BSE 3144 – Engineering Analysis for Biological Systems using Numerical Methods

Credit / contact hours: 2 credits, 2 contact hours

Course instructor: Durelle Scott

Textbook / materials:
primary textbook:
Steven C. Chapra, Applied Numerical Methods with Matlab for Engineers and Scientists, third edition.

Catalog description:
Solving engineering problems related to biological systems using numerical analysis including root finding, numerical integration, differentiation, interpolation and numerical solution of ordinary differential equations. Error analysis and programming with engineering software.

Co-requisites: MATH 2214

Pre-requisites: none

Course type: required in the program

Specific outcomes of instruction:

- Apply the following numerical techniques to solve problems in biological systems engineering:
    - root finding
    - solution of systems of linear equations
    - interpolation
    - differentiation and integration
    - solution of ordinary differential equations
- Define and quantify sources of error in numerical techniques
- Write programs, using engineering software, that involve loops, logical block constructs, function, plotting, and input/output

Student outcomes addressed by course:

Outcome 1: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

Outcome 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

List of topics covered:

Modeling, Matlab, and Error

- Mathematical model development
- Matlab fundamentals: inputs, outputs, graphing
- M-files: script and functions
- Documentation
- Structured programming
- Numerical Error and model error

Root finding and optimization

- Roots of equations
- Bisection code development
- Matlab use of predefined functions
- Optimization, min or max

Systems of equations

- Matrix algebra
- Setting up systems of equations
- Application within matlab
- Using inverse matrix to optimize and identify linkages

Curve-fitting

- Regression, linear and non-linear
- Interpolation
- Extrapolation

Integration, differentiation, ODEs

- Numerical integration, trapezoidal role
- Derivatives, $1^{st,}$ 2nd
- Euler's method, application of predator-prey models