Southern Connecticut State University
MAT 140–Computational Tools for Mathematics and the Sciences

I. Description

(A) **Catalog Description**: Introduction to computer software as it may be used in the mathematical and scientific disciplines. Includes selected topics from: uses of spreadsheets, computer algebra, interactive geometry, vector graphics, document preparation, modeling, and computational mathematics.

(B) **Expanded Description**: Students will solve a large number and variety of routine and exploratory problems related to mathematics and the sciences using appropriate computer software. The mantra "use the right tool for the job" will echo throughout the course. The focus of the course will be on how and when to use various computational tools. While most of the problems will be motivated by the desire to answer a practical question, certain questions will be motivated solely out of mathematical curiosity. Questions will be drawn from algebra, statistics, geometry, numerical methods, discrete math, and related applications.

II. Credit

(A) MAT 140 carries three (3) semester hours of college credit.
(B) MAT 140 satisfies the Tier I technological fluency requirements.

III. Prerequisite

The prerequisite is one of MAT 100, MAT 100P, or placement beyond these courses. Specifically, competency in high school algebra is required.

IV. Format

(A) MAT 140 is a hands-on course that will be equal parts lecture and laboratory exploration. MAT 140 Should be taught in a computer lab.

(B) A laptop computer is recommended.

V. Technological Fluency Components

(A) Tier 1 tech fluency learning outcomes are indicated in bold throughout the outline and pertain to the LEP document and the university tech fluency affinity group checklist.

(B) Instructors have numerous ways to include embedded competencies. The most direct is **creative thinking**, as problem solving is at the core of almost all areas of the course. Examples of such competencies are found as students identify theorems in the discovery with geometric software and analyze data sets with spreadsheets. The embedded competencies are not limited to creative thinking as it is expected instructors will incorporate **information literacy** and **interpersonal effectiveness** throughout the course with document preparation skills.

(C) Applications to be considered will primarily come from the **physical realm** (**natural world I**) and **life and the environment** (**natural world II**). These applications will come up in the discussions of solving equations via computer algebra, visualizing data sets with a spreadsheet, and modeling population dynamics with a spreadsheet.

(D) Depending on the data sets and models the instructor uses within the course, students might experience any of the **discussion of values** throughout the course. However, it is inescapable for the course to not discuss **rational thought** through problem solving and analysis of computer based outputs in each of the areas of the course.

VI. Outline

The specific competencies that will be discussed are listed below. The references **I.abcf**, **II.a**, etc. refer to the Key Elements for Technological Fluency (with Learning Outcomes) table from **Appendix A**.

(A) Document Preparation (throughout the course, but concentrated during a contiguous 10% of the course)

1. Typesetting mathematics (**I.abcf**, **II.a)**
2. Format and structure of memoranda, reports, classroom materials, journal articles, presentations, etc. that include mathematical content (**I.abcdef, II.a, III.a, IV.a)**
3. Produce and edit graphical content appropriate for inclusion in a mathematical document (**I.abcf, II.a, III.a)**
4. Technology to enhance presentations (**I.c, III.a)**

(B) Symbolic computer algebra (25%)

1. Exact computation (**II.a)**
2. Simplifying algebraic expressions (**II.a)**
3. Solving equations (**II.a)**
4. Graphing functions of one variable (**I.f, II.a)**
5. Use the skills listed above to solve application problems (**IV.a)**
6. Storing and recalling functions; use of functions for stored list (**I.d)**

(C) Spreadsheets (25%)

1. Visualizing data sets (**I.ef)**
2. Basic statistical computations and their meanings (**II.a)**
3. Exploration of applied discrete mathematical systems such as consumer loans and population dynamics (**IV.a)**

(D) Interactive Geometry (20%) (**IV.a)**

1. Geometric constructions **(I.af, II.a)**
2. Theorem discovery through interaction and analysis (**I.af, III.a)**
3. Demonstrations (**I.c)**

(E) Vector graphics (20%)

1. Creating graphs of functions (**I.f, II.a)**
2. Creating diagrams (**I.f, II.a)**
3. Exporting from a drawing program (e.g., figures and graphs) (**II.a)**
4. Importing graphics into a report or other document (**I.f, II.a)**

VII. Goals

(A) Communicate mathematical ideas effectively, and explain mathematics both verbally and in writing.

(B) Demonstrate the ability to use and understand multiple representations (including graphical, numerical and analytical) of mathematical concepts.

(C) Understand and appreciate connections among different areas of mathematics and with other disciplines.

(D) Utilize appropriate technology to develop models for solving problems and analyzing new situations.

(E) Create vector graphics of functions and other figures.

(F) Understand the difference between a mathematical model and the real-world.

(G) Understand the uses and limitations of a mathematical model.

VIII. Outcomes

Students passing MAT 140 should be able to do each of the following tasks.

(A) Determine which computational tool is the most appropriate to use for a given task.

(B) Create histograms and boxplots, and calculate basic statistical measures using a spreadsheet.

(C) Complete basic algebraic manipulations using a computer algebra system.

(D) Write about mathematics using a mathematical typesetting engine.

(E) Understand the difference between raster and vector graphics, and when and how to use each.

(F) Create geometric constructions electronically.

(G) Use interactive geometry to discover geometric relationships.

(H) Demonstrate competency in production of graphics suitable for insertion into other documents.

IX. Waiver Policy

There is no waiver policy for MAT 140.

X. Bibliography

LaTeX: https://trms.me/a-gentle-introduction-to-latex/

SymPy: https://docs.sympy.org/latest/index.html

GeoGebra: https://wiki.geogebra.org/en/Manual

Spreadsheets: https://zapier.com/learn/google-sheets/google-sheets-tutorial/

XI. Preparation and Approval

Prepared on 28 April 2015.

Modified on 12 October 2018

Approved by the MDCC on

Approved by the department on

XII. Preparers

Prepared by Leon Brin and Joseph Fields
Modified by Braxton Carrigan, Aaron Clark

LEP Course Proposal
MAT 140–Computational Tools for Mathematics and the Sciences

I. Course Information

(A) Department: Mathematics

(B) Course Code & Number: MAT 140

(C) Course Title: Computational Tools for Mathematics and the Sciences

(D) Course Description: Introduction to computer software as it may be used in the mathematical and scientific disciplines. Includes selected topics from: uses of spreadsheets, computer algebra, interactive geometry, vector graphics, document preparation, modeling, and computational mathematics.

(E) Prerequisite: MAT 100 or MAT 100P

(F) Recommended Textbook: No textbook, but existing documentation and tutorials for the software used in the course will be leaned upon for reference, lessons, and exercises.

(G) Date course planned to be first offered: Fall 2021

II. Rationale for Course

To give mathematics majors or students who have an interest in mathematical subjects a Tier 1 Technological Fluency course that was more oriented towards using mathematical software.

III. Learning Objectives

(A) Communicate mathematical ideas effectively, and explain mathematics both verbally and in writing.

(B) Demonstrate the ability to use and understand multiple representations (including graphical, numerical and analytical) of mathematical concepts.

(C) Understand and appreciate connections among different areas of mathematics and with other disciplines.

(D) Utilize appropriate technology to develop models for solving problems and analyzing new situations.

(E) Create vector graphics of functions and other figures.

(F) Understand the difference between a mathematical model and the real-world.

(G) Understand the uses and limitations of a mathematical model.

Students passing MAT 140 should be able to do each of the following tasks.

(A) Determine which computational tool is the most appropriate to use for a given task.

(B) Create histograms and boxplots, and calculate basic statistical measures using a spreadsheet.

(C) Complete basic algebraic manipulations using a computer algebra system.

(D) Write about mathematics using a mathematical typesetting engine.

(E) Understand the difference between raster and vector graphics, and when and how to use each.

(F) Create geometric constructions electronically.

(G) Use interactive geometry to discover geometric relationships.

(H) Demonstrate competency in production of graphics suitable for insertion into other documents.

IV. Meeting LEP Tier 1 Technological Fluency Requirements

Embedded Competency: Instructors have numerous ways to include embedded competencies. The most direct is **creative** t**hinking**, as problem solving is at the core of almost all areas of the course. Examples of such competencies are found as students identify theorems in the discovery with geometric software and analyze data sets with spreadsheets. The embedded competencies are not limited to creative thinking as it is expected instructors will incorporate **information literacy** and **interpersonal effectiveness** throughout the

course with document preparation skills.

Area of Knowledge and Experience: Applications to be considered will primarily come from the physical realm (**natural world I**) and life and the environment (**natural world II**). These applications will come up in the discussions of solving equations via computer algebra, visualizing data sets with a spreadsheet, and modeling population dynamics with a spreadsheet.

Discussion of Values: Depending on the data sets and models the instructor uses within the course, students might experience any of the discussion of values throughout the course. However, it is inescapable for the course to not discuss **rational thought** through problem solving and analysis of computer based outputs in each of the areas of the course.

V. Course Schedule

Weeks	Topics	TF Key Elements / Embedded Competencies	Learning Activities / Assessment Activities
2	(1) Typesetting mathematics; (2) Format and structure of memoranda, reports, classroom materials, journal articles, presentations, etc. that include mathematical content; (3) Produce and edit graphical content appropriate for inclusion in a mathematical document; (4) Technology to enhance presentations.	I.abcdef, II.a, III.a, IV.a	**LA:** 1,2,3,4 **AA:** 4,5,6
3.5	(1) Exact computation; (2) Simplifying algebraic expressions; (3) Solving equations; (4) Graphing functions of one variable; (5) Use the skills listed above to solve application problems; (6) Storing and recalling functions.	I.df, II.a, IV.a	**LA:** 1,2 **AA:** 4,5,6
3.5	Visualizing data sets; (2) Basic statistical computations and their meanings; (3) Exploration of applied discrete mathematical systems such as consumer loans and population dynamics.	I.ef, II.a, IV.a	**LA:** 1,2,3 **AA:** 5,6
3	(1) Geometric constructions; (2) Theorem discovery through interaction and analysis; (3) Demonstrations.	I.acf, II.a, III.a, IV.a	**LA:** 1,2,3 **AA:** 3,6
3	(1) Creating graphs of functions; (2) Creating diagrams; (3) Exporting from a drawing program (e.g. figures and graphs); (4) Importing graphics into a report or other document.	I.abcf, II.a	**LA:** 1,2,3 **AA:** 3,6

Activities: (1) lessons/lectures, (2) in-class/hands-on exercises, (3) projects, (4) discussions, (5) quizzes, (6) homework exercises

VI. Assessment of Student Learning Students will be assessed according to the above course schedule table.

Appendix A

Key Elements for Technological Fluency (with Learning Outcomes)
I. Common Tasks
Solving problems, accessing info, and communicating info and ideas using appropriate technologies
a. Students will be able to engage in electronic collaboration.
b. Students will be able to use and create structured electronic documents.
c. Students will be able to do technology-enhanced presentations.
d. Students will be able to use databases to manage information.
e. Students will be able to use spreadsheets to manage information.
f. Students will be able to use graphical and multimedia technologies.
II. Focus
Using emergent or recently developed technologies (hardware or software) to address specialized tasks
a. Students will have the ability to perform basic operations in at least one current technology platform, or
b. Students will acquire advanced level skills in three out of six of the Common Tasks listed in (I).
III. Future Technological Change
Navigating and adapting to future technological developments
a. Students will be able to use electronic tools to navigate, to compare or contrast, to research and to know enough to evaluate the technology as a tool.
IV. Broader Implications
Being cognizant of ethical and social implications of revolutionary technologies, including but not limited to, their impact on security, privacy, censorship, intellectual property, and the reliability of information.
a. Students will be familiar with major legal, ethical, privacy and security issues in information technology.