THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

# Process Fundamentals

## CBE 2200

**Credit Hours:**
3.00 - 3.00

**Course Levels:**
Undergraduate (1000-5000 level)

**Course Components:**
Lecture

**Course Description:**
Application of physicochemical principles to problems of the chemical industry; stoichiometry and material balance.

**Prerequisites and Co-requisites:**
Prereq: Chem 1210, and Engr 1181 or 1281.xxH. Prereq or concur: Math 1172, and CPHR 2.0 or above; and permission of department.

**Course Goals / Objectives:**

- Master fundamentals of dimensions and unit conversions in engineering calculations
- Become familiar with chemical processes, process variables, unit operations
- Master the preparation of simple process flow sheets and performing degree of freedom analysis
- Master fundamentals of stoichiometry and material balances for reacting and non-reacting systems, including the importance of recycle to minimize environmental impact and improve the economics of chemical processes
- Become familiar with phase behavior of pure components and mixtures, with emphasis on vapor/liquid equilibrium and its application to separation processes
- Be exposed to thermodynamics of non-ideal gases, with emphasis on the use of equations of state to describe volumetric behavior of non-ideal gases
- Be exposed to process data representation and analysis, including basic linear regression, and become familiar with MATLAB and Microsoft Excel as computational tools for solving material balance problems
- Demonstrate ability to work effectively in assigned teams for homework problems
- Be familiar with various forms of energy including shaft and flow work, heat, kinetic and potential energy, internal energy and enthalpy
- Master methods of obtaining thermodynamic data from tables, psychrometric charts, enthalpy-concentration diagrams
- Be familiar with simple equations of state and how they are used to describe volumetric properties of pure and mixed materials
- Master application of the general energy balance equation to solve a variety of problems of moderate complexity, including the simultaneous application of material and energy balances and systems involving phase changes and chemical reactions
- Be familiar with transient mass and energy balances and their general use
- Master the use of transient mass balances to solve simple problems

**Course Topics:**

- Units, dimensions, conversions, force and weight, numerical calculation and estimation, basic statistics, dimensional consistency, dimensionless numbers
- Data representation and analysis, method of least squares mass, volume, density, flow rates
- Composition and concentration, pressure and temperature types of processes, general mass balance equation, steady-state and batch processes, flowcharts
- Material balance calculations, degree of freedom analysis, multiple unit processes, recycle and bypass
- Chemical reaction stoichiometry, reactive systems, conversion, extent of reaction, equilibrium reactions, multiple reactions (yield and selectivity), atomic balances,
- Combustion, excess air
- Single-phase systems: solid/liquid/gas densities, the ideal gas equation of state, standard temperature and pressure
- Real (nonideal) gases, reduced properties, equations of state for nonideal gas conditions
- Phase diagrams, single-component phase equilibria, vapor pressure, Gibbs phase rule, gas/liquid systems with one condensable component, humidity
- Vapor/liquid equilibrium, Raoult's Law, Pxy and Txy diagrams
- Introduction and orientation; first law of thermodynamics; forms of energy; heat and work; closed and open systems; the general energy balance equation
- Tables of thermodynamic data; the mechanical energy balance
- State properties; hypothetical paths; pressure and temperature changes
- Phase changes; mixing; solutions
- Heats of reaction and Hess's Law
- Heats of combustion reactions; the energy balance for reactive systems
- Fuels and combustions
- General balance equation for unsteady-state (transient) processes
- Material balances on transient processes
- Energy balances on transient processes

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**Designation:**
Required