From Lectures **2016W**

Ch2

* **Relate** units of measure from various measurement systems and convert between them - Ch 2.2, Ch. 2.3
* **Use** order of magnitude to reasonably estimate solutions - Ch 2.5b
* **Choose** appropriate units for variables based on dimensional consistency of equations - Ch 2.6

Ch3

* **Indicate** basic process variables - Ch 3
  + Density – Ch3.1
  + Flow rate – Ch 3.2
  + Chemical Composition – Ch 3.3
  + Pressure – Ch 3.4
  + Temperature – Ch 3.5

Ch4

* **Classify** steady and unsteady state processes and process types - Ch 4.1
* **Apply** the general mass balance equation in differential and integral forms - Ch 4.2
* **Construct** block flow diagrams for chemical processes - Ch 4.3a/b
* **Analyze** the degrees of freedom (DOF) of processes to understand whether they are under specified, adequately specified or over specified - Ch 4.3 d
* **Apply** a general procedure to organize process flow calculations - Ch 4.3e
* **Identify** reaction and bypass streams in a chemical process - Ch 4.5
* **Manipulate** chemical reactions to balance reaction stoichiometry - Ch 4.6
* **Characterize** reactor performance using fractional conversion, limiting reactants and excess reactants - Ch 4.6b
* **Calculate** reaction extent in order to characterize a chemical reaction - Ch 4.6b
* **Calculate** the equilibrium constant for a given chemical system - Ch 4.6c
* **Analyze** scenarios with multiple reactions using selectivity, yield and fractional conversion - Ch 4.6d
* **Apply** reactive material balances to solve material balances on reactive system.
* **Calculate** Degrees of Freedom using molecular species, atomic species or extent of reaction for reactive systems
* **Characterize** separation, recycle and purging operations in chemical systems.
* **Identify** purge streams in processes
* **Apply** combustion concepts such as incomplete combustion, theoretical air/O2 and excess air/O2 to analyze combustion reactions.

Ch 5

* **Estimate** densities of solid and liquid mixtures
* **Characterize** ideal and non-ideal gasses
* **Calculate** ideal and non-ideal gas properties

Ch 6

* Interpret phase diagrams
* Estimate vapour pressure using Clapeyron, Clausius-Clapeyron and Antoine equations
* Calculate the degrees of freedom in a thermodynamic system using the Gibb’s phase rule.
* Characterize condensation of one component in a mixture using Raoult’s law.
* Understand when to apply Raoult’s or Henry’s law
* Calculate concentrations of dissolved gasses using Raoult’s or Henry’s law.
* Calculate dew and bubble point pressure, temperature and phase compositions
* Interpret graphical representations of 2-phase systems
* **Characterize** the effects of solids dissolved in liquids
* **Calculate** concentrations of components in liquid systems based on the distribution coefficient
* **Interpret** ternary phase diagrams describing liquid systems
* **Solve** systems with adsorption using adsorption isotherms

Ch 7

* **Identify** relevant terms for energy balances for open and closed systems
* **Calculate** changes in various forms of energy for a system
* **Use** thermodynamic data tables to find system volume, internal energy or enthalpy based on system temperature and pressure
* **Solve** multi-component energy balance problems using tabulated thermodynamic data.

PFD & Stream Tables

* Interpret PFD’s
* Understand stream tables and their application

Ch 8

* **Apply** a strategy for solving energy balances
* **Calculate** energy changes associated with changes in pressure at a constant temperature and state of aggregation
* **Characterize** energy changes in a system due to changes in temperature.
* **Analyze** energy balances on processes involving phase changes.
* **Analyze** psychrometric charts to obtain relevant system data
* **Calculate** changes in system energy due to mixing

Ch 9

* **Explain** heats of reaction as well as endothermic and exothermic reactions
* **Determine** the standard heat of reaction given other heats of reaction or heats of formation
* **Calculate** standard heats of combustion for a variety of substances
* **Solve** material and energy balances involving reactions
* **Characterize** fuels using heating value and adiabatic flame temperature.
* **Apply** ignition and flammability limits to chemical systems

This year’s content list **2017W**

Module 1: Process Basics – drinking water purification, wastewater treatment, pulp mills

* Input-Output Diagrams
* Conservation of Mass
* Mass flow
* Material balances
* Block Flow Diagrams
* Mixer
* Degrees of Freedom (DOF)
* Process economics
* Excel
* Unit conversion

Module 2: Reactors - pharmaceuticals

* Reactor
* Batch, Semi-batch, continuous
* Transient and steady state
* Process Flow Diagrams
* Converting moles to mass
* Reactive Balances
* Atomic Balances
* Molecular species balances
* Extent of reaction
* % excess
* Fractional conversion
* Yield and selectivity

Module 3: Separation I

* Splitter
* Recycle
* Purge
* Process and Instrumentation Diagram (P&ID)
* Centrifugation and cyclones
* Dimensional Homogeneity
* Density and specific gravity
* Solid-Liquid Equilibrium
* Temperature systems (K, C, F, R)
* Trend/Curve fitting
* Solid-Vapour Equilibrium
* Liquid-Liquid Equilibrium

Module 4: Separation II (VLE)

* Separators (Distillation columns, LL extractions {note:contradicts above})
* Pressure measurement
* Gauge vs. Abs pressure
* Ideal gas law
* Difference between vapour and gas
* Gibb’s phase rule
* Vapour-Liquid Equilibrium (VLE)
* Phase diagrams
* Non-ideal gas laws
* Standard cubic feet, and standard flow rates
* Raoult’s law
* Henry’s Law
* Antoine equation and vapour pressure
* Humidity
* Dew point
* Steam Tables
* Interpolation

Module 5: Non-reactive Energy Balances

* Energy Balance DOFs
* First Law (E= Q+W) and when terms can be neglected
* Closed, open, adiabatic, isothermal, isobaric, isochoric systems
* Closed systems and internal energy
* Open systems and enthalpy
* Classification of Energy (Q, W, Ek, Ep, Eu)
* Conservation of energy
* Reference states and state properties
* State functions
* E change from pressure change
* Cv + Cp, heat capacities
* Psychrometric charts and spray drying
* Heat of mixing

Module 6: Reactive Energy Balances

* Heat of reaction/combustion
* Hess’ law for heats of reaction
* Heating values (HHV, LHV)
* Heat of reaction method for solving energy balances
* Heat of Vapourization/Melting