Outlines

Introduction to the properties of fluid mechanics (density, viscosity, etc), fluid characteristics, Newton's law, hydrostatic laws, dimension measurement and units

Introduction to pressure and pressure measurement.

Introduction and derivation of basic laws, theories and equations fluid flow continuity energy equation and momentum equation as applicable to fluid flow in real and ideal conditions.

Application of these laws in solving problems with fluid at rest and in motion.

Introduction to fluid flow measurement, pressure, velocity, rate of discharge.

RECOMMENDED TEXTBOOKS

Fluid Mechanics and Hydraulic Machines by R. K. Rajput.

Fluid Mechanics by Douglas J. F. Gasiorek, J. M. Swaffield J. A. and Lynn Jack

Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Analyse the properties and characteristics of fluid (density, viscosity, etc) Newton's law, hydrostatic laws,	Cognitive	2	2	Classwork + Assignment + Test + Attendance

	dimension measurement and units				
2	analyse pressure and pressure measurement.	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Evaluate the hydrostatic forces in fluids	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Evaluate the basic laws and principles fluid	Cognitive	3	3	Classwork + Assignment + Test + Attendance

DETAILED LECTURE PLAN			
Week No	Lecture	Course Content to be Covered	References
1	1 – 2	Introduction to fundamental concept of fluid mechanics, properties of fluid (viscosity, density, specific gravity).	Engineering Mechanics Dynamics J.L. Meriam and L.G. Kraige (6th edition) Engineering Dynamics A comprehensive introduction, N. Jeremy Kasdin and Derek A. Paley
2	3 – 4	Thermodynamic properties – compressibility and Bulk Modulus vapour Pressure	
3	5 - 7	Introduction to pressure/measure, pressure head, Pascal law, absolute, Gauge and atmospheric pressure.	
4	8 – 9	Use of manometers and mechanical gauges for pressure measurement.	
5	10	Introduction to hydrostatic forces on immersed surfaces.	
6 – 7	11 – 12	Horizontal and vertical induced surfaces application for problem solving.	
8 – 9	13 – 14	Introduction to Buoyancy condition of bodies in fluid stability, meta centre, meta-centre height	

		application in solving problems.	
10 – 11	15 – 16	Introduction to fluid types and flows, steady/unsteady, uniform/non-uniform, one, two, three-dimensional flow, rotational/irrotational flow, laminar/turbulent flow, compressible/incompressible flow.	
12 – 13	17 – 19	Fluid dynamics, different heads, derivation of Bernoulli's Euler's Equations for ideal and real fluid.	
14	20	Derivation of momentum equation, application to fluid measurement (flow rate, velocity, pressure)	
15	21 – 22	Revision	
16	Final Semester Examination		

WORKSHOP TECHNOLOGY (FCE 263)

Course Time table				
Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:
Workshop Technology (FCE 263)	Engr. Dr. K, Kotingo Engr. Dr E. Amula	200 Level	First Semester	April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Monday 10pm – 12pm Friday 12pm – 2pm		

Course Description/Objectives
The course introduces students to the various manufacturing processes, types of patterns and pattern making, molding sand and sand casting operations ,welding processes and various metal forming operations, measuring instruments, forging operations and carpentry and joinery as well as industrial safety and good house-keeping practices

Course Outlines

Types of pattern and pattern making, molding sand, molding process; machine molding.

Ferrous and non-ferrous casting, sand casting, and casting defects.

Arc and gas welding processes, soldering and brazing.

Introduction to lathe; milling, shaping, cutting and drilling operations. Cutting fluids.

Carpentry and joinery processes. Forging, Industrial safety, good house keeping.

Recommended textbooks

A Textbook of Workshop Technology (Manufacturing Processes) By R.S Khurmi and J.K Gupta.

B.S Raghuwanshi (2011) Workshop Technology.Vol 11 (Machine Tools)

Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Identify the principles of pattern making, molding sand, manufacturing processes and metal forming processes.	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Description of the fundamentals of production parts by casting techniques, sand casting outlines, ferrous and non-ferrous castings	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Evaluation of the Industrial safety practices, good house keeping, carpentry	Cognitive	5	1	Classwork + Assignment + Test + Attendance

4	Application of cutting fluids, introduction to lathe machine	Cognitive	5	3	Classwork + Assignment + Test + Attendance
5	Description of forging, engineering measurement, gauging, joinery.	Cognitive	3	3	Classwork + Assignment + Test + Attendance

DETAILED LECTURE PLAN

Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Introduction to industrial safety, PPE, carpentry and joinery	(1) B.S Raghuwanshi (2011) Workshop Technology.Vol 11 (Machine Tools) (2)A Textbook Of Workshop Technology (Manufacturing Processes) By R.S Khurmi And J.K Gupta.
2	2 - 3	The Study of patterns, types of patterns and pattern making	
3	4	The Study of foundry tools, molding and sand molds	
4	5	Introduction to lathe and working principles, milling and cutting	
5	6	Introduction to arc and gas welding processes, soldering, slotting	
6	7 – 9	Cutting fluids and types of cutting fluids	
7 – 9	8 – 12	Casting defects, forging	
10 – 11	13 – 15	Engineering measurements	
12 – 13	16 – 18	Test/continuos assessment	
14	19 – 20	Practical Section	
15	21 – 22	Revision	
16	**Final Semester Examination**		

300 LEVEL COURSES

CHEMICAL ENGINEERING THERMODYNAMICS (CHE 321)

1. Course Time table				
Course Title/Code: Chemical Thermodynamics/CHE 321	Name of Lecturers: Dr. Rewrad K. Douglas	Class Level: 300 Level	Semester: First Semester	Duration: April, 2023 – July, 2023
Credit Unit: 4	Credit hours: 4	Class Timing: **Tuesdays 12noon – 2pm** **Wednesday 2pm – 4pm**		

2. Course Description/Objectives

This course introduces to the need for second Law and calculation of entropy changes. Students are taught thermodynamic potentials; Free energy and functions; Chemical potentials and affinity of reactions; Equilibrium in chemical reaction systems; Equilibrium constant of a reaction. Third Law of thermodynamics; Thermal data; Thermodynamics of electrochemical cells; Work production from chemically reacting systems; Phase relations and thermodynamics of solutions; and Equilibrium in heterogeneous reactions are taught.

3. Course Outlines

1. Review of the Second Law of thermodynamics; the nature of the second law; and the statement of the second law of thermodynamics (concept of entropy). Also, processes - isobaric, isothermal, adiabatic, polytropic; and work, heat, internal energy, etc. shall be revised. Students shall be taught reversible processes and cycles; heat engines.
2. Review of thermodynamic temperature scale; proof that S is a thermodynamic property; know the general equations for the S of ideal gas; S of real gas; and plot temperature-entropy (T-S) diagrams. Calculation of the change in entropy (ΔS). Adiabatic mixing. Derivation of expression for the combined form of the **1st** and **2nd** Law of thermodynamics.
3. The need for the **3rd** Law of thermodynamics; formulation of **3rd** Law; Planck's formulation; apparent exceptions to the **3rd**; and the usefulness of Thermal data.
4. Learn free energy: Gibb's free energy (G) changes for a process at known pressures, and also calculate the G at one pressure level if the free energy at the other pressure level is known; define chemical potential, and its mathematical expression. Students will be taught phase relations and thermodynamic of solutions.

5. To write equilibrium constant (K) expression (s) using various chemical reactions, and its determination; reaction stoichiometry Gibb's and Planck's functions as criteria of equilibrium in isothermal changes of state at constant pressure. Derivation of Gibbs-Helmholtz Equation and its application.
6. Rankine cycle, Carnot cycle etc; their schematic presentations, derivation and calculation of network done.
7. The difference between diffusers, nozzles, compressors, expanders, and turbines, etc.; and their applications.

RECOMMENDED TEXTBOOKS

Introduction to Chemical Engineering Thermodynamics, Sixth Edition in SI Units- **J.M. Smith; H.C. Van Ness; and M.M. Abbott.**

Introduction to Chemical Engineering Thermodynamics, Second Edition-**Gopinath Halder;** 2014

Chemical Engineering. An introduction. Morton M. Denn, 2012.

The Beginner's Guide to Engineering. Chemical Engineering. John T. Stimus, 2013.

4. Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	The application the Second Law of thermodynamics in problem solving	Cognitive	3	1	Classwork + Assignment + Test + Attendance
2	The usefulness of Thermal data	Cognitive	2	1	Classwork + Assignment + Test + Attendance
3	Evaluation of various operational steps of: Rankine cycle, Carnot cycle etc;	Cognitive	4	1	Classwork + Assignment + Test + Attendance
4	Analysis of	Cognitive	2	1	Classwork + Assignment +

	diffusers, nozzles, compressors, expanders, and turbines.				Test + Attendance

5. DETAILED LECTURE PLAN			
Week No	Lecture	Course Content to be Covered	References
1	1 – 2	1. Introduction of course contents; and recap of the **1st** Law of Thermodynamics. 2. Needs for the 2nd law **(**limitations of the **1st** Law); Basic concepts of heat engines, heat pumps, and refrigerators.	Introduction to Chemical Engineering Thermodynamics, Sixth Edition in SI Units- **J.M. Smith; H.C. Van Ness; and M.M. Abbott.** Introduction to Chemical Engineering Thermodynamics, Second Edition-**Gopinath Halder.**
2 – 3	3 - 5	**Statement of Second Law:** 1. Kelvin-Planck statement, Clausius statement, and equivalence of Kelvin-Planck and Clausius statements. 1. Efficiency of Carnot cycle, Carnot theorem, Ideal-gas temperature scale, PV-diagram showing Carnot cycle for an ideal gas. **Class exercise**	
4 – 5	6 – 8	**The concept of entropy and calculations of entropy changes:** Entropy- a thermodynamic state function; entropy-at a glance; relationship between entropy and internal energy; relationship between entropy and enthalpy. Calculation of entropy changes-entropy changes in reversible and irreversible processes; entropy at phase change; entropy changes of ideal gases, entropy change with	

		temperature. **Class exercise.**	
6 – 8	9 – 11	**Mathematical statement of the Second Law, and the Third Law:** Entropy balances for open systems; calculation of ideal work. Entropy: microscopic point of view; criterion for irreversibility, Clausius inequality. **Class exercise.**	
9 – 11	12 – 14	**Free energy functions:** Helmholtz free energy (work function); Gibb's free energy (Gibb's function); Gibb's- Helmholtz equation.	
12 – 14	15 – 18	1. **Free energy functions:** General equations for differential changes in internal energy, enthalpy, and entropy. TdS Equations, Heat capacity relations. 2. Thermal data	
15	19 – 20	General Revision and Test.	
16	**Final Semester Examination**		

6. EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Class Seminar/Attendance Assignment Test	10% 10% 10%
Examination	Semester Examination	70%
Total		100%

Process Calculation (CHE 351)

1. Course Time table				
Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:

Process Calculation/CHE 351	Engr. Dr. Reward K. Douglas	300 Level	First Semester	November, 2022 – March, 2023
Credit Unit: 3	Credit hours: 3	Class Timing: Tuesdays 10am – 12noon		

2. Course Description/Objectives

In this course students are introduced into the basic definitions: Chemical equations and stoichiometry; combustion; Ideal gas laws; Real gas relationships; Vapour pressure, saturation and humidity. Students are to understand Material balances and do calculations involving different systems- steady state processes involving chemical reaction, stepwise counter-current processes, recycle, bypass, and purge calculations, condensation and abeling. Also students introduced into energy balances and carry out calculations. Calculation of enthalpy changes, without change of phase and for phase transitions are to be carried out. Students are also introduced into combined material and energy balances for steady state and unsteady state processes.

3. Course Outlines

Write and balance chemical equations; determine stoichiometric coefficients in reactions. Determine limited reactants, excess reactants, extent of reaction, conversion, selectivity, and yield in reactions.

Know the difference between steady and unsteady processes. Write material balances: steady state processes involving chemical reactions, and solve problems. Write energy balance equations for processes, and solve problems.

Write combined material and energy balances for steady state and unsteady state processes; and solve problems.

Know how recycle, bypass, and purge work, and their importance in the process industry.

Calculate enthalpy changes involving without change of phase and for phase transitions.

Recommended textbooks

1. Basic Principles and Calculations in Chemical Engineering, 6ixth Edition-**David M.**

Himmelblau.

4. Course Learning Outcomes (CLOs)					
S/N	CLO	Domain	Taxonomy Level	PEO	Assessment
1	Determination of limited reactants, excess reactants, extent of reaction, conversion, selectivity, and yield in reactions.	Cognitive	3	1	Classwork + Assignment + Test + Attendance
2	Evaluation of conversion, selectivity, and yield in reactions.	Cognitive	4	1	Classwork + Assignment + Test + Attendance
3	Application of recycle, bypass, and purge in the process industry	Cognitive	4	1	Classwork + Assignment + Test + Attendance
4	To differentiate between steady and unsteady processes.	Cognitive	4	1	Classwork + Assignment + Test + Attendance
5	Application of combined material and energy balances for steady state and unsteady state problems.	Cognitive	5	1	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN			
Week	Lecture	Course Content to be Covered	References

No			
1	1	**Introduction** Introduction of course contents; Revision on chemical equations and balancing of chemical equations.	Engineering Mechanics Dynamics J.L. Meriam and L.G. Kraige (6th edition) Engineering Dynamics A comprehensive introduction, N. Jeremy Kasdin and Derek A. Paley
2 – 3	2–3	**Chemical equations and stoichiometry** Meaning and determination of stoichiometric ratios, and quantity; Terminologies for application of stoichiometry: Extent of reaction, limiting reactant, excess of reactant, conversion, selectivity, and yield. Class exercise	
4 – 5	4 – 6	Combustion, Ideal gas laws, Real gas relationships, Vapour pressure, Saturation, and Humidity. Class exercise	
7 – 8	7 – 9	**Material balances** Steady state processes involving chemical reactions, step-wise counter-current processes, recycle, bypass, and purge calculations, condensation and abeling. **Class exercise**	
9 – 11	10 – 12	Energy balances, Heat capacity, Calculation of enthalpy changes without change of phase and for phase transitions, and heat of reaction. **Class exercise**	
12 – 14	13 – 15	Combined material and energy balances for steady state and unsteady state processes. **Class exercise**	
15	16 – 18	General Revision and Test.	

16	Final Semester Examination

6.EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Class Seminar/Attendance Assignment Test	5% 10% 15%
Examination	Semester Examination	70%
Total		100%

FLUID PARTICLE TECHNOLOGY (CHE 353)

1. Course Time table				
Course Title/Code: Fluid Particle Technology/ CHE 353	Name of Lecturer: Engr. W. Ifidi ,	Class Level: 300 Level	Semester: First Semester	Duration: September, 2023 – December, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Tuesdays 12pm – 2pm Thursdays 8am – 12pm (Lab)		

2. Course Description/Objectives
This is as an introductory course in particle technology. The course describes and explains the fundamentals of fluid-particle mechanics, which are essential for the understanding of numerous industrial fluid-solid processes like packed bed operation, fluidization, sedimentation, filtration, separation of solids from fluids, etc. Along with the fundamentals, industrial applications will also be discussed. Particle technology is of increasing importance to a wide range of industries, including food, pharmaceuticals, chemicals, minerals, and metals. In these industries, graduates with knowledge

of particle technology have a competitive advantage in product development, quality control and waste minimization.

3. Course Outlines

Identify methods of particle size measurement.

Characterize solid particles by size distribution.

Explain the motion of particles through fluids.

Identify the various flow regimes and their relationship to the drag coefficient.

Develop the general equation for the total force acting on a body in any force field.

Derive Stokes law for the terminal velocity of a particle falling in a fluid.

Design a gravity settling tank,

Explain the principle of centrifugal separation of solids from liquids, and between two liquids of different densities.

Explain fluid flow through packed beds and the hydrodynamics of fluidized beds.

Introduction to drying and dehumidification.

Recommended textbooks.

Martin Rhodes: Introduction to Particle Technology, 2nd Edition: John Wiley & Sons 2008

McCabe W.L, Smith J.C, Harriot P, Unit Operations of Chemical Engineering, 5th Edition: McGraw-Hill, Inc.

Coulson, J. M & Richardson, J. F.: Chemical Engineering Series Vol 2: Particle Technology and Separation Processes, 5th Edition, Butterworth-Heinemann

4. Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand flow around immersed bodies, Concept of Drag force and boundary layer separation	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Analyse the motion of particles in a	Cognitive	3	2	Classwork + Assignment + Test + Attendance

	fluid, effect of particle shape and influence of boundaries on terminal velocity				
3	Introduction to separation of solids from fluid, design of gravity settling tank, cyclone, and centrifuge	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Fluid flow through granular and packed beds of particles.	Cognitive	4	3	Classwork + Assignment + Test + Attendance
5	Derivation of the Carman-Kozeny, Burke-Plummer and Ergun's equations for pressure drop in a packed bed.	Cognitive	4	2	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Introduction to the concept of drag force, boundary layer separation and particle classification	1. Theory Martin Rhodes: Introduction to Particle Technology, 2nd Edition: John Wiley & Sons 2008 2.McCabe W.L, Smith J.C,
2	2	Derivation of the terminal velocities for Newton's and Stoke's law. Design of the Gravity Settling Tank	

3	3	Application of the fundamental principle of fluid flow in cyclone separation and centrifugation	Harriot P, Unit Operations of Chemical Engineering, 5th Edition: McGraw-Hill, Inc 3.Coulson, J. M & Richardson, J. F.: Chemical Engineering Series Vol 2: Particle Technology and Separation Processes, 5th Edition, Butterworth-Heinemann
4	4	Introduction to hydrodynamic of single-phase flow through packed beds.	
5-6	5	The total pressure-drop of fluid flow past an object. Carman-Kozeny, Burke-Plummer and Ergun's equation for pressure drop in a packed bed.	
7	5	Introduction to fluidization and fluidization theory, Calculation of pressure drop in liquid and gas fluidized beds and minimum fluidization velocity	
8-9	6	Vapor-liquid Equilibria, Raoult's law, Dalton's law of partial pressure and determination of vapor pressure	
10	7	Equilibrium Phase Diagram and calculation of the number of trays using the McCabe Thiele Method	
11		Practical Section	
12		Revision	
	Final Semester Examination		

6. EVALUATION CRITERIA

Component of Assessment	Methods	Marks
During Semester	Classwork	5%
	Laboratory Practical	10%
	Test	10%
	Class Attendance	5%
Examination	Semester Examination	70%
Total		100%

SEPARATION PROCESSES 1 (CHE 314)

1.Course Time table				
Course Title/Code: Fluid Particle Technology/ CHE 314	Name of Lecturer: Engr. W. Ifidi,	Class Level: 300 Level	Semester: Second Semester	Duration: January 2024 – March, 2024
Credit Unit: 3	Credit hours: 4	Class Timing: Tuesdays 8pm – 10pm Thursdays 8am – 12pm (Lab)		

2.Course Description/Objectives
This course covers the principles and design of large-scale diffusional separation processes in equilibrium-stage and processes mass transfer continuous-contact operations. Throughout emphasis is placed on developing quantitative problem-solving skills that will be essential to practicing graduates. This course introduces the fundamental concepts of equilibrium and rate-based analysis of separation processes and gives examples of relevant separation processes. It introduces the concept and analysis of a unit operation as applied to separation processes and demonstrates the analysis of relevant separation processes by applying mass and energy balance methods. Separation processes are a core part of global chemical engineering, making up a large proportion of capital investment in plants, and are vital to economically produce useful and safe products.
3.Course Outlines
. Apply phase equilibria principles to mass transfer problems. . Introduction to the phenomenon of equimolar counter diffusion and heat transfer . Equilibrium Phase diagrams and equilibrium curve. . The concept of bulk flow in mass transfer and diffusion through a stationary gas. . Heat and mass transfer with internal generation . Describe various stage-wise and continuous separation units. . Integrate principle concepts of mass transfer to analyse mass transfer equipment . Analyse and design gas absorption, distillation equipment.

Recommended textbooks

Treybal R. E.: Mass Transfer Operations, 2nd Edition: McGraw-Hill

Er. R.K. Rajput: Heat and Mass Transfer: S. Chand & Company

Binay K. Dutta: Principles of Mass Transfer and Separation Processes

McCabe W.L, Smith J.C, Harriot P, Unit Operations of Chemical Engineering, 5th Edition: McGraw-Hill

4.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand the principles for designing selected separation units including distillation columns, gas absorption columns, extraction processes, washing and leaching processes, membrane processes and adsorption columns.	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Understand and explain the fundamental principles involved in these separation processes based on equilibrium and mass transfer processes	Cognitive	2	1	Classwork + Assignment + Test + Attendance

3	Perform analysis and size separation processes using concepts including mass and energy balance, thermodynamics, heat and mass transfer, fluid mechanics, and phase equilibria.	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Demonstrate skills in assessment of separation unit performance and optimisation	Cognitive	4	3	Classwork + Assignment + Test + Attendance
5	Understand and read diagrams and tables such as phase diagrams, equilibrium curve.	Cognitive	4	3	Classwork + Assignment + Test + Attendance

5.DETAILED LECTURE PLAN

Week No	Lecture	Course Content to be Covered	References
1	1	Heat and Mass Transfer (Fick's law and Fourier's law Simple transfer of transferent property & the concept of tortuosity Role of the Area presented for transfer of the transferent property.	1. Treybal R. E.: Mass Transfer Operations, 2nd Edition: McGraw-Hill 2. Er. R.K. Rajput: Heat and Mass Transfer: S. Chand & Company

2 -3	2	Heat and mass transfer with internal generation, Example application to a cylinder in which heat is internally generated/mass is internally generated during a first order chemical reaction.	3. Binay K. Dutta: Principles of Mass Transfer and Separation Processes 4. McCabe W.L, Smith J.C, Harriot P, Unit Operations of Chemical Engineering, 5th Edition: McGraw-Hill
4-5	3	Vapor-Liquid Equilibria Raoult's law Henry's law The Temperature-Composition diagram and how it is obtained. Determination of the bubble point and dew point for a given liquid composition x, or a given vapor composition y. Equilibrium curve Determination of the minimum number of theoretical plates	
6-7	4	Description of separation processes: stagewise contacting processes, cascades, co-countercurrent flows	
8-9	5	Membrane separation processes: Applications to Reverse Osmosis & Dialysis Knudsen diffusivity Molecular diffusivity	
10		Practical Section	
11		Revision	
	Final Semester Examination		

6.EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Classwork	5%

	Laboratory Practical Test Class Attendance	10% 10% 5%
Examination	Semester Examination	70%
Total		100%

FUNDAMENTALS OF PETROLEUM ENGINEERING (CHE 311)

1. Course Time table

Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:
Fundamentals of Petroleum Engineering (CHE 311)	Engr. Dr. Duduna William-Porbeni	300 Level	First Semester	
Credit Unit: 3	Credit hours: 4	Class Timing: Monda 8:00am to10:00am. Wednesday 8.00am to 10.00am.		

2. Course Description/Objectives

Introduction to petroleum engineering is a critical and fundamental course in Chemical Engineering study. To produce Chemical Engineering graduates going into oil and gas industries and research in the petroleum oil and gas fields, the course is designed to expose students to the science of hydrocarbon crude formation, reservoirs, drilling, processing and storage of crude petroleum. The topics covered in the course will introduce students to various activities related to the production of hydrocarbons, crude oil or natural gas.

It further introduces the chemical engineering undergraduate students to the fundamental terminologies and concepts from geology, geophysics, drilling, production, and reservoir engineering. It covers upstream sector of the oil and gas industry, which are the activities of finding and producing oil and gas.

This course is designed to introduce the student the broad understanding of the engineering technology needed to produce oil and gas. The learning outcomes will afford students with the basic understanding of the concepts of crude oil and gas formation, reservoir geology, wellhead and drilling operations and The course objectives and learning outcomes are outline below.

3. Course Outline

Introduction to the origins and occurrence of petroleum and gas.

Oil exploration methods.

Drilling rigs and drilling bits.

Blowout preventers and drilling fluids.

Finishing techniques.

Off-shore drilling; Well completion, Logging, petroleum production.

Stabilization of petroleum - Oil, gas and water separation.

Basic tests on petroleum quality.

Petroleum transport and storage.

4.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand the basic concepts of petroleum engineering and crude oil and gas generation.	Cognitive	2	6	Classwork + Assignment + Test + Attendance
2	Identify the parameters controlling petroleum occurrence, migration, entrapment and oil exploration methods.	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Articulate and utilize knowledge on reservoir types, porosity, permeability, rock and fluid interaction.	Cognitive	5	4	Classwork + Assignment + Test + Attendance

4	Demonstrate an understanding of the types of oil rigs, well control, drilling procedures, cementing operation, directional drilling, and drilling problems.	Cognitive	2	1	Classwork + Assignment + Test + Attendance
5	Analyse options and Select the appropriate procedure for drilling operations.	Cognitive	3	2	Classwork + Assignment + Test + Attendance
6	Demonstrate an understanding of prevention and control strategies in cases of drilling problems.	Cognitive	5	6	Classwork + Assignment + Test + Attendance
7	Utilize knowledge on crude oil treating, transportation and storage and an understanding of marketing and sale of oil.	Cognitive	4	5	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Introduction: What is Petroleum Engineering? Generation of Petroleum-diagenesis, catagenesis and metagenesis. Chemical	Fanchi, J.R. and

		Composition of Petroleum and Petroleum Products.	Christiansen, R.C. (2016). Introduction to Petroleum Engineering. (1st ed.) John Wiley & Sons, Inc. Hoboken, New Jersey. Akpoturi. P., Okotie, S., Ogbarode, S. and Ofesi, S. (2016) Introduction to Oil and Gas Operation. M&J Grand Orbit communications ltd. No 12/14 Njemanze street mile1, Diobu, Port Harcourt, Rivers State.
2	2 – 3	Geology and Exploration: Rock Types, Parameters Controlling Petroleum Occurrence. Migration of Petroleum. Entrapment of Petroleum.	
3	3	Oil Exploration Methods. Surface geology, geophysical exploration. Well correlation.	
4	4	Rock and Fluid Properties: Reservoir Rock Characteristics. Porosity. Permeability. Rock and Fluid Interaction. Type of Reservoir. Recovery.	
5	5	Drilling Operations: Types of Oil Rigs. Rotary Drilling. Well Control. Drilling Procedure.	
6	6-7	Formation Evaluation: Mud Logging. Open-hole Logging. Logging While Drilling. Cased Hole Logging.	
7 – 9	8 – 9	Well cementing: primary cementing process, squeeze cementing. Plug cementing. Functions of cement. Well Completion and Stimulation: What is Well Completion?	
10 – 11	10-11	Well Completion and Stimulation contd: Setting Production Casing and tubing. Installing the Christmas Tree. Types of Well Completion. Factors Influencing Well Completion Selection. Well perforation. Well Stimulation.	
12 – 13	11-12	Production: Introduction. Flowing Wells. Artificial Lift. Oil Treating and processing techniques. Classification of separators. Storage and Sale	

		of Oil. Salt Water Disposal	
14	12	Oil and gas transportation.	
15	13	Revision	
	Final Semester Examination		

6.EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Class Seminar/Attendance Assignment Test	10% 10% 10%
Examination	Semester Examination	70%
Total		100%

Corrosion Engineering (CHE 362)

1. Course Time table				
Course Title/Code: Corrosion (CHE 362)	Name of Lecturers: Engr. Dr. Duduna William-Porbeni	Class Level: 300 Level	Semester: Second Semester	Duration: April, 2023 – July, 2023
Credit Unit: 2	Credit hours: 4	Class Timing: Monday 8:00am to 10:00 am. Friday 12.00am to 2.00pm.		

2. Course Description/Objectives
Course objectives - The main objective of this course on corrosion engineering is to: Introduce and define the underlying concepts and science of corrosion. To offer a background in corrosion science and its applications in chemical and process industries.

Introducing the basic principles of corrosion, corrosion damage and its classification.

Studying the principles of electrochemical reactions.

Identification of corrosion mechanisms.

Studying the methods of corrosion monitoring, detection, prevention and control.

3. Course Outlines

1. Basic concepts of corrosion.
2. Classification of corrosion processes.
3. Nature of films, scales and corrosion products of metals.
4. Effects of metallurgical structure on corrosion.
5. Effects of environment on corrosivity, effects of mechanical factors.
6. Corrosion control: cathodic and anodic protection, metallic paint coatings.
7. Corrosion testing, monitoring and inspection.

Recommended textbooks

Hand Book of Corrosion Engineering. Roberge, P.R. 1999. (Mcgraw-Hill, 2000).

Corrosion Inhibitors Principles and Applications. Sastri, V.S. 1998 (John Wiley and Sons,2001)

Fontana, M.G. Corrosion Engineering, 3rd Edition, Mc Graw-Hill Book Company, 1987.

4. Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand the basic concepts of corrosion-definition and classification.	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Identify and differentiate between the various types of corrosion.	Cognitive	3	1	Classwork + Assignment + Test + Attendance

3	Estimate the corrosion behaviours of materials and select appropriate procedures for the protection of materials.	Cognitive	4	2	Classwork + Assignment + Test + Attendance
4	Articulate and utilize knowledge on corrosion prevention strategies.	Cognitive	3	1	Classwork + Assignment + Test + Attendance
5	Demonstrate an understanding and evaluation of the methods for corrosion mitigation and control for the protection of materials and structures.	Cognitive	5	4	Classwork + Assignment + Test + Attendance
6	Analyze options and Select the appropriate procedure for the protection of materials.	Cognitive	4	3	Classwork + Assignment + Test + Attendance
7	Evaluate the cost and efficiency of implementing procedures for the protection of materials and structures.	Cognitive	5	2	Classwork + Assignment + Test + Attendance
8	Demonstrate an understanding of	Cognitive	2	5	Classwork + Assignment + Test + Attendance

	corrosion prevention and control strategies.				

5. DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Introduction to basic concepts of Corrosion and Corrosion Control. Definitions of Corrosion and corrosion Terminology. Cost and economic impact of Corrosion. Factors Influencing Corrosion	Hand Book of Corrosion Engineering. Roberge, P.R. 1999. (Mcgraw-Hill, 2000). Corrosion Inhibitors Principles and Applications. Sastri, V.S. 1998 (John Wiley and Sons,2001) Fontana, M.G. Corrosion Engineering, 3rd Edition, Mc Graw-Hill Book Company, 1987.
2	2 – 3	Classification of corrosion processes. Forms and mechanisms of corrosion. Principles of Electrochemistry: Faraday's Law, Cathodic and Anodic processes. Cell Potentials and electrode Potentials.	
3	4	Thermodynamics of Corrosion. Free Energy. Standard Electrode Potentials. Nernst Equation. Electrochemical and Galvanic Series and their relevance in corrosion and materials selection.	
4	5	Pourbaix Diagrams of Various Metals: Fe, Al, Ni, Ti, etc. Electrochemical Kinetics of Corrosion: Polarization and Overvoltage Activation Polarization. Concentration Polarization.	
5	6	Anodic and Cathodic Polarization. Corrosion Potential and Corrosion Rate. Passivity and Passivators.	
6	7	Protective Coating. Corrosion protection by environmentally friendly corrosion inhibitors.	
7 – 9	8 – 9	Cathodic and Anodic Protection. The impact of the sacrificial anodes on the environment.	

10 – 11	10 – 11	Corrosion Testing, Monitoring and Inspection: Laboratory Tests.	
12 – 13	12 – 13	Techniques for Diagnosing Corrosion Failures. Case Studies of Corrosion Failures.	
14	14	Practical Section	
15	15	Revision	
16	**Final Semester Examination**		

6. EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Class Seminar/Attendance Assignment Test	10% 10% 10%
Examination	Semester Examination	70%
Total		100%

Chemical Kinetics and Catalysis (CHE 342)

1. Course Time table				
Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:
Chemical Kinetics and Catalysis/ ChE 342	Engr. Osaribie Nelson. A	300 Level	Second Semester	April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Wednesdays 12pm – 2pm Fridays 4pm – 6pm		

2. Course Description/Objectives

The course is designed to expose students with the basic knowledge of the principles of chemical kinetics as related to the analysis of reacting systems and the factors that influence the system. It further, introduces the students to the pathway of rate expressions using rate determining step, reaction intermediate, equilibrium or steady state assumptions and reaction mechanisms. The quantitative aspect of the course such as integration of rate equations: - zero, first, second order cases, graphical analysis of rate data for rate constant and half life determination for each of the cases for both single and multistep reactions that will help the students in chemical reactor design is also considered.

It will also provide students with the knowledge of collision and transition state theories and the concept of catalysis in chemical reactions.

3. Course Outlines

Introduction , Rate Expressions for Chemical Reactions Law of Mass Action

Constant Volume Reversible, Irreversible, Parallel and Consecutive Reactions

Order and its Determination, Variable Volume Reactions

Arrhenius Equation and Activation Energy, The Theory of Reaction Rates, especially:- The collision theory and theory of absolute reaction rates analysis

Homogeneous and heterogeneous catalytic reactions and their kinetics,

Kinetics of electrochemical processes

Equilibrium ionic solutions.

Recommended textbooks

1. "Chemical Engineering Kinetics" by Smith J.M

2. "Elements of Chemical Reaction Engineering" by Fogler H.S

3. "Chemical Reaction Engineering" by Levenspiel O

4. "An Introduction to Chemical Engineering Kinetics & Reactor Design" by Charles G. H

5. "Kinetics and Mechanisms of Chemical Transformations" by Rajaram J. and Kuriacose J. C

6. "Chemical Kinetics and Reaction Dynamics" by Santosh K.U

7. "Chemical and Catalytic Reaction Engineering" by Carberry J.J

8. "Fundamentals of Chemical Reaction Engineering" by Davis M.E and Davis R.

4. Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Identify the different ways of expressing rate equation	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Application of the different rate equations.	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Evaluate the performance of constant and variable volume reactions	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Estimate the effect of temperature on rate of reaction using the Arrhenius Equation and the theory of reaction rates	Cognitive	5	3	Classwork + Assignment + Test + Attendance
5	Apply the practical based knowledge to validate the theoretical concepts.	Cognitive	3	3	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN

Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Introduction and Importance of Chemical Kinetics and Catalysis in the Industry	5. Chemical Engineering Kinetics by Smith J.M

2	2 - 3	The Study of chemical reaction rates, relative rates, the law of mass action and derivation of rate expressions	
3	4	The Study of the methods to determine reaction order and molecularity of a reaction	7. Elements of Chemical Reaction Engineering by Fogler H.S
4	5	The Study of constant volume reactions and derivation of the rate laws	
5	6	Variable volume reaction and rate law derivation	
6	7 – 9	Application of: Arrhenius Equation and Activation Energy	
7 – 9	8 – 12	The Theory of Reaction Rates: The Collision Theory and Absolute reaction rates	8. Chemical Reaction Engineering" by Levenspiel O
10 – 11	13 – 15	The Study of: The characteristics/role of Catalyst in chemical reaction Homogeneous and Heterogeneous catalysis	9. A Textbook of Chemical and Catalytic Reaction Engineering" by Carberry J.J
12 – 13	16 – 18	Kinetics of Electrochemical Processes	
14	19 – 20	The Study of Equilibrium ionic solutions	
15	21 – 22	Revision	10. A Textbook of Kinetics and Mechanisms of Chemical Transformations by Rajaram J. and Kuriacose J. C
16	**Final Semester Examination**		

6. EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Classwork Assignment Test Class Attendance	5% 10% 10% 5%

Examination	Semester Examination	70%
Total		100%

PETROLEUM PROCESSING I (CHE 312)

1. Course Time table				
Course Title/Code: Petroleum Processing I ChE 312	Name of Lecturers: Engr. Osaribie Nelson. A	Class Level: 300 Level	Semester: Second Semester	Duration: April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Monday 10am – 12 noon Wednesday 10am – 12 noon		

2. Course Description/Objectives

This course is designed to impart basic knowledge about the overview of the chemical composition and physical properties of petroleum, petroleum products and the chemistry behind the various processing units to students in order to have adequate understanding of petroleum refining industry. It also helps students to know the impurities associated with crude oil and its products and on how to pretreat the crude oil before downstream processing.

The concepts behind the major petroleum refining units and conversion processes are illustrated with extensive graphics, Flow diagrams and various manufacturing schemes for the students understanding.

The course also presents briefly the environmental hazards as a result of refining and conversion processes and the stringent measures to conserve the environment.

3. Course Outlines

1. Chemical composition of petroleum
2. Desalination or desalting processes
3. Atmospheric and Vacuum distillation of petroleum
4. True boiling and Equilibrium flash vaporization curves for petroleum and petroleum fractions
5. Gasoline stabilization and Sweetening

6. Properties of fuels:- Octane number, Cetane number, Flash Point, Fire Point, Pour Point, Cloud Point
Specific gravity, Aniline Point etc
7. Hydrocarbon gas purification and Separation e,g, Amine scrubbing, SCOT and CLAUS processes etc
8. LPG production:- From Oil wellhead and refinery operations
9. Gas processing:- Alkylation and Polymerization
10. Chemistry, Thermodynamics and kinetics of thermal and catalytic processes in the petroleum business
11. Thermal processes:- Thermal cracking, Coking and Pyrolysis
12. Catalytic reforming and Isomerization

Recommended textbooks

1. Fundamentals of Petroleum Refining by Fahim M.A., Sahhhaf T.A., Elkilani A.S.
2. Fundamentals of Petroleum and Petrochemical Engineering by Chaudhuri U.R.
3. Handbook of petroleum refining processes by Meyers Robert A.
4. Petroleum Refining Technology by Ram Prasad.
5. Advanced Petroleum Refining by Sarkar G.N.
6. The Chemistry and Technology of Petroleum and Gas by Erikh V.N., Rasina M.G., Rudin M.G.
7. Engineering Chemistry by Dara S.S and Umare S.S

4. Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Introductory information about origin, exploration and production of crude oil and understand their	Cognitive	2	2	Classwork + Assignment + Test + Attendance

	properties and their significance.				
2	Identify the Types of crude, crude composition and classification	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Acquire knowledge about pretreatment and the different separation processes involved in petroleum refinery.	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Acquire knowledge of various conversion processes involved in petroleum refinery.	Cognitive	5	3	Classwork + Assignment + Test + Attendance
5	Understand and evaluate various residue processing schemes	Cognitive	3	3	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Crude composition, Types of crudes, Characteristics and classification, Crude oil properties and their significance.	1. The Chemistry and Technology of Petroleum and Gas by Erikh V.N., Rasina M.G., Rudin M.G. 2. Engineering Chemistry by Dara S.S and Umare S.S 3. Petroleum Refining Technology by Ram Prasad. 4. Fundamentals of Petroleum Refining by Fahim M.A., Sahhhaf T.A.,
2	2 - 3	The Study of the basic principles involved in Pre-treatment of crude oil for Refining– Dehydration and desalting and Physical Separation Processes–Atmospheric distillation, Vacuum distillation of residue products	
3	4	True boiling and Equilibrium flash vaporization curves for petroleum and petroleum fractions	
4	5	. Gasoline stabilization and Sweetening	

5	6	Properties of fuels: Octane number, Cetane number Flash Point, Fire Point, Pour Point, Cloud Point Specific gravity, Aniline Point etc	Elkilani A.S. 5. Fundamentals of Petroleum and Petrochemical Engineering by Chaudhuri U.R.. 6. Handbook of petroleum refining processes by Meyers Robert A. 7. Advanced Petroleum Refining by Sarkar G.N.
6	7 – 9	Hydrocarbon gas purification and Separation e,g, Amine scrubbing, SCOT and CLAUS processes etc LPG production:-From Oil wellhead and refinery operations	
7 – 9	8 – 12	Hydrocarbon Gas Processing and Applications	
10 – 11	13 – 15	Chemistry, Thermodynamics and kinetics of thermal and catalytic processes in the petroleum business	
12 – 13	16 – 18	Thermal processes: Thermal cracking, Coking and Pyrolysis	
14	19 – 20	The study of the principle, operating parameters and advantages of Catalytic reforming and Isomerisation	
15	21 – 22	Revision	
16	**Final Semester Examination**		

6. EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Classwork Assignment Test Class Attendance	5% 10% 10% 5%

Examination	Semester Examination	70%
Total		100%

ORGANIC PROCESSES (CHE 323)

1. Course Time table				
Course Title/Code: Organic Processes ChE 323	Name of Lecturers: Engr. Osaribie Nelson. A	Class Level: 300 Level	Semester: FIRST Semester	Duration: January, 2023 – March, 2023
Credit Unit: 2	Credit hours: 4	Class Timing: Tuesday 8am – 10am Wednesday 8am – 10am		

2.Course Description/Objectives
This course presents the fundamental principles of organic chemistry as related to chemical process engineering. It introduces the basic techniques of organic compound synthesis such as polymers and/or fine chemicals e.t.c; structure, properties, and nomenclature of organic compounds; and some basic organic reactions such as addition, substitution, elimination, rearrangement reactions of organic compounds found in the chemical processing industry and reaction mechanisms. Furthermore, the course exposes students to a better understanding of the aromatic compounds and organic functional groups, which include carboxylic acids and nitrogen, sulphur, oxygen containing, halogenated hydrocarbons and their reactivity patterns. The course also presents briefly the basic concepts of electrochemical processes, nuclear reactions and chemical kinetics.
Course Outlines
1. Nomenclature of hydrocarbons 2. Conformation properties of hydrocarbons 3. Aromatic and heterocyclic hydrocarbons 4. Mechanism and stereochemistry of hydrocarbon reactions

5. Aromatic substitution rearrangements

6. Characteristic reactions of functional groups:- alcohols, carbonyl etc,

7. Isomerism:-Optical, geometric, chain and diastereoisomerism

8. Basic Principles of:-

Electrochemistry

Chemical kinetics and

Nuclear chemistry.

Recommended textbooks

1. Engineering Chemistry by Dara S.S and Umare S.S

2. Undergraduate Chemistry (Fundamental Principles) by Manilla P. N, Ogali R. E and Uzoukwu B. A

3. Principles of General Chemistry (A Programmed Approach) by Anusiem A. C. I

4. Organic Chemistry by Solomon G.T.W and Fryhle C.B

5. Kinetics and Mechanisms of Chemical Transformations by Rajaram J. and Kuriacose J. C

3.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Identify the different system of naming organic compounds	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Application of the naming systems	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Evaluate different conformational properties of hydrocarbon compounds	Cognitive	5	1	Classwork + Assignment + Test + Attendance

4	Estimate the possible processes involved in chemical production	Cognitive	5	3	Classwork + Assignment + Test + Attendance
5	Apply the practical based knowledge to validate the theoretical concepts.	Cognitive	3	3	Classwork + Assignment + Test + Attendance

5.DETAILED LECTURE PLAN

Week No	Lecture	Course Content to be Covered	References
1	1	Introduction and the significance of Organic Processes in Chemical and the Allied Industry	1. Engineering Chemistry by Dara S.S and Umare S.S 2. Undergraduate Chemistry (Fundamental Principles) by Manilla P. N, Ogali R. E and Uzoukwu B. A 3. Organic Chemistry by Solomon G.T.W and Fryhle C.B 4. Kinetics and Mechanisms of Chemical Transformations by Rajaram J. and Kuriacose J. C 5. Principles of General
2	2 - 3	The Study of the basic principle involved in naming organic compounds	
3	4	The Study of the methods of viewing organic compounds and their conformational analysis	
4	5	Aromaticity and Applications	
5	6	Functional groups and their characteristics and involvement in chemical reactions	
6	7 – 9	The study of reaction mechanism and its importance in the process industry	
7 – 9	8 – 12		
10 – 11	13 – 15	Electrochemistry and Applications	
12 – 13	16 – 18	Component of a reaction, Types of reactions, rate of reaction, rate laws for different reactions, significance of rate constant	
14	19 – 20	The basic principles of nuclear chemistry	
15	21 – 22	Revision	

			Chemistry (A Programmed Approach) by Anusiem A. C. I
16	**Final Semester Examination**		

6.EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Classwork Assignment Test Class Attendance	5% 10% 10% 5%
Examination	Semester Examination	70%
Total		100%

METALLURGY (CHE 361)

1.Course Time table				
Course Title/Code: Metallurgy/ CHE 361	Name of Lecturer(s): Mr. Sunny Ogbereyo	Class Level: 300 Level	Semester: First Semester	Duration: January, 2023 – April, 2023
Credit Unit: 2	Credit hours: 4	Class Timing: Tuesday 12pm – 2pm Wednesday 8am – 10am		

2.Course Description/Objectives
Chemical metallurgy encompasses the extraction and refining of metals, liquid metal treatments, and the corrosion protection and surface treatment of metals. A study of each of the topics in the course outline section below demands an understanding of the principles of thermodynamics, reaction kinetics and electrochemistry. The course will enhance students' skills and knowledge to metal ore concentration, processes in iron & steel manufacturing.

3.Course Outlines

1. Geology of Metals
2. Ore Concentration
3. Ore Processing
4. Iron Ore and Steel Production
5. Manufacture of Aluminium, Copper, Zinc, Tin and Silver
6. Metallurgical Slag
7. Testing of Metal Crystallography
8. Coal Carbonization

Recommended textbooks

1. J. J. MOORE (1981). Chemical Metallurgy. Butterworth & Co (Publishers) Ltd.
Seshadri Seetharaman (2005). Fundamentals of Metallurgy. Woodhead Publishing and Maney Publishing.

4.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Introduction to metals and its formation	Cognitive	2	1	Classwork + Assignment + Test + Attendance
2	Introduction to ore concentration	Cognitive	2,3	1	Classwork + Assignment + Test + Attendance
3	Study of methods of ore processing	Cognitive	3	1	Classwork + Assignment + Test + Attendance
4	Introduction to Iron and Steel Production	Cognitive	3,5	2	Classwork + Assignment + Test + Attendance
5	Study of Manufacture of	Cognitive	2,3	2	Classwork + Assignment + Test + Attendance

	Aluminium, Copper, Zinc, Tin and Silver				
6	Understanding of Metallurgical Slag	Cognitive	3	2	Classwork + Assignment + Test + Attendance
7	Testing of Metal Crystallography	Cognitive	2,3	2	Classwork + Assignment + Test + Attendance
8	Coal Carbonization	Cognitive	2	2	Classwork + Assignment + Test + Attendance

5.DETAILED LECTURE PLAN

Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Geology of Metals	J. J. MOORE (1981). Chemical Metallurgy. Butterworth & Co (Publishers) Ltd. Seshadri Seetharaman (2005). Fundamentals of Metallurgy. Woodhead Publishing and Maney Publishing.
	2 – 3	The study, identification of the various methods of ore concentration	
3 - 5	4 - 5	The study of the methods of ore processing	
6	6 - 8	Methods of Iron Ore and Steel Production	
7 - 8	9 - 11	Manufacture of Aluminium, Copper, Zinc, Tin and Silver	
9	12	The study of Metallurgical Slag	
10 – 13	13 – 14	Material Testing of Metal Crystallography	
	15 – 16	Study of Coal Carbonization	
14	17	Test	
15	18 – 19	Revision	
16	**Final Semester Examination**		

6. EVALUATION CRITERIA

Component of Assessment	Methods	Marks
During Semester	Classwork Assignment	5% 10%

	Test Class Attendance	10% 5%
Examination	Semester Examination	70%
Total		100%

TRANSPORT PHENOMENA (CHE 352)

1. Course Time Table	
Course Title/Code	Transport Phenomena (CHE 352)
Credit Unit	4
Credit Hours	4
Class Level	300
Name of Lecturer	Engr. Dr. Orlando Ketebu
Semester	Second Semester
Duration	April, 2023-August, 2023
Class Timing	Wednesday 12-3 pm (Engineering Lecture Room 6 (EN 6))

2. Course Description/Objectives
Transport Phenomena is a core Chemical engineering course that provides excellent foundation for students to understand the applications of common principles of heat transfer, mass transfer and fluid mechanics.

3. Course Outlines
1. Fundamentals of Mass Transfer. Similarity of Momentum, and Heat 2. Convective Mass Transfer. General, Molecular and Turbulent Diffusion Equations. 3. Fick‘s Law for Diffusion. Molecular Diffusion in Gases, Liquids and Solids. Diffusion Coefficients in Gases. 4. Reynolds' Analogy. 5. Steady State Conduction. Forced and Natural Convection. Unsteady-State Conduction. 2-D Conduction. 6. Heat Transfer Film Coefficient Correlations. LMTD Heat Transfer Design. Fouling Factors. 7. Shell and Tube Heat Exchangers. LMTD Correction Factors 8. Heat Transfer and Pressure Drop Correlations. HX Design and Performance (Kern‘s and NTU Methods for Multipass and Cross-Flow HX).

9. Compact Heat Exchangers. Plate Heat Exchangers. Operating Principles, Series and Parallel Combination, Use and Limitations. Comparison with Shell and Tube Heat Exchangers.

10. Radiation; Blackbody Radiation, Emission from Real Surfaces. Kirchoff's Law.

Recommended textbooks

1. Transport Phenomena, Revised 2nd Edition by R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, published by Wiley

2. Transport Phenomena Fundamentals By Joel L. Plawsky, Published by CRC press.

4. Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand the Fundamentals of Mass Transfer. Similarity of Momentum, and Heat.	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Explain Convective Mass Transfer. General, Molecular and Turbulent Diffusion Equations.	Cognitive	2	2	Classwork + Assignment + Test + Attendance
3	Understand Fick's Law for Diffusion. Molecular Diffusion in Gases, Liquids and Solids. Diffusion Coefficients in Gases.	Cognitive	2	3	Classwork + Assignment + Test + Attendance
4	Analyze Steady State Conduction. Forced and Natural Convection. Unsteady-State Conduction. 2-D Conduction.	Cognitive	4	3	Classwork + Assignment + Test + Attendance
5	Evaluate Heat Transfer Film Coefficient Correlations. LMTD Heat		5	3	Classwork + Assignment + Test + Attendance

	Transfer Design. Fouling Factors.				
5	Understand the working principles of Shell and Tube Heat Exchangers. LMTD Correction Factors	Cognitive	2	1	Classwork + Assignment + Test + Attendance
6	Evaluate Heat Transfer and Pressure Drop Correlations. HX Design and Performance (Kern‘s and NTU Methods for Multipass and Cross-Flow HX).	Cognitive	5	3	Classwork + Assignment + Test + Attendance
7	Understand and explain Compact Heat Exchangers. Plate Heat Exchangers. Operating Principles, Series and Parallel Combination, Use and Limitations. Comparison with Shell and Tube Heat Exchangers.	Cognitive	2	2	Classwork + Assignment + Test + Attendance

5. Detailed Lecture Plan

Week No	Lecture	Course Content to be Covered	References
1-2	1-3	Introduction transport phenomena, transport phenomena relations.	1. Transport Phenomena, Revised 2nd Edition by R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, published by Wiley 2. Transport Phenomena Fundamentals By Joel L.
3	4-5	The basic concepts of Convective Mass Transfer. General, Molecular and Turbulent Diffusion Equations.	
4	6-7	Fick‘s Law for Diffusion. Molecular Diffusion in Gases, Liquids and Solids. Diffusion Coefficients in Gases.	

5-7	8-12	Steady State Conduction. Forced and Natural Convection. Unsteady-State Conduction. 2-D Conduction. Reynolds analogies	Plawsky, Published by CRC press.
8	13-14	Heat Transfer Film Coefficient Correlations. LMTD Heat Transfer Design. Fouling Factors	
9-10	15-16	Shell and Tube Heat Exchangers. LMTD Correction Factors.	
11-12	17-18	Heat Transfer and Pressure Drop Correlations. HX Design and Performance (Kern's and NTU Methods for Multipass and Cross-Flow HX).	
13	29	Compact Heat Exchangers. Plate Heat Exchangers. Operating Principles, Series and Parallel Combination, Use and Limitations. Comparison with Shell and Tube Heat Exchangers.	
14	20	Radiation; Blackbody Radiation, Emission from Real Surfaces. Kirchoff's Law	
15	21-22	**Revision**	
16		**Final Semester Examination**	

6. Evaluation Criteria		
Components of Assessment	Methods	Marks
During Semester	Classwork Assignment Test Class Attendance	5% 10% 10% 5%
Examination	Semester Examination	70%
Total		100%

400 LEVEL COURSES

SEPARATION PROCESSES II (CHE 453)

1.Course Time table				
Course Title/Code: Separation	Name of Lecturers:	Class Level:	Semester:	Duration:

Processes II – CHE 453	Engr. Dr Ebiundu Komonibo	400 Level	First Semester	April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 12pm – 2pm Wednesday 12pm – 2pm Thursdays 4pm – 5pm (Lab)		

2.Course Description/Objectives

This engineering course covers the technological applications of Separation processes in the manufacturing well of the chemical process industries. Separation processes are used for such important chores as removal of contaminants from raw materials, recovery and purification of primary products and elimination of contaminants from effluent water and air streams. Separation processes or unit operations is important in our society, due to its wide technological applications in the areas of Medicine, Physical and Environment Science, Manufacturing of chemicals and Petroleum products design.

To understand and be able to apply methods to analyse the characteristics and performance of a range of typical mixing, separation, and similar processing steps for fluids, particulates and multi-phases.

To have a Knowledge and understanding of the governing principles of separation behind distillation, absorption and drying processes. Design separation unit operations based on transfer of mass between phases (distillation, absorption, adsorption, crystallization and drying units)

This course will enable students understand complex systems, relating to unit operations and separation processes in the design and construction of chemical plants, in Chemical Industries. It is concerned mainly with the physical nature of the processes that take place in industrial units, and in particular, with determining the factors that influence the rate of transfer of materials. The basic principles underlying these operations, namely fluid dynamics, heat and mass transfer and applications of these principles. An overview of the general principles of Separation processes which includes: Distillation, foam fractionation, gas-liquid chromatography, membrane filtration, dialysis, ultrafiltration, Crystallization, electrolysis and reverse osmosis in water treatment.

3.Course Outlines

Vapour –liquid Equilibrium and distillation.

Distillation equipment. Multicomponent distillation.

Vacuum distillation and steam stripping.

Azeotropic and Extraction distillation. Molecular distillation.

Leaching of solids. Liquid – Liquid extraction.

Theory of crystallization in mono – and multi-systems.

Crystal growth. Dialysis. Reverse Osmosis. Electro-dialysis.

Resources/Recommended Textbooks:

Books:

i. Coulson and Richardson's chemical engineering. Volume 2, Particle technology and separation processes / J.F. Richardson and J.H. Harker with J.R. Backhurst. – available as e-book

This book contains several chapters with detailed explanations of fundamental principles and design methods for separation equipment. This is a fundamental book for chemical engineers – you should buy it!

ii Coulson and Richardson's chemical engineering. Volume 6, Chemical engineering design – Sinnott, R. K., Coulson, J. M., Richardson, J. F. 2005, available as e-book

Equipment selection for separations, and quick design methods.

iii Separation Process Principles / Ernest J. Henley, J.D. Seader, D. Keith Roper. (John Wiley & Sons, 2011)

Physical and chemical data

- R. H. Perry, Don W. Green: Perry's Chemical Engineers' Handbook, 1999 McGraw-Hill Inc.
- Knovel (available through IChemE) Data search
- http://www.engineeringtoolbox.com/
- Subscription services to databases:
- AspenPlus, HYSYS prediction

4. Course Learning Outcomes (CLOs)

At the end of this course, students shall be able to understand the following:

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand the principles on which processing	Cognitive	2	2	Classwork + Assignment + Test + Attendance

	equipment operates, and be able to apply methods to determine equipment size and performance of common items such as reactors, exchangers and columns. -Integration of knowledge and understanding to design distillation and absorption columns, and direct heat driers				
2	Understand the inherent nature of safety and loss prevention, and the principal hazard sources in chemical and related processes – including flammability, explosivity and toxicity (including biological hazards). - Knowledge and understanding of chemical hazards in	Cognitive	3	1	Classwork + Assignment + Test + Attendance

	a distillation process, eg flammability, auto-ignition temperature, flash-point; and of safety measures in a vapour-liquid separation				
3	Have a knowledge and understanding of laboratory practice, and able to operate bench-(or larger) scale chemical engineering equipment - Operation and study of lab scale separation equipment and understanding of how different variables impact on equipment behaviour	Cognitive	5	1	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN

WEEK 1: Introductory class and preliminaries

WEEK 2, 3: Vapour –liquid Equilibrium and distillation. Distillation equipment

WEEK 4, 5, 6: Multicomponent distillation. Vacuum distillation and steam stripping. Azeotropic and Extraction distillation. Molecular distillation

WEEK 7: Leaching of solids. Liquid – Liquid extraction

WEEK 8, 9: Theory of crystallization in mono – and multi-systems. Crystal growth

WEEK 10: Dialysis. Reverse Osmosis. Electro-dialysis.

6. STUDENT ASSESSMENT AND GRADE ASSIGNMENT

Assessment shall be based on the following:

Assignment 1:	5marks
Assignment 2:	5marks
Test 1:	10marks
Test 2:	10marks
Final Examination:	70marks
Total:	**100marks**

CHEMICAL ENGINEERING PROCESS ANALYSIS AND OPTIMIZATION (CHE 431)

1.Course Time table				
Course Title/Code:	Name of Lecturer:	Class Level:	Semester:	Duration:
Fluid Particle Technology/ CHE 413	Engr. W. Ifidi,	400 Level	First Semester	September, 2023 – December, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 8am – 10am Wednesdays 8am – 10am		

2. Course Description/Objectives
This course is intended to teach students how to use optimization algorithms to improve the design and operation of chemical processes. The first part of the course emphasizes problem formulation, i.e., how one develops mathematical statements for the objective function (usually economic model) to be minimized or maximized and the equality and inequality constraints (the process model). Once the problem is formulated, the student should be able to select the optimization technique which is best suited to the problem characteristics. The second part of the course introduces applications of optimization in chemical process synthesis and planning problems.
3.Course Outline
1. Review of the theorems and operations of vectors and matrices.

2. Application to chemical engineering stage processes.
3. Formation of simple and complex chemical engineering problems and their solutions.
4. Numerical methods for solving linear and non-linear equations, ordinary differential equations, and partial differential equations.
5. Introduction to optimization, general optimization problems, basic steps of solving optimization problems and methods.
6. Linear programming.
7. Numerical optimization techniques
8. Optimization of stage systems.

Recommended textbooks

1. Chapra, S.C. and Canale, R.P. (2010) Numerical Methods for Engineers. 6th Edition, McGraw-Hill, New York
2. Edgar, T.F., Himmelblau, D.M. and Lasdon, L.S. (2001) Optimization of Chemical Processes. McGraw Hill Chemical Engineering Series, New York

4.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand theoretical background about setting up objective functions and constraints for chemical processes.	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Identify and set up functions describing an optimization problem in chemical processes.	Cognitive	2	1	Classwork + Assignment + Test + Attendance

3	Be able to use economics to derive an objective function.	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Be familiar with the preferred software packages and optimization techniques to solve linear programming and nonlinear programming problems	Cognitive	4	3	Classwork + Assignment + Test + Attendance
5	Learn how to think about and use optimization as a tool in process design and operation	Cognitive	4	3	Classwork + Assignment + Test + Attendance

4.DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Review of matrices and vectors	1. Chapra, S.C. and Canale, R.P. (2010) Numerical Methods for Engineers. 6th Edition, McGraw-Hill, New York 2. Edgar, T.F., Himmelblau, D.M. and Lasdon, L.S. (2001) Optimization of
2 -3	2	The Nature and Organization of Optimization Problems	
4-5	3	Developing Models for Optimization	
6	4	Formulation of the Objective Function	
7	5	Solving Optimization Problems using Computer Programs (Excel)	
8	6	Optimization of Unconstrained Functions: One-Dimensional Search	

9	7	Unconstrained Multivariable Optimization	Chemical Processes. McGraw Hill Chemical Engineering Series, New York
10	8	Linear Programming	
11	9		
9		Revision	
	Final Semester Examination		

6.EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Classwork Laboratory Practical Test Class Attendance	5% 10% 10% 5%
Examination	Semester Examination	70%
Total		100%

POLYMER SCIENCE AND TECHNOLOGY I (CHE 413)

1. Course Time Table

Course Title/Code	Class Level	Semester	Duration	Credit Units	Credit hours	Class Timing
POLYMER SCIENCE AND TECHNOLOGY I /CHE 413	400 Level	First Semester	April, 2023 to July 2023	2	4	Mondays: 2-4pm and Tuesdays: 12-2pm

2. Course Description/Objectives

(i) Course Description

The course introduces students to the historical development of polymers; basic definitions and classifications of polymers. Detail discussion of structures of polymers and thermal transitions in polymers. Students will be made to study polymer preparation, polymerization processes and modification of polymers.

(ii) Objectives:

The major objectives are to

1. Provide the basic knowledge in understand the historical background of polymer.
2. Produce students who have an in-depth knowledge of polymer and its classifications.
3. Develop students to prepare and modify polymers.
4. Encourage students to go into the field of polymer science and technology.

3. Course outline

1. Introduction: historical Development.
2. Basic Definitions (Polymer degree of polymerization, molecular weight, molecular weight distribution, molecular weight average.
3. Classification of polymers: synthetic versus natural, polymer structure, polymerization mechanisms, preparation techniques, end use.
4. Structure of polymers, chemical bonding in polymers (primary and secondary bonding forces).
5. Primary structures (morphology), secondary structure (confirmation, configuration, tacticity, molecular weight and its measurement, Tertiary structure, cohesive energy density, crystallinity and factors affecting crystallinity.
6. Thermal transitions in polymers: the glass transition temperature, theories of glass transition, measurement of Tg, factors affecting Tg, the crystalline melting point, Tm (crystallization tendencies, measurement of Tm, factors affecting Tm).
7. Polymer preparation, polymerization processes (addition and condensation, co-polymerization), modification of polymers (alloying, blending, post polymerization reactions).

Recommended textbooks

1. Robert O. Ebewele (200). Polymer Science and Technology, *Department of Chemical Engineering, University of Benin*, *Benin City, Nigeria*. Boca Raton New York, CRC Press Copyright 2000.
2. Others: Available in the www. polymer science and Technology

4. Learning Outcomes

S/N	CLO	DOMAIN	TAXANOMY LEVEL	PEOS	ASSESSMENT
1.	List and identify the	Cognitive	1	1	Class work +

	stages of polymer development from inception				Assignment + Test + Attendance
2.	Analyze the definitions of polymer and some terms applicable to polymer.	Cognitive	3	4	Class work + Assignment + Test + Attendance
3.	State, describe and explain the classifications and structures of polymers.	Cognitive	5	7	Class work + Assignment + Test + Attendance
4.	Identify polymer structures and carry out detail study on polymers	Cognitive	4	3	Class work + Assignment + Test + Attendance
5.	Prepare simple polymers	Cognitive	5	2	Class work + Assignment + Test + Attendance

5. Detailed Lecture Plan

Week NO	Lectures	Course Content to be covered
1.	1-2	Introduction: historical Development. Basic definitions (Polymer and monomer
2.	3-4	Introduction: Basic definitions (Degree of polymerization and molecular weight)
3.	5-6	Introduction: Basic definitions (Molecular weight distribution, molecular weight average)
4.	7-8	Classification of polymers: synthetic versus natural, Addition versus Condensation, etc
5.	9-10	Polymer structure and polymerization mechanisms
6.	11-12	Polymer preparation techniques and end use.

7.	13-14	Structure of polymers, chemical bonding in polymers (primary and secondary bonding forces).
8.	15-16	Evaluation of Assignment and Mid semester Test
9.	17-18	Primary structures (morphology), secondary structure (confirmation, configuration, tacticity, molecular weight and its measurement, Tertiary structure, cohesive energy density, crystallinity and factors affecting crystallinity.
10.	19-20	Thermal transitions in polymers: the glass transition temperature,
11.	21-22	Theories of glass transition, measurement of Tg, factors affecting Tg, the crystalline melting point,
12.	23-24	Tm (crystallization tendencies, measurement of Tm, factors affecting Tm).
13.	25-26	Polymer preparation and polymerization processes (addition and condensation, co-polymerization),
14.	27-28	Modification of polymers (alloying, blending, post polymerization reactions.
15.	29-30	Revision
16.	31-32	Final semester Examination

6. Evaluation Criteria

Component of Assessment	**Method**	**Marks (%)**
Continuous Assessment	Class attendance	5
	Asssignment	10
	Mid semester Test	15
Examination	Semester Examination	70
Total		100

CHEMICAL REACTION ENGINEERING I (CHE 441)

1.Course Time table				
Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:

Chemical Reaction Engineering I – CHE 441	Engr. Dr Ebiundu Komonibo	400 Level	First Semester	April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 12pm – 2pm Wednesday 12pm – 2pm Thursdays 4pm – 5pm (Lab)		

2.Course Description/Objectives

Reactor design is a core fundamental course in Chemical Engineering research. Chemical reaction engineering is that engineering activity concerned with the exploitation of chemical reactions on a commercial scale (i.e., minimizing cost and maximizing profits). Its goal is the successful design and operation of chemical reactors, and probably more than any other activity it sets chemical engineering apart as a distinct branch of the engineering profession in the society. To produce a world class Chemical Engineer, the course therefore, is essentially a compulsory one for every Chemical Engineer to study.

To enable students, develop a clear understanding of the fundamentals of Chemical Reaction Engineering and the ability to apply these methods to design different types of reactors. Reactor design uses information, knowledge, and experience from a variety of areas-thermodynamics, chemical kinetics, fluid mechanics, heat transfer, mass transfer, and economics. Chemical reaction engineering is the synthesis of all these factors with the aim of properly designing a chemical reactor.

This course will introduce the students to Chemical Reaction Engineering and the different types of Chemical reactors and where in the Industry, they are applied. Design concepts. Safety considerations in reactor design (Preliminary discussion to address the safety issues). Instrumentation for reactors.

3.Course Outline

1. Classification of reactors.

2. Chemical Kinetics as applied to Batch and Continuous reactors, Single ideal reactors.

3. Steady State, mixed, and plug flow reactors.

4. Holding time and Space for flow systems.

5. Design equations for single reactors. Batch reactor, mixed versus plug flow reactors.

6. Reactors in Series and in Parallel.

7. Recycle reactors concepts of residence time distribution

Resources/Recommended Textbooks:

1. Levenspiel, O. Chemical Reaction Engineering, John Wiley & Sons, Inc, New York 1999
2. Froment, G.F Bischoff K.B and De Wilde J. Chemical Reactor Analysis and Design, 3rd Ed. John Wiley & Sons, Inc, New York, 2011
3. Smith, J.M. Chemical Engineering Kinetics, 3rd Ed. McGraw-Hill Book Company
4. Charles G. Hill, Thatcher W. Root. Introduction to Chemical Engineering Kinetics & Reactor Design, 2nd Ed. Claire Vallance: An Introduction to Chemical Kinetics
5. Elements of Chemical Reaction Engineering, 5th Edition, By H. Scott Foglar

4.Course Learning Outcomes (CLOs)

At the end of this course, students shall be able to understand the following:

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	What reactors are and where they are used	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Types of reactors	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Design concepts (deriving design equations using mass balance)	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Embedding Rate laws and Stoichiometry in	Cognitive	5	3	Classwork + Assignment + Test + Attendance

	the design equations and Energy balances				
5	Safety considerations in reactor design	Cognitive	3	3	Classwork + Assignment + Test + Attendance
6	Instrumentation for reactors	Cognitive	3	3	Classwork + Assignment + Test + Attendance

5.DETAILED LECTURE PLAN

WEEK 1: Introductory class and preliminaries

WEEK 2,3: Classification of reactors. Chemical Kinetics as applied to Batch and Continuous reactors, Single ideal reactors.

WEEK 4: Holding time and Space for flow systems.

WEEK 5 -7: Design equations for single reactors.

WEEK 8, 9: Batch reactor, mixed versus plug flow reactors. Reactors in Series and in Parallel

WEEK 10: Recycle reactors concepts of residence time distribution.

6.STUDENT ASSESSMENT AND GRADE ASSIGNMENT

Assessment shall be based on the following:

Assignment 1: 5marks

Assignment 2: 5marks

Test 1: 10marks

Test 2: 10marks

Final Examination: 70marks

Total: 100marks

500 LEVEL COURSES

PROCESS DYNAMICS (CHE 532)

1.Course Time table				
Course Title/Code:	Name of Lecturer(s):	Class Level:	Semester:	Duration:

Process Dynamics/ CHE 532	Mr. Sunny Ogbereyo	500 Level	Second Semester	April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 10am – 12noon Thursday 12pm – 2pm		

2.Course Description/Objectives

Chemical Engineering Process Dynamic involves the analysis of a system's dynamic behaviour and response to various inputs to the system. This is the study of the behaviour of a system as time progresses with is a continuation of process modelling where the focus is on the study of the behavior dynamic model.

The course will enhance students' skills to understand and develop dynamic process models and will also broaden their knowledge on solution methods in solving dynamic equations. This course will also help students come up with control measures to dynamic systems.

3.Course Outlines

1.Components of a control system
2. Operation and Design
3. Basic control actions (Valves)
4. Transfer functions
5. Derivation of dynamic equations for simple instruments
6. Thermometer
7. Liquid levels
8. Manometer
9. Dynamic equations for simple models:
10. Mixing vessels
11. Single Isothermal Continuously Stirred Tank Reactors (CSTR)
12. CSTR in series
13. Introduction and use of Block diagram
14. System response to impulses
15. Step and Sinusoidal inputs
16. Frequency response

Recommended textbooks

1. William L. Luyben (1996). "Process Modeling, Simulation and Control for Chemical Engineers" (2nd Edition). McGraw-Hill Publishing Company, New York.

2. University of Michigan Chemical Engineering (2007). "Chemical Process Dynamics and Controls". Open Source

4.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Identify the components of a control system including their operations and design	Cognitive	2	2,3	Classwork + Assignment + Test + Attendance
2	Develop models of various control valves	Cognitive	3,4	1,2,4	Classwork + Assignment + Test + Attendance
3	Evaluate dynamic models and apply Laplace Transforms/Transfer function as a solution method	Cognitive	3,5	1,5	Classwork + Assignment + Test + Attendance
4	Develop dynamic models for simple instruments such as Thermometer, Liquid level etc.	Cognitive	4	3	Classwork + Assignment + Test + Attendance
5	Introduction to Block diagram and Transfer	Cognitive	2,3	1,2	Classwork + Assignment + Test + Attendance

	function application				

5.DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Introduction to Components of a control system including their operations and design	William L. Luyben (1996). "Process Modeling, Simulation and Control for Chemical Engineers" (2nd Edition). McGraw-Hill Publishing Company, New York. University of Michigan Chemical Engineering (2007). "Chemical Process Dynamics and Controls". Open Source
2	2 - 3	The study of Basic control actions a case study of Valves	
3 - 5	4 - 5	Introduction to Laplace transforms and Transfer functions and its application to dynamic models	
6	6 - 8	Derivation of dynamic equations for simple instruments such as Thermometer, Manometer and Liquid Level controller	
7 - 8	9 - 11	Development of Dynamic equations for simple models Mixing vessels Single Isothermal Continuously Stirred Tank Reactors (CSTR) CSTR in series	
9	12	Introduction to Block Diagram	
10 – 13	13 – 16	Various system behaviour: System response to impulses Step and Sinusoidal inputs Frequency response	
14	17	Test	
15	18 – 19	Revision	
16	**Final Semester Examination**		

6.EVALUATION CRITERIA		
Component of Assessment	Methods	Marks

During Semester	Classwork Assignment Test Class Attendance	5% 10% 10% 5%
Examination	Semester Examination	70%
Total		100%

MODELLING OF CHEMICAL ENGINEERING PROCESSES (CHE 533)

1.Course Time table				
Course Title/Code: Modelling of Chemical Engineering Processes/ CHE 533	Name of Lecturer(s): Mr. Sunny Ogbereyo	Class Level: 500 Level	Semester: First Semester	Duration: January, 2023 – April, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 10am – 12noon Thursday 8am – 10am		

2.Course Description/Objectives
Chemical Engineering Process Modelling is described as assembling sets of equations (models) which describes the behaviour and interrelations of the variables and parameters of a process system or set of systems. This is the study of the prediction of a system behavior as time progresses mathematically. The course will enhance students' skills to understand and develop dynamic process models and able to predict chemical engineering process system.
3.Course Outlines
1. Introduction to process model building 2. Process variables 3. Lumped and Distributed Processes

4. Model formulation for Simple and Complicated Systems
5. Empirical modelling and Analysis
6. Modelling: Flow through tanks; Continuous Stirred Tank Reactors; Plug flow Reactors; Heat Exchangers; Distillation Columns; Extraction Units
7. Digital and Analogue Simulations

Recommended textbooks

1. William L. Luyben (1996). "Process Modeling, Simulation and Control for Chemical Engineers" (2nd Edition). McGraw-Hill Publishing Company, New York.
2. Richard G. Rice and Duong D. Do (1994). Applied Mathematics and Modeling for Chemical Engineers. John Wiley & Sons Inc. New York
3. Amiya K. Jana (2011). Chemical Process Modeling & Computer Simulation (2nd Edition). PHI Learning Private Limited. Delhi

4.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Introduction to process model building	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Introduction to Process variables	Cognitive	2,3	1	Classwork + Assignment + Test + Attendance
3	Model development for Lumped and Distributed Processes	Cognitive	3,5	1	Classwork + Assignment + Test + Attendance
4	Model development for Simple and Complicated Systems	Cognitive	3,5	2,3	Classwork + Assignment + Test + Attendance
5	Introduction to Empirical modelling and Analysis	Cognitive	2,3	2,4,5	Classwork + Assignment + Test + Attendance
6	Design models for Chemical Engineering systems such as: Flow	Cognitive	5	2,5	Classwork + Assignment + Test + Attendance

	through tanks; Continuous Stirred Tank Reactors; Plug flow Reactors; Heat Exchangers;Distillation Columns; Extraction Units				
7	Introduction to Digital and Analogue Simulations	Cognitive	2,3	1,2	Classwork + Assignment + Test + Attendance

5.DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Introduction to process model building	William L. Luyben (1996). "Process Modeling, Simulation and Control for Chemical Engineers" (2nd Edition). McGraw-Hill Publishing Company, New York. 2. Richard G. Rice and Duong D. Do (1994). Applied Mathematics and Modeling for Chemical Engineers. John Wiley & Sons Inc. New York Amiya K. Jana (2011). Chemical Process Modeling & Computer Simulation (2nd
2	2- 3	The study, identification and use of Process variables	
3 - 5	4 - 5	Model development for Lumped and Distributed Processes	
6	6 - 8	Model formulation for Simple and Complicated Systems	
7 - 8	9 - 11	Model Development for: a) Flow through tanks b) Continuous Stirred Tank Reactors c) Plug flow Reactors d) Heat Exchangers e) Distillation Columns f) Extraction Units	
9	12	Introduction to Block Diagram	

10 – 13	13 – 14	Empirical modelling and Analysis	Edition). PHI Learning Private Limited. Delhi
	15 – 16	Introduction to Digital and Analogue Simulations	
14	17	Test	
15	18 – 19	Revision	
16	**Final Semester Examination**		

6.EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Classwork Assignment Test Class Attendance	5% 10% 10% 5%
Examination	Semester Examination	70%
Total		100%

ENVIRONMENTAL POLLUTION CONTROL AND SAFETY (CH 566)

1.Course Time table				
Course Title/Code: Environmental pollution control and safety (CHE 566)	Name of Lecturers: Engr. Dr. Duduna William-Porbeni	Class Level: 500 Level	Semester: Second Semester	Duration: April, 2023 – July, 2023
Credit Unit: 2	Credit hours: 4	Class Timing: Tuesday12:00noon to 2:00pm. Friday 10.00am to 12.00noon.		

2.Course Description/Objectives
This is a key introductory course in chemical engineering, exposing students into the environmental aspects in chemical engineering. The course is designed to teach students what

pollution means, different environmental (soil, water and air) pollutants and their sources; their impacts on the environment; understand pollution control legislation; to apply methods to analyse water, wastewaters and air pollutants; design unit operations for filtration ion exchange, chemical and biological treatment of wastewaters from industrial and domestic sources; and to understand adsorption, absorption, condensation and combustion in air pollution control. Students will exposed pollution control measures, monitoring, and biodegradation. Students will be taught gaseous pollutants separation and treatment options.

3. Course Outlines

1. Air and water pollution control legislation.
2. Air and water quality standards, toxicity of pollutants to the natural environment.
3. Water and wastewater treatment methods.
3. Air pollution control by particulates and gas removal. Filtration, cyclones, adsorption, combustion and dispersion.
4. Water pollution control by biodegradation.
5. Filtration ion exchange, chemical treatment and coagulation.
6. Noise pollution and sonic booms.
7. Pollution monitoring and pollution control in petroleum industries.
8. Treatment of refinery effluents.

Recommended textbooks

1. Unit Operations and Processes in Environmental Engineering. Second edition.-Reynolds, T.D., Richards, P.A. 1995. (PWS Publishing 1995).

2. Environmental Engineering. Kiely, G. 2007. (Tata McGraw-Hill, 2007).

3. Waste Treatment and Disposal. Williams, P.T. 2005. (John Wiley & Sons, Ltd, 2005).

4. Perry, R.H. and Green, D.W.: Perry's Chemical Engineers' Handbook, 1999 McGraw-Hill Inc.

4.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1.	Demonstrate a knowledge of	Cognitive	4	4	Classwork + Assignment + Test + Attendance

	global and national air and water pollution control legislations.				
2.	Understanding of global and national air and water quality standards, toxicity of pollutants to the natural environment.	Cognitive	2	4	Classwork + Assignment + Test + Attendance
3.	Analyse the characteristics and Constituents of municipal and industrial wastewaters.	Cognitive	4	1	Classwork + Assignment + Test + Attendance
4	Demonstrates an understanding of processes and design of waste water treatment unit operations.	Cognitive	3	5	Classwork + Assignment + Test + Attendance
5	Demonstrate an understanding of biological systems in wastewater treatment.	Cognitive	3	5	Classwork + Assignment + Test + Attendance
6	Identify the sources of air pollution and control strategies by	Cognitive	1	1	Classwork + Assignment + Test + Attendance

	particulates and gas removal.				
7	Demonstrate and understanding the design principles and unit operations for air pollution control.	Cognitive	3	2	Classwork + Assignment + Test + Attendance
7	Identify the methods for pollution remediation, monitoring and control in petroleum industries.	Cognitive	1	6	Classwork + Assignment + Test + Attendance

5.DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1	Air and water pollution control legislation. Air and water quality standards, toxicity of pollutants to the natural environment.	• Unit Operations and Processes in Environmental Engineering. Second edition.-Reynolds, T.D., Richards, P.A. 1995. (PWS Publishing 1995). • Environmental Engineering. Kiely, G. 2007. (Tata McGraw-Hill, 2007). • Waste Treatment and Disposal. Williams, P.T. 2005. (John Wiley & Sons,
2	2 - 3	**WASTE WATER CHARACTERISTICS** Classification of wastewaters. Wastewater contaminants- sources and environmental significance. Analysis of municipal and industrial wastewater constituents.	
3	4	Waste water treatment unit operations and processes: Introduction Unit operations for treatment – sedimentation,	

		screening and comminution, filtration, flotation, chemical-polymer addition,	Ltd, 2005). Perry, R.H. and Green,
4	5	Primary waste water treatment. Secondary waste water treatment.	D.W.: Perry's Chemical Engineers' Handbook, 1999
5	6	Tertiary waste water treatment-Biological treatment Design examples	McGraw-Hill Inc.
6	7	Design of Biological Systems; Biological principles and metabolism. Micro-organisms in biological treatment. Kinetics of metabolism growth and substrate utilization. Factors affecting biomass production and food utilization. Reactor types-principles of mass balance.	
7 – 9	8 – 9	AIR POLLUTION Introduction-composition of the atmosphere. Air quality standards. Sources of pollutants. Unit operations in particulate removal. Unit operations in gas removal. Design examples.	
10 – 11	10 – 11	Noise Pollution	
12 – 13	12 – 13	Treatment of refinery effluents	
14	14 – 15	Practical Section	
15	16	Revision	
	Final Semester Examination		

6.EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Class Seminar/Attendance Assignment Test	10% 10% 10%
Examination	Semester Examination	70%

Total	100%

FUEL TECHNOLOGY (CHE 563)

1.Course Time table				
Course Title/Code: Fuel Technology (CHE 563)	Name of Lecturer: Prof. Salome T. Torubeli	Class Level: 500 Level	Semester: First Semester	Duration: July, 2023 – December, 2023
Credit Unit: 2	Credit hours: 2	Class Timing: Wednesday's: 8am-10am		

2.Course Description/Objectives
Fuel technology introduce students solid fuels-wood, peat,coal etc, and their origin; gaseous fuels (natural gas, coal gas); liquid fuels. Students are also introduced to fuel gas cleaning and purification; choice of fuels and fuels economics; techno-economic aspects of renewable energies-the present and future, and non renewable-energies- present and the future. Students were also introduced to, and the Fisher-Tropsch process.
3.Course Outlines
1. Solid fuel-wood, peat and coal, and their origin, classification and mechanical preparation 2. Combustion of coal-low and high temperature cokes 3. The Fisher-Tropsch Process 4. Liquid fuels, oil fuels, gaseous fuels (natural gas, coal gas) 5. Choice of fuels and fuel economics 6. techno-economic aspects of renewable energies-the present and future, and 7. Non renewable-energies- present and the future. **Recommended textbooks:** 1. Future of energy: The 2021 guide to the energy transition by John Michael Armstrong. 2. Renewable energy systems from biomass by Vladimir Strezov, Hossain Md. Anawar 2022. 3. Energy for keeps. Creating clean electricity from renewable resources by Marilyn Nemzer, Deborah Page, Anna Carter, Will Sickle 2022.

4.Course Learning Outcomes (CLOs)					
S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1.	Differentiate between solid, liquid oil fuel, and gaseous fuels	Cognitive	4	4	Classwork + Assignment + Test + Attendance
2.	Differentiate between primary and secondary fuels	Cognitive	2	4	Classwork + Assignment + Test + Attendance
3.	Application of the Fisher-Tropsch process How to make choice of fuels, and fuel economics	Cognitive	4	1	Classwork + Assignment + Test + Attendance
4	How to make choice of fuels, and fuel economics	Cognitive	3	5	Classwork + Assignment + Test + Attendance
5	Demonstration of fuel gas cleaning and purification	Cognitive	3	5	Classwork + Assignment + Test + Attendance
6	To understand the techno-economics aspects renewable and non-renewable energies	Cognitive	1	1	Classwork + Assignment + Test + Attendance
7	Identification of the various gases emitted during	Cognitive	1	6	Classwork + Assignment + Test + Attendance

	pyrolysis, gasification etc.				

5. DETAILED LECTURE PLAN

Week No	Lecture	Course Content to be Covered	References
1	1	Introduction to solid fuel-wood, peat and coal, and their origin.	
2	2 - 3	1. The origin of solid fuels 2. Classification and mechanical preparation of solid fuels	
3	4	Solid fuel for specific purposes	
4	5	Combustion of coal-low and high temperature cokes	
5	6	The Fisher-Tropsch Process	
6	7	Liquid fuels, oil fuels, gaseous fuels (natural gas, coal gas)	
7 − 9	8 − 9	Choice of fuels and fuel economics	
10 − 11	10 − 11	Techno-economic aspects of renewable energies-the present and future	
12 − 13	12 − 13	Techno-economic aspects of Non renewable-energies- present and the future.	
14	14 − 15	Practical Section	
15	16	Revision	
	Final Semester Examination		

6. EVALUATION CRITERIA

Component of Assessment	Methods	Marks
During Semester	Classwork	5%
	Assignment	10%
	Test	10%
	Class Attendance	5%

Examination	Semester Examination	70%
Total		100%

ENGINEERING ECONOMICS AND MANAGEMENT (FCE 571)

1. Course Time table				
Course Title/Code: Engineering Economics and Management/FCE 571	Name of Lecturers: Prof. A.N. Okpala Dr. Agonga Oyinbonogha Fred Dr. Sibete Godfrey	Class Level: 500 Level	Semester: First Semester	Duration: November, 2022 – March, 2023
Credit Unit: 2	Credit hours: 4	Class Timing: Wednesdays 10am – 12noon Fridays 8am – 10am		

2. Course Description/Objectives

Engineering Economics and Management gives an understanding of how Economics and management relates to Engineering especially the technical part of Engineering. This course will help students understand better the time value of money basically for decision making as well as the process of leading and directing.

3. Course Outlines

Understanding the Nature and Scope of Economics, Basic Concepts in Engineering Economics.
Applying the Techniques for Analyzing Capital investments.
Evaluation of public alternatives, Replacement Analysis, Make or buy decision.
Understanding the concept, principles and functions of Management.
Evaluating Personnel management; objectives and functions, recruitment and selection personnel development.
Evaluating financial management; sources of financial accounting and book keeping, cost planning and control.
Understanding the concept, principles and structure of a business Organization

Recommended textbooks

Sepulveda, Jose A. Schaum's Outline of Theory and Problems of Engineering Economics.

Engineering Management by B S, Dhillon, Technornic Publishing Co., 1987.

Essentials of Management by Joseph L. Massie, Prentice hall Publishing Co., 4 th Edition.

Engineering Management by D.I. Cleland and D. E Kocaoglu, McGraw-Hill, 1981.

4.Course Learning Outcomes (CLOs)

S/N	CLO	Domain	Taxonomy Level	PEO	Assessment
1	Understanding the Nature and Scope of Economics, Basic Concepts in Engineering Economics.	Cognitive	2	1	Classwork + Assignment + Test + Attendance
2	Applying the Techniques for Analyzing Capital investments	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Evaluation of public alternatives, Replacement Analysis, Make or buy decision	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Understanding the concept, principles and functions of Management.	Cognitive	2	1	Classwork + Assignment + Test + Attendance
5	Evaluating Personnel management; objectives and functions, recruitment and selection personnel	Cognitive	5	1	Classwork + Assignment + Test + Attendance

	development				
6	Evaluating Financial management; sources of financial accounting and book keeping, cost planning and control.	Cognitive	5	1	Classwork + Assignment + Test + Attendance

5.DETAILED LECTURE PLAN			
Week No	**Lecture**	**Course Content to be Covered**	**References**
1	1 – 2	Basic Concepts –Engineering Economics a) Introduction b) The Time Value of Money c) Interest and Interest rate d) Simple Interest and Compound Interest e) Inflation and Taxation f) Cash Flows (Discounted and Compounded)	Sepulveda, Jose A. Schaum's Outline of Theory and Problems of Engineering Economics. Copyright 1984 by The McGraw-Hill Companies. ISBN 0-07-023834-0
2 – 3	3 – 5	Techniques for analyzing capital investment – Compounding Periods a) Annual Compounding b) Discrete and Periodic Compounding c) Continuous Compounding d) Present Worth and Future Worth	Engineering Management by B S, Dhillon, Technornic Publishing Co., 1987.
4 – 5	6 – 8	Techniques for analyzing capital investment a) Net Present Worth, b) Rate of Returns, c) Payback Period, d) Benefit-Cost Ratio	Essentials of Management by Joseph L. Massie, Prentice hall Publishing Co., 4 th Edition.
6 – 8	9 – 11	Evaluation of public alternatives, Replacement Analysis, Make or buy decision, Understanding the concept, principles and	Engineering Management by D.I. Cleland and D. E Kocaoglu, McGraw-Hill,

		functions of Management.	1981.
9 – 11	12 – 14	Evaluating Personnel management; objectives and functions, recruitment and selection personnel development. Evaluating Financial management; sources of financial accounting and book keeping, cost planning and control.	
12 – 14	15 – 18	Understanding the concept, principles and structure of a business Organization) Explain main factors affecting productivity. A detailed note on productivity and methods for measuring the productivity.	
15	19 – 20	Revision	
16	**Final Semester Examination**		

6. EVALUATION CRITERIA		
Component of Assessment	Methods	Marks
During Semester	Classwork Assignment Test Class Attendance	5% 10% 10% 5%
Examination	Semester Examination	70%
Total		100%

PETROCHEMICAL TECHNOLOGY I (CHE 513)

1. Course Time Table

Course Title/Code	Class Level	Semester	Duration	Credit Units	Credit hours	Class Timing
PETROCHEMICAL TECHNOLOGY I	500 Level	First Semester	April, 2023 to July 2023	3	4	Mondays: 12-2pm and Tuesdays: 2-4pm

/CHE 513						

2. Course Description/Objectives

(i) Course Description

The course introduces students to raw materials and their processing techniques; Properties of olefins and use of polymerization reactions, refining of petroleum and the various refining processes, organic reaction types and methanol production using oxosynthesis discussed. Students will be made to synthesis on the basis of acetylene, carbon monoxide and synthesis gas. Students will be made to evaluate activation energy using Arrhenius equation and the law of active masses

(ii) Objectives:

The major objectives are to:

1. Provide basic knowledge and skills needed to understand the various raw materials for the petrochemical industry.
2. Equip students with an in depth knowledge of the production of olefins and the use of polymerization reactions.
3. To develop students to prepare some petrochemical compounds: acetylene, carbon monoxide and synthesis gas.
4. Equip students with the ability to evaluate activation energy, Heat of Enthalpy and the heat of entropy.

3. Course outline

1. Raw materials and their processing techniques; ethylene, acetylene, synthesis gas and liquid hydrocarbons.
2. Properties of olefins, thermo-dynamic stability of hydrocarbons, olefin production.
3. Use of polymerization reactions and raw materials from aromatic hydrocarbons.
4. Petrochemical reactions: Sulphonation, chlorination, nitration, oxidation, hydrogenation, aromatization, nomerization reactions and others. Refining of petroleum crude, petroleum refining processes.
5. Atmospheric distillation and vacuum distillation of petroleum crude and petroleum products.
6. Catalytic and thermal cracking of petroleum products.
7. Methanol production using different methods and oxosynthesis reaction. Le-Chateliar's principle and oxosynthesis reaction.

8. Synthesis on the basis of acetylene, carbon monoxide and synthesis gas.

9. Law of active masses. Evaluation of the equilibrium constant with respect to concentration and partial pressures. Evaluation of the Gibbs free energy from the equilibrium constant.

10. Energy barrier and evaluation of the activation energy using the Arrhenius equation. Graphical evaluation of the activation energy using the Arrhenius equation. Exothermic and Endothermic reactions.

11. Evaluation of the Gibbs free energy using Enthalpy and entropy of reactions.

Recommended textbooks

1. Sakar G.N. (2002), "Advanced petrochemicals", 1st edition

2. Sakar G.N. (1998), "Petroleum refining", 1st edition

3. Aggarwal O.P. and Avinash Aggawal (2001), "Engineering Chemistry", 3rd edition, Khana publishers Delhi 110006.

4. O/L & A/L Organic text books.

5. Browse the Internet.

4. Learning Outcomes

S/N	CLO	DOMAIN	TAXANOMY LEVEL	PEOS	ASSESSMENT
1.	Enumerate the different sources of hydrocarbons and state the major groups of hydrocarbons.	Cognitive	1	1	Class work + Assignment + Test + Attendance
2.	Explain the importance of Petroleum crude (crude oil) as the primary source of starting materials (raw materials) for the petrochemical industry	Cognitive	2	7	Class work + Assignment + Test + Attendance
3.	List and identify the products of Petroleum refining	Cognitive	1	5	Class work + Assignment + Test + Attendance

4.	Prepare useful chemical (petrochemical) intermediates from petroleum feed stocks	Cognitive	5	4	Class work + Assignment + Test + Attendance
5.	List and identify the properties and production processes of olefins.	Cognitive	1	5	Class work + Assignment + Test + Attendance
6.	State the use of polymerization reactions and raw materials from aromatic hydrocarbons.		1	3	Class work + Assignment + Test + Attendance
7.	Determine the activation energy, heat of reaction, enthalpy and entropy of reactions		4	4	Class work + Assignment + Test + Attendance
8.	Predict the Gibbs free energy and the type of reaction with respect to whether it is exothermic or endothermic reaction.		6	4	Class work + Assignment + Test + Attendance
9.	Synthesis base on acetylene, carbon monoxide and synthesis gas.		5	3	Class work + Assignment + Test + Attendance

5. Detailed Lecture Plan

Week NO	Lectures	Course Content to be covered
1.	1-2	Raw materials and their processing techniques; ethylene, acetylene, synthesis gas and liquid hydrocarbons.

2.	3-4	Properties of olefins, thermo-dynamic stability of hydrocarbons, olefin production
3.	5-6	Use of polymerization reactions and raw materials from aromatic hydrocarbons.
4.	7-8	Petrochemical reactions: Sulphonation, chlorination, nitration, oxidation, hydrogenation, aromatization, nomerization reactions and others. Refining of petroleum crude, petroleum refining processes.
5.	9-10	Atmospheric distillation and vacuum distillation of petroleum crude and petroleum products.
6.	11-12	Catalytic and thermal cracking of petroleum products
7.	13-14	Methanol production using different methods and oxosynthesis reaction. Le-Chateliar's principle and oxosynthesis reaction.
8.	15-16	Evaluation of Assignment 1 and Test 2
9.	17-18	Synthesis on the basis of acetylene, carbon monoxide and synthesis gas
10.	19-20	Law of active masses. Evaluation of the equilibrium constant with respect to concentration and partial pressures.
11.	21-22	Evaluation of the Gibbs free energy from the equilibrium constant.
12.	23-24	Energy barrier and evaluation of the activation energy using the Arrhenius equation.
13.	25-26	Graphical evaluation of the activation energy using the Arrhenius equation. Exothermic and Endothermic reactions
14.	27-28	Evaluation of the gibbs free energy using Enthalpy and entropy of reactions.
15.	29-30	Revision
16.	31-32	Final semester Examination

6. Evaluation Criteria

Component of Assessment	**Method**	**Marks (%)**
Continuous Assessment	Class attendance	5
	Asssignment	10
	Mid semester Test	15
Examination	Semester Examination	70
Total		100

PETROCHEMICAL TECHNOLOGY II (CHE 516)

1. Course Time Table

Course Title/Code	Class Level	Semester	Duration	Credit Units	Credit hours	Class Timing
PETROCHEMICAL TECHNOLOGY I /CHE 516	500 Level	Second Semester	April, 2023 to July 2023	3	4	Mondays: 12-2pm and Tuesdays: 2-4pm

2. Course Description/Objectives

(i) Course Description

The course introduces students to paraffin, olefins and halogenations processes; Chlorination products and polymerization. Detail discussion of organic reaction types, oxidation of paraffin and olefins and condensation of Aldehyde. Students will be made to study Natural and synthetic polymers: synthetic and natural rubbers, Fibers, plastics and resins.

(ii) Objectives:

The major objectives are to:

1. Equip students with the knowledge in understanding the processes of adding halogens to paraffins and olefins.
2. Provide students with an in-depth knowledge of the chlorination products, polymerization processes and oxidation of paraffin
3. Produce students with skills in differentiating between natural and synthetic polymers
4. Prepare polymers: nylons, plastics, dyes, gums soaps, detergents and other consumer polymer products.

3. Course outline

1. Halogenations of Paraffin: Methane, ethane. Olefins:
2. Ethylene liquid and gaseous phase halogenations processes.
3. Chlorination products of Olefins:
4. Nylons and production of nylons. Uses of nylons.
5. Synthetic fibres and glue. Plastics and resins:
6. Characteristics of plastics, moulding of plastics, methods of fabricating plastics.

7. Thermosetting and thermoplastic resins.
8. Vinyl Chloride from acetylene.
9. Freon and antifreezes.
10. Polymers and polymerization processes.
11. Hydrolysis, hydration, dehydration, esterification processes in the production of solvents.
12. Plastificators and synthetic lubricants.
13. Oxidation of paraffin and Olefins: ethylene oxide and some higher oxides of hydrocarbons.
14. Amines and types of amines. Amines production and uses.
15. Amides and types of amides. Amides production and uses.
16. Condensation of Aldehyde with Olefins.
17. Natural rubbers. Synthetic Rubbers- Synthesis of isoprene and others synthetic rubbers.

Recommended textbooks

1. Sakar G.N. (2002), "Advanced petrochemicals", 1st edition
2. Sakar G.N. (1998), "Petroleum refining", 1st edition
3. Aggarwal O.P. and Avinash Aggawal (2001), "Engineering Chemistry", 3rd edition, Khana publishers Delhi 110006.
4. O/L & A/L Organic text books.
5. Browse the Internet.

4. Learning Outcomes

S/N	CLO	DOMAIN	TAXANOMY LEVEL	PEOS	ASSESSMENT
1.	Describe paraffin and olefin halogenations processes.	Cognitive	2	1	Class work + Assignment + Test + Attendance
2.	List and identify different chlorination products.	Cognitive	1	2	Class work + Assignment + Test + Attendance
3.	Explain the uses and applications of the	Cognitive	3	7	Class work + Assignment + Test

	chlorination products and polymerization processes				+ Attendance
4.	Equip and engage students to reclaim rubber in our surroundings.	Cognitive	5	5	Class work + Assignment + Test + Attendance
5.	Explain the use of the various organic reactions for the production of petrochemicals	Cognitive	2	4	Class work + Assignment + Test + Attendance
6.	Differentiate natural rubber from synthetic rubbers.		4	1	Class work + Assignment + Test + Attendance
7.	Prepare various consumer products: Nylon, glue or gum, antifreezers, lubricants, plastificators, dyes, amines, amides soap, detergents and other products.		6	5	Class work + Assignment + Test + Attendance

5. Detailed Lecture Plan

Week NO	Lectures	Course Content to be covered
1.	1-2	Halogenations of Paraffin: Methane, ethane. Olefins:
2.	3-4	Ethylene liquid and gaseous phase halogenations processes.
3.	5-6	Chlorination products of Olefins
4.	7-8	Nylons and production of nylons. Uses of nylons.

5.	9-10	Synthetic fibres and glue. Plastics and resins
6.	11-12	Characteristics of plastics, moulding of plastics, methods of fabricating plastics.
7.	13-14	Thermosetting and thermoplastic resins
8.	15-16	Evaluation of Assignment 1 and Test 2
9.	17-18	Vinyl Chloride from acetylene. Freon and antifreezes
10.	19-20	Polymers and polymerization processes
11.	21-22	Hydrolysis, hydration, dehydration, esterification processes in the production of solvents. Plastificators and synthetic lubricants.
12.	23-24	Oxidation of paraffin and Olefins: ethylene oxide and some higher oxides of hydrocarbons
13.	25-26	Amines and types of amines. Amines production and uses. Amides and types of amides. Amides production and uses.
14.	27-28	nsation of Aldehyde with Olefins. Natural rubbers. Synthetic Rubbers-Synthesis of isoprene and others synthetic rubbers
15.	29-30	Revision
16.	31-32	Final semester Examination

6. Evaluation Criteria

Component of Assessment	**Method**	**Marks (%)**
Continuous Assessment	Class attendance	5
	Asssignment	10
	Mid semester Test	15
Examination	Semester Examination	70
Total		100

POLYMER SCIENCE AND TECHNOLOGY II (CHE 544)

1. Course Time Table

Course Title/Code	Class Level	Semester	Duration	Credit Units	Credit hours	Class Timing
POLYMER SCIENCE	500	Second	April, 2023	3	4	Mondays: 2-4pm

AND TECHNOLOGY II / CHE 544	Level	Semester	to July 2023			and Tuesdays: 12-2pm

2. Course Description/Objectives

(i) Course Description

The course introduces students to polymer properties and application; Polymer melt Rheology; Viscous flow and Solid state properties. It explains Stress and Basic mechanical properties. It discusses in detail elastic stress- strain relations, viscoelastic models and dynamic mechanical tests.

(ii) Objectives:

The major objectives are to:

1. Produce high level students that can understand polymer properties and application.
2. Provide basic knowledge and skills needed for the understanding and analysis of polymer properties and application problems.
3. Develop students to use tests machinery.
4. To introduce students to the concept of Polymer melt Rheology; Viscous flow and Solid state properties.
5. To lead students to independently study stress-strain relations and dynamic mechanical tests.
6. To encourage students to go into the field of polymers.

3. Course outline

1. Polymer properties and application: Polymer solution properties.
2. Criteria for polymer solubility chain conformations of dissolved polymer.
3. Thermodynamics of polymer solutions, fractionation of polymers.
4. Polymer melt Rheology: Simple rheological responses (ideally elastic, purely viscous flow, viscoelastic response, rubber elasticity.
5. Viscous flow (Newton law of viscosity, Non-Newtonian behavior (various models), Laminar flow of Newtonian fluids.
6. Solid state properties (mechanical properties only).
7. Introduction to mechanical tests (stress-strain, creep, stress – relaxation, dynamics mechanical tests, hardness, compact).
8. Stress – strain measurements: definitions (true Engineering), Strain (true Engineering).

9. Elasticity and plasticity.
10. Basic mechanical properties: stiffness, elasticity, strength toughness, resilience.
11. Typical polymer stress-strain responses.
12. Elastic stress- strain relations (uniaxial loading).
13. Hooke;s law and Young;s modulus.
14. Shear modulus and interrelationship between elastic constants, biaxial loading.
15. Theory of plasticity, polymer fraction, creep and stress- relaxation tests.
16. Viscoelastic models (Maxwell, voigt combined response, relaxation and Retardation spectra).
17. Generalized linear viscoelasticity and superposition principles (Boltzman superposition principle, Time-Temperature equivalence i.e IOLF equation).
18. Dynamic mechanical tests, and phenomenological aspect of mechanical tests. **(Pre-requisites CHE 413)**

Recommended textbooks

1. Robert O. Ebewele (200). Polymer Science and Technology, *Department of Chemical Engineering, University of Benin*, *Benin City, Nigeria*. Boca Raton New York, CRC Press Copyright 2000.

2. Others: Available in the www. polymer science and Technology

4. Learning Outcomes

S/N	CLO	DOMAIN	TAXANOMY LEVEL	PEOS	ASSESSMENT
1.	List and identify polymer properties and application.	Cognitive	1	1	Class work + Assignment + Test + Attendance
2.	Explain rheology, viscosity and some terms applicable to polymer flow.	Cognitive	2	7	Class work + Assignment + Test + Attendance
3.	Describe Newtonian and non-Newtonian fluids.	Cognitive	2	2	Class work + Assignment + Test + Attendance
4.	Analyze various concepts in relation to fluid	Cognitive	4	4	Class work + Assignment + Test

					+ Attendance
5.	Explain stress-strain relations and dynamic mechanical tests.	Cognitive	2	7	Class work + Assignment + Test + Attendance
6.	State some laws in rheology and viscous flow	Cognitive	1	1	Class work + Assignment + Test + Attendance
7.	Assess the challenges of stress-strain measurement tests equipments	Cognitive	6	5	Class work + Assignment + Test + Attendance

5. Detailed Lecture Plan

Week NO	Lectures	Course Content to be covered
1.	1-2	Polymer properties and application: Polymer solution properties.
2.	3-4	Criteria for polymer solubility chain conformations of dissolved polymer.
3.	5-6	Thermodynamics of polymer solutions, fractionation of polymers
4.	7-8	Polymer melt Rheology: Simple rheological responses (ideally elastic, purely viscous flow, viscoelastic response, rubber elasticity
5.	9-10	Viscous flow (Newton law of viscosity, Non-Newtonian behavior (various models), Laminar flow of Newtonian fluids
6.	11-12	Solid state properties (mechanical properties only).
7.	13-14	Introduction to mechanical tests (stress-strain, creep, stress – relaxation, dynamics mechanical tests, hardness, compact).
8.	15-16	Stress – strain measurements: definitions (true Engineering), Strain (true Engineering).
9.	17-18	Elasticity and plasticity. Basic mechanical properties: stiffness, elasticity, strength toughness, resilience
10.	19-20	Typical polymer stress-strain responses. Elastic stress- strain relations (uniaxial loading).

11.	21-22	Evaluation of Assignments and tests. Hooke;s law and Young;s modulus.
12.	23-24	Shear modulus and interrelationship between elastic constants, biaxial loading. Theory of plasticity, polymer fraction, creep and stress- relaxation tests.
13.	25-26	Viscoelastic models (Maxwell, voigt combined response, relaxation and Retardation spectra).
14.	27-28	Generalized linear viscoelasticity and superposition principles (Boltzman superposition principle, Time-Temperature equivalence i.e IOLF equation). Dynamic mechanical tests, and phenomenological aspect of mechanical tests. **(Pre-requisites CHE 413)**
15.	29-30	Revision
16.	31-32	Final semester Examination

6. Evaluation Criteria

Component of Assessment	**Method**	**Marks (%)**
Continuous Assessment	Class attendance Asssignment Mid semester Test	5 10 15
Examination	Semester Examination	70
Total		100

CHEMICAL TECHNOLOGY I (CHE 511)

1.Course Time table				
Course Title/Code: Chemical Technology I – CHE 511	Name of Lecturers: Engr. Dr Ebiundu Komonibo	Class Level: 500 Level	Semester: First Semester	Duration: April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 12pm – 2pm Wednesday 12pm – 2pm		

		Thursdays 4pm – 5pm (Lab)

2.Course Description/Objectives

Chemical Technology is a core fundamental course in Chemical Engineering research. It offers sound approaches to Chemical plant design, Economics and unit operations in the manufacture of Chemicals and other useful products in various Industrial sectors such as in Chemical Industries, Medicine and Pharmaceutical Industries, Petrochemicals, Agricultural Industries, Plastic Industries, Manmade Fiber and Film Industries. To produce a world class Chemical Engineer, the course therefore, is essentially a compulsory one for every Chemical Engineer to study.

Relevance is seen in Chemical Engineers from the department being able to apply these Engineering technics, such as design, manufacture, protect, preserve, install, manage and operate the equipment and tools in the laboratories for better performance and safety being the watchword, especially in the aforementioned Industrial Sectors in Nigeria and abroad.

This course will introduce students into Chemical processing of raw materials into useful and profitable products, which are used both as consumer goods and as intermediates for further chemical and physical modifications to yield consumer products. An indebt understanding and operations of Chemical Industries in Nigeria. The basic principles of Chemical Technology and the work of a Chemical Engineer. Understand the principles on which processing equipment operates in the conversion of raw materials gotten from the environment, i.e air, water, petroleum, agricultural products, minerals, organic, inorganic materials, etc. into basic or intermediate chemicals as well as companies that convert these intermediate into finished or consumer products

.

The objectives sought in this course are:

1. To explain the various chemical processes in a generalized form through correlations into flow sheets and descriptive text.
2. To enable students understand and explain Unit processes: chemical change. The commercialization of a chemical reaction under such conditions as to be economically profitable.
3. To describe Unit operations: physical changes.

4. To explain Physical chemistry: equilibriums and reaction rates.
5. To analyse the Economic principles of Chemical Processing Industries: costs, statistics, and consumption.
6. To analyse and explain Energy and power utilization in Chemical Processing Industries: chemical as well as electrical and mechanical.

3. Course Outlines

Chemical Industry in Nigeria. Chemical Processing and the work of a Chemical Engineer.

Raw material resources and utilization.

Basic principles of Chemical Technology.

Technology of Industrial acids – Sulphuric, Phosphoric etc. Fertilizers.

The silicate industry: Ceramics Industries, Glass Industries and Cement Industries.

The Electrolytic Industries: Electrolysis and the production of sodium hydroxide, chlorine and hydrochloric acid. Electro-thermal Industries:

Artificial abrasives, Calcium Carbide and Miscellaneous Electro-Thermal Products.

Plastic Industries: Raw materials and manufacturing processes.

Industrial Carbon: Potassium Industries

Resources/Recommended Textbooks:

Books:

Shreve's Chemical process industries 5th Edition, R. NORRIS SHREVE Professor of Chemical Engineering Purdue University, Lafayette, Ind. Mc GRAW-HILL BOOK COMPANY, INC. New York /, Toronto London, KOGAKUSHA COMPANY, LTD. Tokyo

4.Course Learning Outcomes (CLOs)

At the end of this course, students shall be able to understand the following:

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand the principles on which processing equipment operates in the conversion of	Cognitive	2	2	Classwork + Assignment + Test + Attendance

	raw materials gotten from the environment, i.e air, water, petroleum, agricultural products, minerals, organic, inorganic materials, etc. into basic or intermediate chemicals as well as companies that convert these intermediate into finished or consumer products.				
2	Explain Unit processes: chemical change. The commercialization of a chemical reaction	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Analyse the Economic principles of Chemical Processing Industries: costs, statistics, and consumption	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Explain Chemical Processing and the work of a Chemical Engineer	Cognitive	5	3	Classwork + Assignment + Test + Attendance

5	Describe the Technology and manufacture of Industrial acids.	Cognitive	3	3	Classwork + Assignment + Test + Attendance
6	Describe how the Silicate Industries operate in the manufacturing process of Ceramics, Glass and Cement	Cognitive	3	3	Classwork + Assignment + Test + Attendance
7	Describe and explain the full operations in the Electrolytic and Electro-Thermal Industries	Cognitive	3	3	Classwork + Assignment + Test + Attendance
8	Explain how raw materials are converted to useful products in the Plastic Industries	Cognitive	3	3	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN

WEEK 1: Introductory class and preliminaries

WEEK 2,3: Chemical Industry in Nigeria. Raw material resources and utilization

WEEK 4: Basic principles of Chemical Technology.

WEEK 5,6,7: Technology of Industrial acids – Sulphuric, Phosphoric etc. Fertilizers.

WEEK 8: The silicate industry: ceramics, glass and cement manufacture

WEEK 9,10: The Electrolytic Industries: Electrolysis and the production of sodium hydroxide, chlorine and hydrochloric acid. Electro-thermal Industries: Artificial abrasives, Calcium Carbide and Miscellaneous Electro-Thermal Products. Plastic Industries: Raw materials and manufacturing processes. Industrial Carbon: Potassium Industries

6.STUDENT ASSESSMENT AND GRADE ASSIGNMENT

Assessment shall be based on the following:

Assignment 1:	5marks
Assignment 2:	5marks
Test 1:	10marks
Test 2:	10marks
Final Examination:	70marks
Total:	**100marks**

CHEMICAL TECHNOLOGY II (CHE 514)

1.Course Time table				
Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:
Chemical Technology II – CHE 514	Engr. Dr Ebiundu Komonibo	500 Level	First Semester	April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing:	Mondays 12pm – 2pm Wednesday 12pm – 2pm Thursdays 4pm – 5pm (Lab)	
2.Course Description/Objectives				

Chemical Technology is a core fundamental course in Chemical Engineering research. It offers sound approaches to Chemical plant design, Economics and unit operations in the manufacture of Chemicals and other useful products in various Industrial sectors such as in Chemical Industries, Medicine and Pharmaceutical Industries, Petrochemicals, Agricultural Industries, Plastic Industries, Manmade Fiber and Film Industries. To produce a world class Chemical Engineer, the course therefore, is essentially a compulsory one for every Chemical Engineer to study.

Relevance is seen in Chemical Engineers from the department being able to apply these Engineering technics, such as design, manufacture, protect, preserve, install, manage and operate the equipment and tools in the laboratories for better performance and safety being the

watchword, especially in the aforementioned Industrial Sectors in Nigeria and abroad.

This course will introduce students into Chemical processing of raw materials into useful and profitable products, which are used both as consumer goods and as intermediates for further chemical and physical modifications to yield consumer products. An indebt understanding and operations of Chemical Industries in Nigeria. The basic principles of Chemical Technology and the work of a Chemical Engineer. Understand the principles on which processing equipment operates in the conversion of raw materials gotten from the environment, i.e air, water, petroleum, agricultural products, minerals, organic, inorganic materials, etc. into basic or intermediate chemicals as well as companies that convert these intermediate into finished or consumer products. The processes involved in the manufacture of valuable products from Industries such as, Fermentation Industries, Pulp and paper Industries, Soap and detergent Industries, Sugar and Starch Industries, Processing of Cassava and its derivatives

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The objectives sought in this course are:

1. To explain the various chemical processes in a generalized form through correlations into flow sheets and descriptive text.
2. To enable students understand and explain Unit processes: chemical change. The commercialization of a chemical reaction under such conditions as to be economically profitable.
3. To describe Unit operations: physical changes.
4. To explain Physical chemistry: equilibriums and reaction rates.
5. To analyse the Economic principles of Chemical Processing Industries: costs, statistics, and consumption.
6. To analyse and explain Energy and power utilization in Chemical Processing Industries: chemical as well as electrical and mechanical.
7. To describe how the Fermentation Industries operate in the manufacturing process of Industrial Alcohols.
8. To describe and explain the full operations in the Soap and Detergents Industries
9. To explain the manufacturing process of Surface Coating Industries
10. To describe the principle involved in the Processing of cassava and its derivatives
11. To explain the principles behind the manufacturing process of Printing inks, polishes and adhesives

3. Course Outlines

1. Fermentation Industries: Manufacture of industrial alcohols, Malt beverages and beer. Sugar from cane and beet.
2. Processing of cassava and its derivatives.
3. Palm oil and soap production. Detergents – natural and synthetic types; manufacture and biodegradability.
4. Pulp and paper Industries; specialty papers.
5. Processing of vegetable oils, animal fats and waxes.
6. Surface coatings and paint processing technology. Printing inks, polishes and adhesives.
7. Rubber Industries: Rubber fabrication.
8. Petrochemical Industries: Unit operations, Chemical conversions, manufacture of Petrochemicals, reactions producing Petrochemicals.
9. Fragrances, Flavours and Food additives: The perfume Industry, the Flavouring Industry and Food additives

Resources/Recommended Textbooks:

Books:

Shreve's Chemical process industries 5th Edition, R. NORRIS SHREVE Professor of Chemical Engineering Purdue University, Lafayette, Ind. Mc GRAW-HILL BOOK COMPANY, INC. New York /, Toronto London, KOGAKUSHA COMPANY, LTD. Tokyo

4.Course Learning Outcomes (CLOs)

At the end of this course, students shall be able to understand the following:

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Understand the principles on which processing equipment operates in the conversion of raw materials gotten from the	Cognitive	2	2	Classwork + Assignment + Test + Attendance

	environment, i.e air, water, petroleum, agricultural products, minerals, organic, inorganic materials, etc. into basic or intermediate chemicals as well as companies that convert these intermediate into finished or consumer products.				
2	Explain Unit processes: chemical change. The commercialization of a chemical reaction	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Analyse the Economic principles of Chemical Processing Industries: costs, statistics, and consumption	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Explain Chemical Processing and the work of a Chemical Engineer	Cognitive	5	3	Classwork + Assignment + Test + Attendance
5	Describe how the Fermentation	Cognitive	3	3	Classwork + Assignment + Test + Attendance

	Industries operate in the manufacturing process of Industrial Alcohols				
6	Describe and explain the full operations in the Soap and Detergents Industries	Cognitive	3	3	Classwork + Assignment + Test + Attendance
7	Explain the manufacturing process of Surface Coating Industries	Cognitive	3	3	Classwork + Assignment + Test + Attendance
8	Explain the principle involved in the Processing of cassava and its derivatives	Cognitive	3	3	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN

WEEK 1: Introductory class and preliminaries

WEEK 2,3: Fermentation. Manufacture of industrial alcohols, Malt beverages and beer. Sugar from cane and beet. Processing of cassava and its derivatives

WEEK 4,5,6: Palm oil and soap production. Detergents – natural and synthetic types; manufacture and biodegradability.

WEEK 7: Pulp and paper manufacture, specialty papers.

WEEK 8-9: Processing of vegetable oils and animal fats. Surface coatings and paint processing technology.

WEEK 10: Printing inks, polishes and adhesives. Rubber Industries: Rubber fabrication. Petrochemical Industries: Unit operations, Chemical conversions, manufacture of Petrochemicals, reactions producing Petrochemicals. Fragrances, Flavours and Food additives: The perfume Industry, the Flavouring Industry and Food additives.

6.STUDENT ASSESSMENT AND GRADE ASSIGNMENT

Assessment shall be based on the following:

Assignment 1:	5marks
Assignment 2:	5marks
Test 1:	10marks
Test 2:	10marks
Final Examination:	70marks
Total:	**100markS**

CHEMICAL REACTION ENGINEERING II (CHE 541)

1. Course Time table

Course Title/Code:	Name of Lecturers:	Class Level:	Semester:	Duration:
Chemical Reaction Engineering II – CHE 541	Engr. Dr Ebiundu Komonibo	500 Level	First Semester	April, 2023 – July, 2023
Credit Unit: 3	Credit hours: 4	Class Timing: Mondays 12pm – 2pm Wednesday 12pm – 2pm Thursdays 4pm – 5pm (Lab)		

2. Course Description/Objectives

Reactor design is a core fundamental course in Chemical Engineering research. Chemical reaction engineering is that engineering activity concerned with the exploitation of chemical reactions on a commercial scale (i.e., minimizing cost and maximizing profits). Its goal is the successful design and operation of chemical reactors, and probably more than any other activity

it sets chemical engineering apart as a distinct branch of the engineering profession in the society. To produce a world class Chemical Engineer, the course therefore, is essentially a compulsory one for every Chemical Engineer to study.

To understand and be able to apply methods to design multiple types of reactors and reactions in complex systems. Reactor design uses information, knowledge, and experience from a variety of areas-thermodynamics, chemical kinetics, fluid mechanics, heat transfer, mass transfer, and economics. Chemical reaction engineering is the synthesis of all these factors with the aim of properly designing chemical reactors.

This course will enable students solve complex systems relating to Multiple reactions and reactor design in Chemical Reaction Engineering. Design concepts. Safety considerations in Multiple reactors. Multiple reactions (Series and Parallel reactions), in reactor design. Homogeneous/Heterogeneous, Exothermic/Endothermic, etc reactions, Reactions on Solid Catalyst: Trickle Beds, Slurry Reactors, Three-Phase Fluidized Beds, Solid Catalysed Reactions Systems. Non-Catalytic Systems. Fluid – particle reactions (Kinetics) and Fluid-particle reactor Systems.

3. Course Outlines

Design for multiple reactions: Reactions in Parallel and in Series.

Extensions and applications of Series and Parallel Reactions.

Temperature and Pressure effects.

Design of fluid particle reactors.

Chemical reactions control and gas film diffusion control processes.

Fluidized bed reactors. Slurry reaction Kinetics.

Design of fluid reactors. Solid catalysed reactors.

Design of stated adiabatic packed bed reactors, and abeling bed reactors

Resources/Recommended Textbooks:

1. Levenspiel, O. Chemical Reaction Engineering, John Wiley & Sons, Inc, New York 1999
2. Froment, G.F Bischoff K.B and De Wilde J. Chemical Reactor Analysis and Design, 3rd Ed. John Wiley & Sons, Inc, New York, 2011
3. Smith, J.M. Chemical Engineering Kinetics, 3rd Ed. McGraw-Hill Book Company

4. Charles G. Hill, Thatcher W. Root. Introduction to Chemical Engineering Kinetics & Reactor Design, 2nd Ed.
5. Claire Vallance: An Introduction to Chemical Kinetics
6. Elements of Chemical Reaction Engineering, 5th Edition, By H. Scott Foglar

4. Course Learning Outcomes (CLOs)

At the end of this course, students shall be able to understand the following:

S/N	CLO	Domain	Taxonomy Level	PEOs	Assessment
1	Multiple reactions (Series and Parallel reactions), in reactor design. Homogeneous/Heterogeneous, Exothermic/Endothermic, etc reactions	Cognitive	2	2	Classwork + Assignment + Test + Attendance
2	Steady-State Isothermal and Non – Isothermal Reactor design	Cognitive	3	1	Classwork + Assignment + Test + Attendance
3	Temperature and Pressure Effects on single and multiple reactions	Cognitive	5	1	Classwork + Assignment + Test + Attendance
4	Reactions on Solid Catalyst: Trickle Beds, Slurry Reactors, Three-Phase Fluidized Beds	Cognitive	5	3	Classwork + Assignment + Test + Attendance
5	Solid Catalysed Reactions Systems	Cognitive	3	3	Classwork + Assignment + Test + Attendance
6	Non-Catalytic Systems. Fluid – particle reactions (Kinetics) and Fluid-particle reactor design	Cognitive	3	3	Classwork + Assignment + Test + Attendance

5. DETAILED LECTURE PLAN

WEEK 1: Introductory class and preliminaries

WEEK 2, 3, 4: Design for multiple reactions: Reactions in Parallel and in Series. Extensions and applications of Series and Parallel Reactions. Temperature and Pressure effects

WEEK 5-6: Design of fluid particle reactors. Chemical reactions control and gas film diffusion control processes

WEEK 7: Fluidized bed reactors. Slurry reaction Kinetics. Design of fluid reactors.

WEEK 8: Solid catalysed reactors

WEEK 9-10: Design of stated adiabatic packed bed reactors, and abeling bed reactors

6. STUDENT ASSESSMENT AND GRADE ASSIGNMENT

Assessment shall be based on the following:

Assignment 1:	5marks
Assignment 2:	5marks
Test 1:	10marks
Test 2:	10marks
Final Examination:	70marks
Total:	**100marks**

Department of Chemical Engineering Hand Book