Duke TIP Field Studies

Course: From Startups to World Hunger: A Mathematical Perspective

Instructor: Blain Patterson
Instructional Counselor: Sarah Ritchey

Course Materials

Required Text(s) – PURCHASE PRIOR TO PROGRAM:

Title: *Introduction to Computational Science: Modeling and Simulation for the Sciences* by Angela and George Shiflet (feel free to purchase a used copy).

Materials: Be sure to paper, writing utensils, and a calculator. If you are able to bring a laptop, please do. Otherwise, we will be using computers in a lab or will borrow laptops.

Course Description

How should we approach the big problems of the world such as energy conservation and world hunger? One way is to attempt to solve these social and economic problems through mathematical modeling. Mathematical models include graphical, numerical, symbolic, and verbal representations of some real world phenomenon. In this course, students will work in groups to solve an open ended problem of their choice. Their solution to this problem will be written up and presented to the class at the end of the two weeks. Mathematical and statistical software such as Matlab and Excel will be used to work with large sets of data. Professionals in the fields of medicine, technology, and energy conservation will come and discuss how they use mathematical models in their work. Students will visit the Duke Smart House, the EPA Center, and Bronto to observe how mathematical modeling is used in practice. The remainder of class time will be spent learning about various mathematical tools that can be used to model and solve problems, including statistical methods and numerical approximations.

Course Objectives/Central Questions

By the end of the course, the students will have done the following:

- Modeled and solved a real world problem using mathematical and statistical methods.
- Used mathematical software to work with large sets of data and perform computations.
- Prepared and delivered a small group presentation on their solution to the problem they choose.
- Discovered various mathematical tools that can be used to model and solve problems including statistical methods and numerical approximations.

Course Assignments

The major assignment of this course will be to write up and present your solution to an open ended problem of your choice. Students will also work on problem sets in class, practicing the mathematical and statistical techniques and algorithms discussed in class.

Weekday Daily Schedule:

Detailed schedules for weekends and residential activities will be provided by your Group Leader.

8:00 – 8:45 AM Breakfast
9:00 – 12:00 PM Class (see below for details)
12:00 – 1:00 PM Lunch
1:00 – 4:00 PM Class
4:00 – 6:00 PM Check in at Residence Hall, Free Time and Dinner
6:00 – 7:30 PM Evening Study (Monday – Thursday, 6-7 on Fridays)
7:30 – 9:30 PM Residential Activities
9:30 – 9:45 PM FS Group Meetings

Course Schedule

Date:	Time:	Topic:
Saturday	Noon – 3:00 Evening	Student Arrival Orientation
Sunday	Morning	Optional Religious Services, Optional Residential Activities

	Afternoon Evening	Academic Orientation: Introduction to the Course Welcome, Overview of Syllabus, Diagnostic Evaluation Residential Activities
Monday	Morning Afternoon Evening Study	Introduction to Mathematical Modeling Review of Functions and Introduction to MATLAB Misleading Data
Tuesday	Morning Afternoon Evening Study	Field Trip to Duke Smart House Linear Regression with Spreadsheets and Guest Speaker: Phil Cooley from RTI Regression Practice
Wednesday	Morning Afternoon Evening Study	Transforming Data, Model Fitting, and Guest Speaker: Dr. Katie Ratterree from RTI Introduction to Matrices, Matrix Operations with MATLAB, and Campus Tour Modeling Drug Concentrations
Thursday	Morning Afternoon Evening Study	Markov Chains with MATLAB Project Brainstorming and Field Trip to EPA Center Modeling Stocks and Brownian Motion
Friday	Morning Afternoon Evening Study	Guest Speaker: Dr. Ralph Smith from North Carolina State University Website Building and Leslie Matrices with MATLAB

		Project Brainstorming
Saturday	Morning Afternoon Evening	Residential Activities Residential Activities Talent Show
Sunday	Morning Afternoon	Optional Religious Services All Campus Event
Monday	Morning Afternoon Evening Study	Guest Speaker: Dr. Hien Tran from North Carolina State University and Unconstrained Growth in Spreadsheets Euler's Method in MATLAB Work on Problem
Tuesday	Morning Afternoon Evening Study	Ranking Algorithms in MATLAB Constrained Growth in Spreadsheets and MATLAB Work on Problem
Wednesday	Morning Afternoon Evening Study	Introduction to Fluid Dynamics Rumor Spreading with MATLAB Work on Problem
Thursday	Morning Afternoon Evening Study	Field Trip to Bronto Guest Speaker: Ken VanDine from Canonical Work on Problem
Friday	Morning Afternoon	Finish Problem and Practice Presentations Symposium
Saturday	10 AM – 2 PM	Student Departure

Course schedule subject to change.