NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF CHEMICAL AND TEXTILE ENGINEERING

CHEMICAL ENGINEERING PROGRAM

PI225 – CHEMICAL KINETICS AND REACTOR DESIGN I

I. GENERAL INFORMATION

CODE	:	PI-225 Chemical Kinetics and Reactor Design I
SEMESTER	:	9
CREDITS	:	3
HOURS PER WEEK	:	4 (Theory–Practice)
PREREQUISITES	:	PI-217 Thermodynamics for Chemical Engineering II
CONDITION	:	Compulsory
DEPARTMENT	:	Chemical Engineering
INSTRUCTOR	:	Violeta ChAvarri, César Osorio Carrera
INSTRUCTOR E-MAIL	:	hchavarri@uni.edu.pe, osoriouni@gmail.com

II. COURSE DESCRIPTION

Brief study of terminology and theory of chemical kinetics. Study of homogeneous reactions. Aspects of chemical kinetics that are important for the education of good chemical engineer and for the presentation of the basic concepts and the fundamental equations. A, B and C anonymous chemical species. Different techniques used in the analysis and management of experimental data and leading to the determination of the rate of reaction rate developed.

III. COURSE OUTCOMES

Knowledge of the basic concepts of the kinetics of chemical reactions and the design of chemical homogeneous reactors.

IV. LEARNING UNITS

1. INTRODUCTION

Basics of Chemical Kinetics / Terminology used and determining the rate of reaction expression.

2. REACTION SYSTEMS I

Kinetics reaction in homogeneous systems / Reaction order / Constant of rate of reaction / Mathematical characterization of reaction systems / Mathematical characterization of simple reaction systems / Constant volume systems / Variable volume systems.

3. REACTION SYSTEMS II

Mathematical characterization of multiple reactions systems / Reversible reactions / Parallel reactions / Serial or consecutive reactions.

4. EXPERIMENTAL ASPECTS

Interpretation of Experimental Data of Chemical Reactions / Experimental aspects of kinetic studies / Preliminary questions to be answered / Experimental techniques and apparatus.

5. DATA INTERPRETATION

Techniques for data interpretation of the rate of reaction / Differential method / Integral method / Method of initial rate of reaction / Half-life method / Method of the reference curve.

6. DATA ANALYSIS

Other techniques for data analysis of the rate of reaction / Isolation Method / Gugghenheim method for first-order reactions / Using measurements of physical properties to follow the course of reaction / Determination of the activation energy / Accuracy measurement of the rate of reaction / Accuracy kinetic constant / Accuracy of the activation energy.

7. REACTOR DESIGN I

Basics in reactor design / Model of ideal reactors / Fundamental concepts used in the design of chemical reactors / Matter Balance and Energy Balance / Design of isothermal reactors / Analysis of Batch and Semibatch reactors / Problems.

8. **REACTOR DESIGN II**

   Isothermal reactor design / Design of Tubular Reactor (Plug Flow Reactor PFR) / Stirred Tank Reactor with Continuous Flow (CSTR) / The space velocity, space time and residence time.

9. **REACTOR DESIGN III**

   CSTR and PFR comparison / Analysis of a battery of series CSTR / Size comparison between a cascade of CSTR and PFR / Reactor with recycle.

10. **THERMIDYNAMIC ASPECTS I**

    Effect of temperature on the design of chemical reactors / Summary of the thermodynamic aspects of chemical reactions / The energy balance applied to chemical reactors / Physical interpretation / Non isothermal Batch reactor / Adiabatic operation.

11. **THERMIDYNAMIC ASPECTS II**

    CSTR reactor with heat exchange / CSTR reactor of adiabatic operation.

12. **THERMIDYNAMIC ASPECTS III**

    PFR reactor with heat exchange / PFR reactor of adiabatic operation.

13. **THERMIDYNAMIC ASPECTS IV**

    Conditions of stable operation in stirred tank reactors / Optimal temperature profiles / Thermodynamics and selectivity considerations.

14. **HETEROGENEOUS SYSTEMS**

    Introduction to the kinetics and reactor design in heterogeneous systems / Heterogeneous catalysis.

V. LABORATORY AND PRACTICAL EXPERIENCES

First Practice: Speed formulation and mathematical characterization of simple systems.
Second Practice: Interpretation of experimental data.
Third Practice: Reactor design of isothermal flow. Comparison CSTR and PFR reactors.
Fourth Practice: Design of non-isothermal reactors. Interpretation of experimental data.

VI. METHODOLOGY

The course is developed in theory and practical sessions. In the theory sessions, the instructor presents the concepts, theorems and applications. In the practical sessions, various problems are solved and their solutions are analyzed. In all sessions the active participation of the student is encouraged.

VII. EVALUATION FORMULA

The Average Grade PF is calculated as follow:

PF = (EP + EF + PP) / 3

EP: Mid-Term Exam
EF: Final Exam
PP: Average of practices

VIII. BIBLIOGRAPHY

1. **MISSEN, R.**
   Introduction to Chemical Reaction Engineering and Kinetics.
2. **SCOTT FOGLER, H.**
   Elements of Chemical Reactions Engineering.
3. **HILL, CHARLES G.**
   An Introduction to Chemical Engineering Kinetics and Reactor Design. Ed. John Wiley and Sons, Inc.
4. **SMITH, J. M.**
   Chemical Engineering Kinetics.