LANDMARK UNIVERSITY, OMU-ARAN

COURSE COMPACT

COLLEGE: SCIENCE AND ENGINEERING
DEPARTMENT: CHEMICAL ENGINEERING
PROGRAMME: CHEMICAL ENGINEERING
COURSE COMPACT for: CHE 416

Course

Course code: CHE 416
Course title: Chemical Reaction Engineering II
Credit unit: 3 Units
Course status: Core

Lecturer's Data

Name of the lecturer: **Olakunle, Michael Sunday**
Qualifications obtained: B.Sc. (UNIBEN), PGDChE (UNIBEN), M.Eng. (UNIBEN), PGDTh (RCBC), CASAP (GGSB Grenoble, France), PhD (ABU).
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College: Science and Engineering
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Office Location: Room A005

Consultation Hours: 10:00 – 12:00p.m. (Mondays to Fridays)

INTRODUCTION TO THE COURSE

Course Description:

Chemical Reaction Engineering II deals with the design consideration for ideal reactors for homogeneous reactions. Performance equation for the reactors are developed and used in design. Starting from the simplified case of a single reaction and a single reactor to the challenging cases of multiple reaction and/or reactor to the more complex case where temperature and pressure effects are considered.

Course Justification:

CHE 416 as a follow up course to CHE 326 utilizes the rate expression generated in the latter to design reactors for use in the chemical process industry. The course exposes students to design for single/multiple reactors/reactions and also how temperature and pressure considerations may affect design.

Course Objectives:

At the end of this course, students would:

(i) understand the concept of reactor design
(ii) know how to develop performance equations for design
(iii) understand the use of performance equation for design

(iv) understand the effect of single/multiple reaction on the performance equation for single multiple reactors

(v) understand the effect of temperature and pressure on reactor design

Course Content:

Introduction to reactor design. Ideal reactors for a single reaction; ideal batch reactors steady-state mixed flow reactors, steady-state plug flow reactors. Design for single reactions; size comparison of single reactors, multiple-reactor systems, recycle reactor, autocatalytic reactions. Design for parallel reactions. Multiple reactions; irreversible first-order reactions in series, first-order followed by zero-order reaction, zero-order followed by first-order reaction, successive irreversible reactions of different orders, reversible reactions, irreversible series-parallel reactions.

Course Expectations:

S/N	GRADING	SCORE(%)
1.	Continuous Assessments • C.AI • C.AII (Mid-Semester Test) • C.AIII	 7% 15% 8%
2.	Assignment	10%
3.	Final Examination	60%
4.	Total	100

Course Delivery Strategies:

Lecturing/teaching method will be adopted as several examples will be presented with their solutions developed in an interactive manner. Also power point presentation will be made of in discussing some topics. Course note will be uploaded on the intranet.

Course Duration: 12 – 14 weeks

LECTURE CONTENT

- **Week 1: Introduction to Reactor Design**
  - **Objectives:**
    The students at the end of the lectures for the week should be able to:
    - ✓ know the difference between a batch, steady-state flow and unsteady-state flow reactor
    - ✓ know the symbols and relationship between C_A and X_A
  - **Description**
    - ✓ First hour: General description of types of reactor
    - ✓ Second and Third hour: Mathematical relationship between C_A, X_A, ε_A etc
  - **Study Question**: List and discuss the various ways in which chemical reactions are classified.
  - **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel

- **Week 2: Ideal Reactors (Homogeneous reaction)**
  - **Objectives**
    The students at the end of the lectures for the week should be able to:
    - ✓ Differentiate between the three ideal reactors

- ✓ Ideal batch reactor performance equation
- **Description**
  - ✓ First hour: Discussion on the properties of the three ideal reactors
  - ✓ Second and Third hour: Development of the performance equation for batch reactor
- **Study Question**: What are the conditions for which reactors are ideal?
- **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel

- **Week 3: Ideal Reactors: Flow reactors**
  - **Objectives**

    The students at the end of the lectures for the week should be able to:
    - ✓ Understand how the performance equation for flow reactors are developed and their application.
  - **Description**
    - ✓ First hour: Mixed flow reactor
    - ✓ Second hour: Plug flow reactor
    - ✓ Third hour: Application of performance equations for flow reactors
  - **Study Question**: Class assignment
- **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel

- **Week 4: Single Reactions**
  - **Objectives**

    The students at the end of the lectures for the week should be able to:
    - ✓ Compare the performance of the various reactors analytically or graphically
  - **Description**
    - ✓ First and Second hours: Size comparison of single reactors
    - ✓ Third hour: General graphical comparison
  - **Study Question**: Assignment to be submitted
  - **Reading List** – Chemical Reaction Engineering (3rd Edn): Octave Levenspiel

- **Week 5: Equal-Size Mixed Flow Reactors in Series**
  - **Objectives**

    The students at the end of the lectures for the week should be able to:
    - ✓ How to optimize desire product quality (conversion/quantity) using the performance equation.
  - **Description**
    - ✓ First hour: Performance equation for 1st order and 2nd order reactions
    - ✓ Second and Third hour: Graphical Comparison of performance of a series of N equal-size mixed flow reactors with a plug flow reactor for elementary reactions.
  - **Study Question**: Find the effect on flowrate and conversion by altering reactor number/size
  - **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel)

- **Week 6: Mixed Flow Reactors of Different Sizes in Series**
  - **Objectives**

    The students at the end of the lectures for the week should be able to:
    - ✓ Analyze performance from reactors of different sizes in series
  - **Description**
    - ✓ First hour: Finding the Conversion in a Given System
    - ✓ Second hour: Determining the Best System for a Given Conversion.

- ✓ Third hour: Tutorials
- **Study Question:**
- **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel)

- **Week 7: Revision on topics so far**

- **Week 8: Mid-Semester Test**

- **Week 9: Autocatalytic reactions**
  - **Objectives**
    The students at the end of the lectures for the week should be able to:
    - ✓ What autocatalytic reactions are
    - ✓ Method of analysis such reactions to obtain kinetic parameters
  - **Description**
    - ✓ First hour: Autocatalytic reaction rate description
    - ✓ Second hour: solving for kinetic parameters
  - **Study Question**: show how the model to be tested is developed
  - **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel)

- **Week 10: Recycle Reactor and Autocatalytic Reaction**
  - **Objectives**
    The students at the end of the lectures for the week should be able to:
    - ✓ Understand the optimization problem associated with autocatalytic reactions
  - **Description**
    - ✓ First hour: Autocatalytic reactions and recycle reactors
    - ✓ Second hour: Performance equation
    - ✓ Third hour: Optimum recycle ratio
  - **Study Question**: Development of kinetic parameters for typical reactions
  - **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel)

- **Week 11: Parallel Reactions: Qualitative and quantitative treatment**
  - **Objectives**
    The students at the end of the lectures for the week should be able to:
    - ✓ To understand optimization of desired product yield for parallel reactions.
  - **Description**
    - ✓ First hour: General characteristics of Parallel reactions
    - ✓ Second hour: Qualitative treatment
    - ✓ Third hour: Quantitative treatment
  - **Study Question**: what are the conditions that favour desired product yield for a system of parallel reactions?
  - **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel)

- **Week 12: Series and Series-parallel reactions: Qualitative and quantitative treatment of Series-Parallel Reactions**
  - **Objectives**
    The students at the end of the lectures for the week should be able to:
    - ✓ Qualitative and quantitative treatment and the use of charts
  - **Description**
    - ✓ First hour: Qualitative and quantitative treatment of series reactions
    - ✓ Second hour: Qualitative and quantitative treatment of series-parallel reactions

- **Study Question**: solve a problem to determine k_2/k_1 for given conditions for a series-parallel reaction
- **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel)

- **Week 13: Temperature and Pressure Effects**
  - **Objectives**
    The students at the end of the lectures for the week should be able to:
    - ✓ Construction of the Rate-Conversion Temperature Chart from Kinetic Data
    - ✓ Heat Effects
  - **Description**
    - ✓ First hour: Thermodynamics and reactions, optimum temperature progression
    - ✓ Second hour: Adiabatic and non-adiabatic operations
  - **Study Question**: Tutorial: solution of typical problems
  - **Reading List** - Chemical Reaction Engineering (3rd Edn): Octave Levenspiel)

- **Week 14: General Revision**

- **Week 15 Topic: Examination**
  - **Objectives:**
    - ✓ To examine the students on all that has been taught during the semester.
  - List of reference material
    - ✓ Chemical Reaction Engineering, 3rd Edition by Octave Levenspiel
    - ✓ Elements of Chemical Reaction Engineering, 3rd Edition by H. Scott Fogler

HOD's COMMENTS: _____
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Name: _____ Signature _____ Date: _____