**CHEN 2650 - CHEMICAL ENGINEERING APPLICATIONS OF MATHEMATICAL TECHNIQUES (3)**

**Required Core Course**

**2018-2019 Catalog Data Lec (3). Application of a broad range of mathematical techniques to chemical engineering problems. Emphasis on engineering significance and interpretation of mathematical operations.**

**Prerequisites** CHEN 2100 and P/C CHEN 2610 and P/C MATH 2650 and COMP 1200 and completion of CHEN 2100 with grade of C or better.

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

**Course Objectives** This course is designed to emphasize the connection between chemical engineering problems and the mathematics used to solve them. Students should expect a better understanding and improved application of mathematics in chemical engineering problems.

**Textbooks**

TBD.

 **Topics Covered**

1. Material balance problems and basic linear algebra
2. Equations of state and root finding techniques
3. Gradient driving force problems and geometric interpretation of derivatives
4. Chemical engineering thermodynamics and differential calculus
5. Thermodynamic properties of mixtures and L’Hôpital’s rule
6. Reaction engineering problems and integral techniques with geometric interpretation
7. Heat transfer problems and integration by parts
8. Interpreting physical property data using integral averaging
9. Chemical engineering problems involving limiting cases and series expansion
10. Multivariable treatment of chemical thermodynamics including Maxwell relationships
11. Transport phenomena problems using vector methods (del operator, dot and cross products)
12. Unsteady state material and energy balance problems using differential equations
13. Transport phenomena problems involving higher order derivatives and application of shortcut methods
14. One week of time will be used for exams.

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

1. Solve material balance problems (often encountered in plant design and optimization) and conduct dimensional analysis (such as for a draining tank) by applying numerical techniques of linear algebra.
2. Solve non-linear equations, such as cubic equations of state, using root finding methods.
3. Apply derivatives in the context of chemical engineering problems, such as in the use of fundamental thermodynamic properties and Fick’s laws of diffusion, and be able to explain their geometric significance.
4. Solve chemical engineering thermodynamics problems, such as generating expressions for partial thermodynamic properties in terms of measurable properties, by application of techniques of differential calculus, including the product, quotient, and chain rules.
5. Solve chemical engineering problems, such as analysis of thermodynamic properties of mixtures and limiting conditions of activity coefficients, by applying L’Hôpital’s rule.
6. Solve reaction engineering problems, such as design of batch reactors, by application of integrals and be able to explain their geometric significance.
7. Solve heat transfer problems, such as those that involve Newton’s law of cooling, using integration by parts and substitution.
8. Apply integral averaging to relevant chemical engineering physical property data as well as temporal and/or spatially variable functions.
9. Define limiting cases in chemical engineering problems and linearize non-linear equations using methods of series expansion.
10. Solve chemical thermodynamics problems, such as derivation and application of the Maxwell relations, by applying multivariable calculus, including partial differentiation and multiple integration.
11. Solve transport phenomena problems involving a velocity gradient, by application of vector dot products, cross products and the del operator.
12. Solve unsteady state mass and energy balance problems, such as in tanks and reactors, by application of first-order, ordinary differential equations, including the use of integrating factor.
13. Solve chemical engineering problems that involve second-order, linear, ordinary differential equations, such as extended-surface heat transfer, porous catalysts, conduction and convection in the same direction, heat and mass transfer with chemical reaction, including the application of “shortcut” methods.

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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** |  | **S** |  | **I** |  |  |  |  | **I** |

**Date of Preparation and Person(s) Preparing This Description:**February 9, 2018: W. R. Ashurst, A. E. David, J. G. Radich, J. Shaeiwitz, S. Cremaschi, W. E. Josephson