NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF CHEMICAL AND TEXTILE ENGINEERING
TEXTILE ENGINEERING PROGRAM

PI111 – MASS AND ENERGY BALANCE

I. GENERAL INFORMATION

CODE	:	PI111 Mass and Energy Balance
SEMESTER	:	5
CREDITS	:	3
HOURS PER WEEK	:	4 (Theory – Practice)
PREREQUISITES	:	QU425 Physical Chemistry I
CONDITION	:	Compulsory

II. COURSE DESCRIPTION

The course prepares students for the understanding and application of mass and energy balance in chemical processes. Students apply the fundamental equations of mass and energy conservation for open and closed systems under different working conditions, including systems in transient or steady states, as well as systems including simple or multiple chemical reactions. Students also understand and apply psicrometrics concepts and methods for systems involving gas-vapor mixtures.

III. COURSE OUTCOMES

At the end of the course, students:

1. Understand the concepts and method of psicrometry for determining the physics and thermodynamic properties of gas-vapor mixtures.
2. Analyze the mass balance of open and closed systems, in transient and steady-state regimes.
3. Analyze the mass balance of systems in equilibrium state, as well as in systems with simple and multiple chemical reactions.
4. Analyze energy balance in non-reactant systems, including closed systems at constant-volume, constant pressure and applying the general equation of energy balance.
5. Understand and apply thermo-chemical concepts, and analyze the energy balance in systems with simple and multiple chemical reactions.

IV. COURSE CONTENTS

1. INTRODUCTION

Units / Units conversion / Psicrometry / Steam pressure / Antoine equation / Cox graphs / Steam tables / Absolute and relative humidity / Dry bulb temperature / Humid bulb temperature / Dew temperature / Adiabatic saturation temperature / Humid volume / Humid heat / Enthalpy / Psicrometric chart / Steam processes / Cooling / Humidification / Dehumidification / Air conditioning.

2. MASS BALANCE

Open and closed systems / Transient and steady state / Flow diagram / Mass balance general equation / Elemental mass balance / Component mass balance / Mass balance in non-reactant systems / Unit mass balance / Mass balance in multiple-unit systems / Recirculation currents / Derivation current and purge.

3. MASS BALANCE IN SYSTEMS IN EQUILIBRIUM

Equilibrium basic concepts / Fundamental laws / Equilibrium state graphs / Binary and ternary systems / Mass balance in in-equilibrium systems / Mass balance in chemical reaction systems / Combustion / Oxygen / Excess air / Orsat analysis / Conversion degree / Multiple chemical reactions / Efficiency /

4. ENERGY BALANCE IN NON-REACTANT SYSTEMS

Basic concepts / Energy forms / Kinetic energy / Potential energy / Internal energy / In-transit energy. Heat and Work / Heat capacity as a function of temperature / Mean heat capacity / General equation of energy balance for open systems / Enthalpy evaluation / Humid air enthalpy / Closed systems / Constant-volume processes / Constant-pressure processes / Phase transition heat / Heat balance with thermodynamic information.

5. THERMO-CHEMISTRY

Reaction heat / Standard reaction heat / Standard formation heat / Standard combustion heat / Calculation of standard reaction heat / Standard dissolution heat / Hess law / Energy balance in one chemical reaction systems / Energy balance in multiple reaction systems / Mass and energy simultaneous balance / Mass and energy balance in chemical processes.

VI. METHODOLOGY

The course consists of theory and practice. In theory sessions, the instructor presents the concepts and principles of mass and energy balance using applets and videos. In practice sessions, students analyze and solve different problems of mass and energy balance. Problems related to engineering are solved with active student participation. At the end of the course, students submit and defend a report on a theme of the course.

VII. GRADING SYSTEM

The Final Grade (FG) is calculated with the following formula:

FG = (EP + EF + PP) / 3

EP: Mid-term exam EF: Final exam PP: Average grade of practice work

VIII. BIBLIOGRAPHY

1. **FELDER AND ROUSSEAU**
   Basic Principles of Chemical Processes
   Mc Graw Hill Editions, 2010

2. **HOUGEN, WATSON and RAGATZ**
   Principles of Chemical Processes
   Reverte Editions, 2012

3. **REKLAITIS G.V.**
   Mass and Energy Balance
   Interamerican Editions, 2012