NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF CHEMICAL AND TEXTILE ENGINEERING

CHEMICAL ENGINEERING PROGRAM

PI135 – LABORATORY OF UNIT OPERATIONS I

I. GENERAL INFORMATION

CODE	:	PI 135 Laboratory of Unit Operations I
SEMESTER	:	9
CREDITS	:	2
HOURS PER WEEK	:	4 (Theory–Practice-Laboratory)
PREREQUISITES	:	PI 143 Heat Transfer PI 146 Operations in Chemical Engineering I
CONDITION	:	Compulsory
DEPARTMENT	:	Chemical Engineering.

II. COURSE DESCRIPTION

The course prepares student for the practical application and analysis of unit operation commonly used in chemical industry. Students work in teams to carry experiments on heat transfer, flow in pipes, pumping systems, filtration, evaporation and agitation. Students explain the principles of each unit operation, take and analyze data, verify its validity and formulate conclusions validating the theoretical background. Students set up equipment, and use and calibrate measurement instruments in an environment similar to actual industrial plants.

III. COURSE OUTCOMES

At the end of the course, students:

1. Understand the principles of unit operations applied to chemical processes.
2. Use proper techniques and methods for analysis and implementation of unit operations.
3. Apply the knowledge of flow mechanics and pumping systems for the design, operation and maintenance of liquid transportation facilities in engineering plants.
4. Analyze and apply separation processes of heterogeneous systems: solid-liquid and/or solid-gas, using proper equipment.
5. Analyze and solve problems of industrial filtration using proper equipment.
6. Analyze and interpret obtained experimental data and document the results, by the presentation of experiment reports.

IV. LEARNING UNITS

1. LABORATORY OF PREASSURE LOSSES IN PIPELINES SYSTEMS

Experimental study of primary and secondary losses / Analysis of the effect of flow and pipe material. PVC, stainless steel and galvanized iron one-inch pipes are available for students use / Analysis of the effect of flow on pressure losses due to typically used piping accessories. Elbow pipes, globe, gate and ball valves, and changes of flow area: contraction and enlargement, are available for students use.

2. LABORATORY OF AGITATION

Analysis of agitation purpose and methods depending on the process stage / Suspension of miscible liquids / Solid particles mixing / Dispersion of a gas in a liquid in the form of small bubbles / Dispersion of a second liquid, immiscible with the first, to form an emulsion or suspension of tiny drops / Improvement of heat transference between liquids and coil or case.

3. **LABORATORY OF FILTRATION**
Analysis and use of filtration equipment in laboratory-pilot plant, and scaling to industrial level / Analysis of principles and problems in filtration equipment: variable pressure, constant volumetric flow, constant pressure and variable volumetric flow / Analysis for determining the number of plates and frames in the design of filtration-press equipment.

4. **LABORATORY OF PUMPS**
Determination and analysis of the characteristics curves of centrifugal pumps / Heat vs Flow / Power vs Flow / Efficiency vs Flow / Analysis of conventional centrifugal pumps and self-priming pumps / Experimental analysis of the operation of pumping systems with pumps in series or parallel configurations.

5. **LABORATORY OF HEAT EXCHANGERS**
Identification of the different types of heat exchangers available for students use in the laboratory / Identification of variables and analysis of transfer rate / Volumetric flow / Mass flow / Temperature differential in heat exchangers / Determination of heat transference by mass and energy balance.

6. **LABORATORY OF EVAPORATION**
Analysis and control of evaporation processes using evaporators of simple effect to concentrate dilute ideal solutions / Control of parameters to achieve maximum evaporation capacity / Analysis of variables in mass and energy balances.

V. LABORATORY SCHEDULE

Students are grouped in teams of four members (five at most) to complete each laboratory experience in a weekly schedule. Each laboratory experience takes two sessions of three-hours each (one session per week). In the following table the laboratory schedule for each student group is presented.

GROUPS	SESION 1	SESION 2	SESION 3	SESION 4	SESION 5	SESION 6
A, D	weeks 2, 3	weeks 4, 5	weeks 6, 7	weeks 9,10	weeks 11, 12	Weeks 13, 14
B, E	weeks 6, 7	weeks 2, 3	weeks 4, 5	weeks 13, 14	weeks 9, 10	weeks 11, 12
E, F	weeks 4, 5	weeks 6, 7	weeks 2, 3	weeks 11, 12	weeks 13, 14	weeks 9, 10

VI. METHODOLOGY

Each laboratory experience starts with a brief presentation of the theoretical background of the unit operation to be analyzed. Afterwards, students carry out the experience using a laboratory guide provided in advance. Students identify required equipment and instruments and formulate the objectives to be achieved. Proper data is taken, analyzed and drawn to verify the pertinence of the results. After completing each laboratory experience, students submit and defend a report according to a given format. Reports are evaluated according to rubrics based on the attainment level of expected outcomes. Student active participation is promoted, as well as continuous bibliography search and analysis regarding experimental unit operations.

VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

PF = (EP + EF + PL) / 3

EP: Mid-term Exam EF: Final Exam
PL: Average of Laboratory Sessions Grade

VIII. BIBLIOGRAPHY

1. MOTT. R. L.
Applied Fluid Mechanics, Prentice Hall – 4th Edition, 2006.
2. ANGEL VIAN and J OCON.
Chemical Engineering Elements, 6th Edition, Madrid, 2013.