PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
SCHOOL OF ENGINEERING
DEPARTAMENT OF CHEMICAL ENGINEERING AND BIOPROCESSES
ABET COURSE SYLLABI

IIQ2013 UNIT OPERATIONS I

Credits and contact hours:	10 UC credits / 10 hours (3 h. Lectures; 1,5 h. Labs; 5,5 h. Independent learning experiences)
Instructor's name:	José Manuel del Valle
Course coordinator's name	None
Textbook:	Badger, W.L. & J.T. Banchero. 1970. Introducción a la Ingeniería Química. McGraw-Hill, Ciudad de México, México. (660.2 B135i.E)
Course Catalog Description:	Unit Operations I is a course that enables students to analyze basic process operations and sizing equipment that are present in most chemical processing, food processing, and industrial fermentations plants, and whose operation principles are limited to transport of momentum and heat. Course contents include, among others, fluid dynamics applied to compressible and incompressible fluids, equipment specification for pumping fluid; mechanisms and heat transfer coefficients; and design of heat exchangers, evaporators' plants, and agitated tanks, among others.
Prerequisite Courses:	ICH1102 Fluid Mechanics + IIQ1112 Chemical Process
Co-requisite Courses:	None
Status in the Curriculum:	Minimum course
Course Learning Outcomes:	1. Identify, analyze, and dimensioning pipe nets components for fluid transport. 2. Identify, analyze, and dimensioning equipment and systems for tasks of heat exchange between fluids. 3. Select, analyze and scale tanks and other devices for stirring fluids for momentum and heat transfer tasks. 4. Perform laboratory experiments or pilot plant, with equipment normally used in the industry, and interprets the experimental results based on transfer momentum and heat content of the course.
Relation of Course to ABET Criteria:	a. Knowledge of mathematics, science and engineering b. Design and conduct experiments: analyze and interpret data c. Design a system, component, or process d. Multidisciplinary teams e. Identify, formulate, and solve engineering problems g. Effective communication

k. Techniques, skills, and modern tools for engineering practice.

Topics covered:

1. Fluid transport (5). Fundamentals of fluid transport (units, energy balance, physical properties). Flow of liquids and gases at low pressure (incompressible fluids), high pressure gas (compressible fluid), and non-Newtonian fluids under different flow regimes (laminar, turbulent, or transitional). Calculation of friction coefficients and coefficients of singular losses. Circular (pipe) and other geometries pipelines. Pipe diameter optimization. Fittings. Piping systems with different configurations (serial, parallel, and mixed).
2. Fluid transport equipment (3). Equipment to push fluids and gases: pumps, fans, and compressors. Operation and suction curves of centrifugal pumps and positive displacement (rotary, reciprocating). Pump systems (connected in series or parallel). Compressors theory of one and multiple stages.
3. Principles of heat transfer - overview (1). Heat conduction and convection. Energy balances. Physical Properties. Heat transfer coefficients for different flow regimes (laminar, turbulent, transition) and geometry (internal flow external flow). Configurations of resistances to heat transfer (in series, parallel, and mixed). Overall heat transfer coefficients. Optimization of thermal insulation. Using extended surfaces to increase heat transfer.
4. Heat exchangers (IC) (8). Fundamentals. Contact patterns between the fluid (co-current flow, counter-current flow, cross flow, etc..). Logarithmic mean temperature difference. Efficiency and number of transfer units ICs, the relationship between the two of them, and application to design and performance evaluation of equipment. Equipment description (IC double pipe, IC of pipes and casing, compact IC). Selection and dimensioning (heat transfer area, pressure loss of the currents) equipment.
5. Evaporators (4). Evaporation. Heat transfer coefficients during evaporation. Evaporation in power plants. "Chemical"evaporation. Energy recovery systems in chemical evaporation (vapor recompression, multi-effect evaporation). Material and energy balances and design equations in multi-effect evaporators.
6. Capacitors (2). Condensation. Heat transfer coefficients during condensation. Equipment and design.
7. Stirring and mixing (4). Principles and mixing quality. Static mixers. Agitated tanks. Flow regimes (laminar, turbulent, or transitional), power consumption, and heat transfer in stirred tanks. Scaling equipment.