

MATH 67: ENHANCED MATHEMATICS LEARNING WITH MATHEMATICA

Foothill College Course Outline of Record

| Heading | Value |
|-------------------------|---|
| Units: | 3 |
| Hours: | 3 lecture per week (36 total per quarter) |
| Advisory: | MATH 48A or equivalent; ability to download software and work with basic programs like Word or Excel. |
| Degree & Credit Status: | Degree-Applicable Credit Course |
| Foothill GE: | Non-GE |
| Transferable: | CSU |
| Grade Type: | Letter Grade (Request for Pass/No Pass) |
| Repeatability: | Not Repeatable |

Student Learning Outcomes

- Students will use "Mathematica" to solve various problems in mathematics and statistics.
- Students will develop conceptual understanding of basic features of the software program "Mathematica".
- Students will demonstrate the ability to use "Mathematica" to perform various tasks involving both computation and visualization in mathematics.

Description

An introduction to Mathematica mathematics software and its use as a tool for computation and visualization in mathematics and statistics. Use of Mathematica for solving problems taken from algebra and statistics through linear algebra and differential equations. Access to Mathematica provided at no additional cost.

Course Objectives

The student will be able to:

- Examine basic features of Mathematica.
- Create a sample Mathematica project.
- Analyze input and output in Mathematica.
- Create documents using word processing and typesetting tools in Mathematica.
- Create slide shows with Mathematica.
- Identify fundamental features of the Wolfram programming language.
- Construct interactive models with a single command.
- Share Mathematica documents.
- Examine ways to get help when working with Mathematica.
- Create 2-D and 3-D graphics in Mathematica using various commands for visualization.
- Create visualizations of data sets using visualization tools in Mathematica.
- Customize graphics using additional arguments to Mathematica commands.
- Create figures and diagrams with graphics primitives.
- Utilize commands available in Mathematica for algebraic manipulation and equation solving.
- Solve selected problems in calculus.
- Solve selected problems in differential equations.
- Solve selected problems in linear algebra.
- Solve selected problems in probability and statistics.
- Import and export data to and from Mathematica.
- Make use of tools in Mathematica to work with and manipulate large-scale curated data sets.

Course Content

- Examine basic features of Mathematica.
 - Download and launch Mathematica
 - Solve equations with free-form input and Mathematica commands
 - Plot a curve in 2-D and a surface in 3-D
 - Execute other simple built-in commands
- Create a sample Mathematica project.
 - Extract data from a curated data set
 - Use visualization tools to plot the data
 - Make the plot dynamic with the Manipulate command
- Analyze input and output in Mathematica.
 - Enter commands using Free-Form Input
 - Entering Wolfram language commands directly
 - From Free-Form Input to formal syntax
 - Use autocompletion and command templates
 - Convert between exact and approximate results
- Create documents using word processing and typesetting tools in Mathematica.
 - Overview of the structure of Mathematica notebooks
 - Plain text and stylized text
 - Adding typesetting to Mathematica notebooks
 - Stylesheet basics
- Create slide shows with Mathematica.
 - Create a new slide show
 - Create a slide show from an existing Mathematica notebook
 - Presentation tips for slideshows
- Identify fundamental features of the Wolfram programming language.
 - Tips for quickly creating input
 - Understanding how Mathematica computes
 - Define variables
 - Create compound expressions
 - Create lists of values to represent data sets
 - Mixing text with calculations
 - Working with units
 - Defining functions
- Construct interactive models with a single command.
 - Build a first model with the Manipulate command
 - Build a model with multiple controls
 - Tips for creating useful models
- Share Mathematica documents.
 - Authoring versus viewing documents
 - Delivering documents in static formats
 - Delivering individual graphics
 - Delivering interactive documents with Computable Document Format (CDF)
- Examine ways to get help when working with Mathematica.
 - Get help while working with Mathematica
 - Understand how to navigate Mathematica documentation
- Create 2-D and 3-D graphics in Mathematica using various commands for visualization.
 - Visualize a function of a single variable

2. Plot multiple functions of a single variable in one plot
3. Plot a user-defined function
4. Visualize functions of multiple variables
5. Plot multiple 3-D surfaces in one plot
6. Other tools for visualization
- K. Create visualizations of data sets using visualization tools in Mathematica.
 1. Visualize a one-dimensional list of numbers
 2. Visualize two-dimensional lists of numbers
 3. Visualize a three-dimensional list of numbers
 4. Visualize data with charts
 - a. Bar chart
 - b. Histogram
 - c. Box and whisker chart
 - L. Customize graphics using additional arguments to Mathematica commands.
 1. Use options commands with graphics
 2. Interactive customization with the Suggestions Bar
 3. Interactive customizations with drawing tools
 4. Using options directly with Wolfram language commands
 - M. Create figures and diagrams with graphics primitives.
 1. Work with 2-D graphics primitives
 2. Create diagrams with multiple 2-D primitives
 3. Work with 3-D primitives
 4. Create diagrams with multiple 3-D primitives
 - N. Utilize commands available in Mathematica for algebraic manipulation and equation solving.
 1. Perform basic algebraic operations
 2. Solve basic equations with Mathematica
 - O. Solve selected problems in calculus.
 1. Compute a derivative using Mathematica
 2. Evaluate limits using Mathematica
 3. Compute an integral using Mathematica
 - a. Indefinite integrals
 - b. Definite integrals
 - P. Solve selected problems in differential equations.
 1. Solve a differential equation symbolically with Mathematica's DSolve command
 2. Solve a differential equation numerically with Mathematica's NDSolve command
 - Q. Solve selected problems in linear algebra.
 1. Define a vector in Mathematica
 2. Vector operations
 - a. Sum and difference
 - b. Dot product
 - c. Cross product
 - d. Norm
 3. Define a matrix in Mathematica
 4. Perform matrix operations
 - a. Inverse, numerical inverse
 - b. Row reduce a matrix
 - c. Use Mathematica's LinearSolve command to solve a matrix equation
 - R. Solve selected problems in probability and statistics.
 1. Probability and probability distributions
 2. Statistics
 - a. Descriptive statistics
 - b. Curve fitting (regression)
 - c. Tools visualizing data sets
 - d. Build statistical models for data sets
 - e. Generate random data using Mathematica
 - S. Import and export data to and from Mathematica.
 1. Import an external file into Mathematica

2. Import common file types into Mathematica
3. Import images and sounds into Mathematica
4. Import local files into Mathematica
5. Import files from the Web into Mathematica
6. Export data from Mathematica
7. Export a list of numbers
8. Export graphics created in Mathematica as images
- T. Make use of tools in Mathematica to work with and manipulate large-scale curated data sets.
 1. Access curated data
 2. Major categories of curated data
 3. Use curated data to visualize relationships
 4. Create a table with curated data

Lab Content

Not applicable.

Special Facilities and/or Equipment

- A. Mathematica license for free use of Mathematica by students during the quarter
- B. When taught on campus: computer classroom with Mathematica program installed on all computers; access to a computer or computer lab (e.g., STEM Success Center) with client computer(s) installed with Mathematica
- C. When taught on Foothill Global Access: ongoing access to a computer with Mathematica installed on it, email software, and email address

Method(s) of Evaluation

- A. Homework exercises
- B. Collaborative projects
- C. Final exam project
- D. Final exam presentation

Method(s) of Instruction

- A. Lecture
- B. Discussion
- C. Cooperative learning exercises

Representative Text(s) and Other Materials

Hastings C., K. Mischo, and M. Morrison. [Hands-On Start to Wolfram Mathematica](#). 1st ed. Champaign: Wolfram Media, Inc. 2015.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

- A. Homework Problems: Homework problems covering subject matter from the textbook and related material ranging from 20-30 problems weekly.
- B. Reading: Reading and study of the textbook, related materials, and course notes.
- C. Projects: Collaborative projects covering subject matter from the textbook and related materials. Projects will require students to discuss problems, devise a plan to solve problems, and write solutions to problems in Mathematica. All Projects will be completed in Mathematica.

D. Final exam project: Comprehensive final exam project using a variety of tools in Mathematica to solve a variety of problems discussed over the course of the quarter.

E. Class Presentation: Present final exam project to the class.

Discipline(s)

Mathematics