**CHEN 3650 - Chemical Engineering Analysis (3)**

**Required Core Course**

**2015-2016 Catalog Data Lec (2), Lab (3).** Mathematical modeling, analytical, numerical and statistical analysis of chemical processes.

**Prerequisites** Pr: CHEN 2AA0 and completion of CHEN 3600 and CHEN 3620 with a grade of C or better.

**Schedule** Two one-hour class sessions and one three hour lab session per week

**Course Objectives** This course is designed to teach students methods to mathematically model and computer simulate any type of process or equipment based on fundamental transport, kinetic, and thermodynamic principles.

**Textbooks**

Zondervan, A Numerical Primer for the Chemical Engineer, 2014, 9781482229448, CRC Press

**Lecture Topics Covered:**

1. Class overview, syllabus, grading (0.5 weeks)
2. Introduction to modeling (1 week)
3. Numerical Methods (1.5 weeks)
4. Mathematical Modeling & Numerical Solution of Chemical Engineering Scenarios (3.5 weeks)
5. Laplace domain dynamics (2 weeks)
6. Transfer Functions (3 weeks)
7. Introduction to controls (1 week)
8. Stability of Steady States using eigenvalue methods (1 week)
9. Exams (1 week)
10. Review for the final exam (0.5 week)

**Lab Topics Covered:**

1. Further examples and problem work-throughs of process modeling, numerical methods and Laplace domain methods. (15 weeks)

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

1. Describe and classify models of low and intermediate complexity according to their properties. These classifications include type of model (linear/nonlinear, steady state/unsteady state, lumped parameter/distributed parameter), solution method, constituent equations and boundary/initial conditions.
2. Formulate mathematical models based on balances for conserved quantities and given or inferred physical phenomena that can be used to predict or explain the behavior of a simple chemical engineering operation or process. Example operations and processes include reactors, heat exchangers, fluid flow, tanks in series or parallel, heat conduction and convection.
3. Identify, explain and apply appropriate analytical or numerical methods (algebraic equations, differential equations, partial differential equations, iterative equations, Euler method, Runga-Kutta 4th order method, Newton-Raphson iteration) to solve common classes of engineering models.
4. Identify and formulate state-space (vector/matrix) and frequency-space representations for models of low complexity.
5. Apply Laplace transform methods to solve differential equation models in terms of transfer functions for chemical engineering systems of low to intermediate complexity. Identify the manipulated variables, controlled variables and disturbance variables for the system. Develop a block diagram for the system under consideration.
6. Linearize nonlinear models using first order Taylor series expansion.
7. Employ deviation variables where appropriate.
8. Map the stability of linear models using eigenvalue methods.
9. Distinguish between feedback and feed forward control strategies. Describe their advantages and disadvantages.
10. Critically evaluate a model and its solution including issues such as accuracy, validity of assumptions, adequacy of description of phenomena, significance and limitations.
11. Prepare technical reports describing an engineering model, solution methodology and model predictions including a critical evaluation.

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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 | S | I |   | S |   | R |   |   | S |   | S |

**Date of Preparation and Person(s) Preparing This Description**January 4, 2016: William Josephson, W. Robert Ashurst and Jin Wang