ABE 301

**Description:**

This course will introduce students to the tenets of critical thinking/arguments as well as principles of analysis, setup, and modeling of biological engineering phenomena using fundamental principles of engineering, such as material and energy balances, elementary thermodynamics, transport phenomena, reaction kinetics, and engineering economics.  Development of algebraic and differential models of steady state and transient processes involving material and energy balances, elementary thermodynamic, transport, and kinetic reaction principles, and economics in biological engineering systems. Emphasis on use of computational tools for modeling and solution of problems.   A variety of computational numerical modeling skills will be introduced for solution of these models, including interpolation, cubic splines, finding roots, statistical regression modeling, and numerical solution of differential equations.  MathCad/MATLAB/EXCEL software programming tools will be used for computational analysis.

**Course Topics:**

Structure of Critical Arguments and Modeling

Subjective vs. Objective; inductive/deductive premises, logic

Critical arguments

Critical argument analysis (written, visual)

Critical argument synthesis

Quantitative Models

Review of fundamental principles/models

Review calculus/geometrical shell elements

Empiricalvs. Theoretical models

Algebraic vs. Calculus/Differential

Linear vs. Nonlinear

Numerical Modeling

Numerical Accuracy/Precision/Error

Approximation methods, error, interpolation

Curve fitting

Review Ordinary Differential Equations

Initial value

Boundary value

Solving ODE's numerically

Power series and Runge Kutta

Solving sets of ODE's numerically

Unsteady state

Finite difference

Non-linear Dynamic systems

**Course Learning Objectives:**

1. Understand the purpose and structure of critical arguments
2. Develop skills to analyze written, visual critical arguments on contemporary issues
3. Develop skills to create critical arguments
4. Understand the structural similarities between critical arguments and quantitative modeling
5. Understand ethical behavior in academic setting
6. Understand process of how to develop mathematical models involved with food and biological phenomena
7. Understand the types of models and their purpose/utility from an engineering context
8. Understand the application of the numerical modeling principles and techniques of modeling and solutions
9. Understand the limitations related to computational accuracy/error and statistical precision of numerical modeling
10. Develop skills to create numerical models involving biological engineering systems using mechanistic concepts, such as reaction kinetics, transport phenomena, and thermodynamics
11. Develop skills for creating computational tools to quantify/evaluate numerical models

Critical arguments

1. Understand the inherent limitations of written communications as related to critical arguments.
2. Understand the written structure of a critical argument (premises and conclusion).
3. Be able to analyze critical arguments from other sources and clearly, concisely express the arguments in written critical argument form. Analysis means to be able to extract the critical argument from the media source; clearly express it in written format; and provide a comprehensive analysis of the weakness/strengths of the argument and determine whether it has a rationally compelling conclusion.
4. Be able to synthesize/create critical arguments and express them clearly, concisely in written critical argument form.

Modeling

1. Be able to demonstrate understanding of fundamental principles of science and engineering commensurate with current level of education.
2. Understand the concepts and structure of mechanistic quantitative modeling, including iteration to improve models.
3. Be able to apply the steps of the modeling process to synthesize/create/analyze/improve quantitative models for scientific and engineering situations.