CM3215
Fundamentals of Chemical Engineering Lab

Curricular Designation: Required

Catalog Description:

This course will be an introduction to basic laboratory methods and instrumentation used in the measurement of fluid flow, heat transfer, and mass transfer. Topics to be covered include methods of statistical data analysis, experimental design, principles of measurement and instrumentation, and presentation of data.

Textbooks(s) and/or Other Required Materials:

No required textbook.

All students must purchase a permanently bound laboratory notebook for experimental data. Safety glasses with side shields (provided), closed-toe shoes, a shirt that covers the entire torso, and long pants must be worn in the laboratory at all times.

Prerequisites by Topic:

CM 2120 Fundamentals of Chemical Engineering II – mastery of mass balance techniques; mastery or elementary energy balance techniques; mastery of the application of the mechanical energy balance; familiarity of the theory behind manometers

CM3110 Transport/Unit Operations 1 (may be taken concurrently) – familiarity with momentum-balance techniques; developing mastery with energy balance techniques; familiarity with the operation of heat exchangers

*(MA 3520 or MA 3521 or MA 3530 or MA 3560) Differential Equation*s - mastery of the mathematics of momentum and energy balances (three-dimensional integration and the solutions of differential equations; partial differentiation)

Course Objectives:

- Master the principles and execution of experimental design including: replicates, measurement limits, systematic error, random error, uncertainty;
- Master the analysis techniques of chemical engineering processes such as: fluid flow and flow-rate measurement, pressure measurement, centrifugal pumps, heat exchangers, control valves, temperature measurement, calibration;
- Master the principles and execution of data handling including: measurement limitations, significant figures, units, trend lines, logarithmic scales, effective graphical presentation;

- Master the technical memo report;
- Familiarity with the statistical handling of experimental data including: use of standard deviations, normal distribution, statistical significance;
- Familiarity with the use of spreadsheet software in data handling and presentation;
- Familiarity with industrial safety practices including: appropriate attire, personal protective equipment, safety meetings, incident reporting, safety culture;
- Introduction to design of experiments;
- Introduction to professional communications including: email, teamwork, supervisor reporting.

Topics Covered:

1. Lab orientation
   1.1 Create P&ID
   1.2 Practice Excel
2. Pressure Measurement,
   2.1 Measure density
   2.2 Calibrate differential pressure cell with manometer
3. Measure Fluid Viscosity
4. Calibrate Flowmeters and Explore Reynolds Number
5. Frictional Losses in a Straight Pipe
6. Characterization of a Pneumatic Control Valve
7. Statistics: General Concepts
8. Visual Basic Programming in Excel and Excel Macros
9. Analysis of a Centrifugal Pump
10. Overall Heat-Transfer Coefficient for a Double-Pipe Heat Exchanger
11. System Identification/RTD Dynamics
12. Heat Transfer to a Solid Ball
13. Safety Meeting

Class/Laboratory Schedule (note: 1 hour = 50 minutes)**:**

Lecture: 13 hours = 1 hour/week for 14 weeks; one 1 h holiday
Laboratory: 42 hours = 2 hours/week in lab and 1 hour/week in lab-preparation presentation

Contribution of Course to Meeting the Professional Component: Engineering Topics

Relationship of Course to Program Outcomes:

Outcome	Topics and Level of Coverage			Comments/Examples
	Important	***Moderately important***	***Not covered***	
a) Apply knowledge of mathematics, science, and engineering	2-12			All laboratories require formal mathematical analysis.
b) Design and conduct experiments, analyze and interpret data	2-7, 9-12			All laboratories require the students to design the experimental protocol, analyze and interpret data.
c) Design a system, component, or process to meet desired needs			x	
d) Function on a multi-disciplinary team			x	
e) Identify, formulate, and solve engineering problems	9 10			Formal calculation of pumping head curves and system head curves; formal calculation of energy balances on heat exchanger
f) Understand professional and ethical responsibility	all			All communications are required to meet a professional standard; safety program emphasizes ethical implications of safety; peer evaluations address ethics of plagiarism and appropriate credit to originators of work
g) Communicate effectively	all			Nine technical memo reports are required; rewrites encouraged in the first half of the course to ensure mastery.
h) Understand global and social impact of engineering solutions		all		Safety program covers impact of releases on society and world.
i) Recognize the need for life-long learning		all		Safety training emphasized throughout to be part of an ongoing life-long process.
j) Demonstrate knowledge of contemporary issues		all		Working with a variety of team members exposes students to a variety of team working styles, abilities.
k) Use the techniques and tools of modern engineering practice	8 10			Excel programming Labview used to acquire temperature data

Relationship of Course to AIChE Program Criteria:

Outcome	Topics and Level of Coverage			Comments/Examples
	Important	***Moderately important***	***Not covered***	
A-1) Thorough grounding in chemistry and a working knowledge of advanced chemistry such as organic, inorganic, physical, analytical, materials chemistry, or biochemistry, selected as appropriate to the goals of the program		2.1 3		Measurement of density Measurement of viscosity
A-2) Working knowledge, including safety and environmental aspects of material and energy balances applied to chemical processes	10 12 13, all			Energy balances Energy balances Safety
A-3) Thermodynamics of physical and chemical equilibria		10		Use of enthalpy in analysis of heat exchanger
A-4) Heat, mass, and momentum transfer	all			This is a transport lab
A-5) Chemical reaction engineering			x	
A-6) Continuous and stage-wise operations	4,5,6,9,10			Analyses of continuous processes
A-7) Process dynamics and control		6,11 10		Instrumentation for controls; Labview data acquisition used;
A-8) Process design			x	
A-9) Modern experimental and computing techniques	10 8			Labview data acquisition used; Excel programming

Prepared by:

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