**CHEN 3620 - Transport II (3)**

**Required Core Course**

**2015-2016 Catalog Data Lec (3).** Fundamentals and applications of heat and mass transfer in chemical processes including conduction, convection, and radiation, heat exchange, evaporation, chemical reaction gas absorption, drying and humidification.

**Prerequisites** Pr: MATH 2630 or MATH 2637, and completion of CHEN 2610 and ENGR 2010 with a grade of C or better, P/C CHEN 3600

**Schedule** Three one-hour class sessions per week

**Course Objectives** This course is designed to provide knowledge of fundamentals and applications of heat and mass transfer in chemical and bio-related processes.

**Textbooks**

Geankoplis, Transport Processes and Separation Process Principles, 4e, 2003, 9780131013674, Prentice-Hall

**Topics Covered**

1. Mechanisms of heat transfer (0.33 week)
2. Steady and transient heat conduction (2.33 weeks)
3. Forced and natural convection (1.33 weeks)
4. Radiation heat transfer (1.00 week)
5. Boiling and condensation (0.33 week)
6. Heat exchangers and evaporators (2.00 weeks)
7. Steady and transient molecular diffusion (2.33 weeks)
8. Convective mass transfer (0.67 week)
9. Boundary layers in heat and mass transfer (0.67 week)
10. Analogies between heat and mass transfer (0.33 week)
11. Simultaneous heat and mass transfer (0.33 week)
12. Gas absorption and drying (2.33 weeks)
13. Tests (1.00 week)

**Course Outcomes:** Upon successful completion of this course, students should be able to:

1. Explain basic heat transfer concepts such as heat transfer rate, heat flux, thermal resistance, thermal driving force, thermal conductivity, thermal diffusivity, heat transfer coefficients (individual and overall), local equilibrium, boiling, condensation and fouling, and dimensionless numbers used in heat transfer.
2. Explain the basis for the mechanism of heat conduction. Apply Fourier’s law to solve problems such as conduction through solids with simple geometries including series and parallel applications.
3. Explain the basis for the mechanism of heat transfer via natural and forced convection. Estimate heat transfer coefficients from correlation equations and solve convective heat transfer problems.
4. Explain the basic concepts and temperature profiles associated with co-current, counter-current, single and multi-pass heat exchangers. Solve a variety of heat exchanger problems.
5. Explain the basic concepts (such as economy, capacity, boiling point elevation) and operational factors (such as pressure, temperature, solubility, scaling, foaming) associated with various types of single effect evaporators. Solve a variety of evaporator problems.
6. Explain basic radiation concepts such as Stefan-Boltzmann law, black and gray bodies, emissivity, absorptivity, view factors. Solve basic heat transfer problems involving radiation.
7. Explain basic thermal boundary layer concepts with reference to hydrodynamic boundary layer concepts. Solve basic thermal boundary problems involving local and overall heat transfer.
8. Apply available methods to solve unsteady-state heat transfer problems.
9. Explain the concept of molecular transport as it applies to momentum, heat and mass transport. Explain the analogy between Newton’s law, Fourier’s law, and Fick’s law.
10. Explain the concept of convective transport as it applies to momentum, heat and mass transport. Explain the analogy between friction factor and j-factors for heat and mass transfer. Interchangeably employ heat and mass transfer correlations to obtain necessary parameters.
11. Explain basic mass transfer concepts such as mass transfer rate, molar fluxes NA and JA, mass transfer resistance, mass transfer driving forces, molecular diffusivity and eddy diffusivity, mass transfer coefficients (individual and overall), local equilibrium, and dimensionless numbers used in mass transfer.
12. Explain the basis for the mechanism of molecular diffusion. Apply the general diffusion equation to solve problems such as diffusion in gases, liquids and solids including equimolar counter-diffusion, diffusion plus convection, and diffusion through stagnant species for simple geometries. Prediction of diffusivity for gases and liquids.
13. Explain the basis for the mechanism of mass transfer via natural and forced convection. Estimate mass transfer coefficients from correlation equations and solve convective mass transfer problems.
14. Apply the available correlation equations to solve steady-state mass transfer problems for simple geometries.
15. Explain the basic concepts (such as equilibrium diagram, operating line, individual and overall driving forces, HTU, NTU) as they apply in the unit operations of gas absorption and stripping. Apply these concepts to solve mass transfer problems involving gas absorption or stripping with dilute and concentrated solutions.
16. Explain basic concentration boundary layer concepts with reference to thermal boundary layer concepts. Solve basic concentration boundary problems involving local and overall mass transfer.
17. Apply available methods to solve unsteady state mass transfer problems.
18. Solve problems involving the diffusion of gases in a single capillary tube and in porous media.
19. Explain the basic concepts involved in drying operations such as equilibrium and free moisture content, drying rate, and drying regimes. Construct drying-rate curves from experimental data, calculate drying times, and predict the effect of changing drying process variables.

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| **Contribution of Course to Meeting ABET Criteria 5 (Curriculum)** | | |
| **Math and Basic Sciences** | **Engineering Topics** | **General Education** |
| 0 Credits | 3 Credits | 0 Credits |

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| **Relationship of Course to Student Outcomes (PO’s)** | | | | | | | | | | | | |
| **Student Outcome** | **A** | **B** | **C** | **D** | **E** | **F** | **G1** | **G2** | **H** | **I** | **J** | **K** |
| **Level of Coverage** | **S** | **I** | **I** |  | **R** |  |  |  |  |  |  | **I** |

**Date of Preparation and Person(s) Preparing This Description**February 6, 2016: Ron Neuman, Joseph Shaeiwitz and Tom Hanley