Southern Connecticut State University
School of Arts and Sciences
Department of Mathematics

OUTLINE FOR MAT 122
Precalculus

I. Catalog Description.

Functions and their graphs, polynomial functions and their zeros, exponential and logarithmic functions, rational functions, trigonometric functions and analytic trigonometry. Function modeling of data and problems from the sciences.

II. Purpose.

The purpose of MAT 122 is to prepare students for the calculus sequence while also enhancing their quantitative reasoning skills. The primary goal of the course is to teach students the properties of various types of functions and their graphs while reinforcing their algebraic and arithmetic skills. A second goal for this course is that students learn how to identify which type of function will model a given set of data or a given scenario best and how to interpret and use that model.

III. Credit.

MAT 122 carries 4 semester hours of university credit. This course satisfies the University's Liberal Education Program (LEP) requirement in Quantitative Reasoning (QR). MAT 122 is an elective; it is not a required course in any program. However, MAT 122, or an appropriate score on the Mathematics Placement Test, is the prerequisite for MAT 150, Calculus I, which is a required course for all students majoring in Mathematics and a number of other programs, including Chemistry, Computer Science (General Program), and Physics.

IV. Prerequisites.

The student must satisfy one of the following three prerequisites:

1. a grade of C- or better in MAT 112;
2. a grade of C- or better in MAT 120;
3. an established placement level appropriate for the course.

V. Format.

MAT 122 is offered in the lecture-discussion format. Classes will meet for four contact hours per week.

VI. Technology.

Graphing of certain functions will be technology-assisted.

VII. Course Objectives.

As a course satisfying the University's quantitative reasoning requirement of the LEP, this course will address the following elements of said requirement. Specific course content addressing these elements is presented at the end of this section.

1. **QR1:** Quantitative Situations - Identifying the essential quantitative elements in both routine and novel situations and understanding the relationships between those quantitative elements, and producing mathematical models appropriate for the intended analysis (e.g., writing equation(s) to represent the situation).
2. **QR2:** Quantitative Data - Representing quantitative information in both technical and common language by using symbolic, graphical, and tabular formats, and drawing correct inferences from quantitative information through the interpretations of such representations.
3. **QR3:** Methods - Acquiring the tools and methods necessary to resolve both routine and novel quantitative questions, including a correct sequencing of procedures, and using them appropriately, given the nature and constraints of a situation. In addition to using knowledge previously acquired in intermediate algebra, students will demonstrate proficiency with information presented in numerical or statistical form and mathematical concepts of growth and decay with their applications (e.g., linear, quadratic, exponential, etc.).
4. **QR4:** Reliability of Data and Solutions - Correctly evaluating the level of accuracy stated or implied for given data, and assessing the correctness and accuracy of an analysis, including the assessment of the method and model used and the reasonableness of the solution.
5. **QR5:** Mathematical Process - Using discovery (e.g., exploration and pattern-recognition), conjecture, and testing to develop mathematical formulas, theorems, and then giving persuasive mathematical arguments to establish their validity.

As a course satisfying the Tier I requirements of the LEP, this course will address the following elements of said requirement.

1. Address at least one *Area of Knowledge and Experience* through the choice of data sets or word problems that are applied to one of the sciences, *Natural World I: Physical Realm* or *Natural World II: Life and the Environment*. Examples of data could also be chosen to introduce other *Areas of Knowledge* such as *American Experience* (for example, data measuring population changes in America) or *Global Awareness* (for example, data measuring poverty levels in different countries).
2. Incorporate at least one *Discussion of Values*. For example, *Environmental Awareness* could be discussed through modeling data that comes from an environmental issues such as global warming trends. *Rational Thought* can be emphasized by asking students to interpret and make predictions from a given mathematical model. For example, students might be asked to interpret the meaning of slope in context or they might be asked about the limitations of the model. *Civic Engagement* is another area that could be discussed by choosing to model data that directly affect students' local communities.

3. Address at least one *Embedded Competency* in a significant manner. Instructors may choose to address this requirement by incorporating one of the following requirements into their course: *Oral Communication* by requiring students to present the results of their work through oral presentations, *Interpersonal Effectiveness* by requiring students to work in group settings, *Information Literacy* by requiring students to find and evaluate their own data for a project, or *Creative Thinking* by requiring students to create a model for a set of data or scenario in which they have not already been told what type of model is most appropriate.
4. Present the Quantitative Reasoning aspects of Precalculus in context.

As a course in Precalculus, students are expected to be able to do the following by the end of the course.

1. Sketch the basic shape and behavior of the graphs of linear, exponential, logarithmic, trigonometric, absolute value, quadratic, and power functions, and their transformations without the assistance of any electronics.
2. Identify and algebraically find important characteristics of polynomials and rational functions such as intercepts, vertical asymptotes, and end behavior. Sketching the graphs of polynomial and rational functions will be technology-assisted.
3. Discuss and use the range of function topics: the definition of function, function notation, domain and range, zeros, local extremes and end behavior, periodicity, algebraic combinations of functions, composition of functions, and inverse functions for all of the basic elementary functions and for the general families of functions studied in the course.
4. Algebraically solve linear, quadratic, exponential, logarithmic, trigonometric and power equations. Algebraically solve higher-order polynomial equations that can be solved using factoring methods. (QR3)
5. Construct linear, exponential, or trigonometric models to fit sets of data. In particular, the review of linear functions can be done through "straight-edge" modeling of a set of data, which then can be used to introduce the topic of linear regression and the correlation coefficient. Similarly, after introducing exponential models, they can be reinforced by looking at exponential regression models of data sets. The modeling of periodic data can be done using trigonometric functions. (QR1, QR2, QR4)
6. Construct and use appropriate functions to model applications. In particular, linear functions, the exponential and logarithmic functions, and the trigonometric functions, should be used to model applications. (QR1, QR2, QR4)
7. Know the definitions of the trigonometric functions from the unit circle and from a right triangle. This includes knowledge of basic identities (minimally including the reciprocal, quotient, and Pythagorean identities). Evaluate trigonometric and inverse trigonometric expressions using the unit circle. (QR5)
8. Use technology in the course. In addition to ordinary scientific calculator capabilities, students completing MAT 122 should procure the technology skills listed

below. However, the use of technology should support, not replace, fundamental skills and knowledge from the course outline, such as those marked with an asterisk in the course outline.

i. Recognize and deal with misleading graphs, including graphs with hidden behavior (for example, removable discontinuities and vertical asymptotes of rational functions), and incomplete graphs, by choosing an appropriate viewing window.

ii. Solving equations graphically by means of tracing/zooming and by using built-in zero/intereset capabilities.

VIII. Outline.

Items in the outline marked with an asterisk indicate skills that students are expected to be able do without the use of a graphing calculator.

Functions and Their Graphs (1.5 weeks - 12.5%)

1. Composition of functions and inverse functions.
2. Fitting linear functions to data, linear regression models and the correlation coefficient. This topic should be used to briefly review linear functions (including slope, intercepts, and the equations of straight lines).

Polynomial and Rational Functions (2 weeks - 15%)

1. The remainder and factor theorems.
2. The rational roots theorem.
3. Complex number arithmetic.
4. Analytical and graphical solution of polynomial equations and their interplay.
5. General characteristics of graphs of polynomial functions (including intercepts, local extremes, the number of local extremes, end behavior, and continuity and the intermediate value property). General characteristics of graphs of power functions and the concept of a complete graph.
6. Brief introduction to the general characteristics of graphs of rational functions (including vertical asymptotes and removable discontinuities, and end behavior and horizontal asymptotes).

Exponential and Logarithmic Functions (3 weeks - 25%)

*1. The basic exponential functions (including the natural exponential function).
*2. The basic logarithmic functions.
3. Graphing exponential and logarithmic functions, including transformations.
4. The laws of exponents and the properties of logarithms.
5. Analytical and graphical solution of exponential and logarithmic equations.
6. Exponential growth and decay models, i.e. interest, population models, radioactive decay.
7. Exponential regression models.

Trigonometric Functions **(4 weeks - 35%)**

1. Angles and their measurement.
2. Unit circle definition of the basic trigonometric functions.
3. Right triangles definition of the basic trigonometric functions.
*4. Common values of the basic trigonometric functions.
5. Derivation and the use of the fundamental trigonometric identities (including the reciprocal and quotient identities and the Pythagorean identities).
*6. Graphs of the basic trigonometric functions (including the concept of periodic functions).
*7. Graphs of sinusoidal functions.
8. Applications of trigonometric functions (including the modeling of periodic phenomena).
9. The inverse trigonometric functions and their graphs.

Analytic Geometry **(1.5 weeks - 12.5%)**

1. Solving right triangles.
2. Analytical and graphical solution of trigonometric equations.
3. Analytical and graphical verification of trigonometric identities.
4. Use of the sum, difference, double angle, and half angle identities for sine and cosine (derivations are optional).

Optional Material **(as time allows)**

1. Laws of sines and cosines
2. Polar coordinates
3. Parametric equations
4. Conic sections

IX. Assessment

Individual instructors may vary assessment modes, but typically grades will be based on a combination of homework assignments, quizzes, and exams.

	QR 1 Quantitative Situations	QR 2 Quantitative Data	QR 3 Methods	QR 4 Reliability of Data and Solutions	QR 5 Mathematical Process
Homework	Individual instructors decide which QR will be assessed appropriately.				
Quizzes	Individual instructors decide which QR will be assessed appropriately.				
Tests	✓	✓	✓	✓	✓
Final Exam	✓	✓	✓	✓	✓

X. Recommended Texts.

1. Stewart, Redlin, and Watson, *Precalculus: Mathematics for Calculus*, 7th Edition, Cengage, 2016.
2. Stitz and Zeager, Precalculus, Version $\lfloor \pi \rfloor$, `http://www.stitz-zeager.com/`, 2013.

XI. Waiver Policy.

This course may be waived. If a student places directly into MAT 150 (and subsequently takes and passes it), OR if a student receives AP credit for MAT 150, then the math department will waive the Quantitative Reasoning requirement for that student.

XII. Document History.

2011 Prepared and proposed by T. Bennett, J. Hong, J. Kavanagh, and J. Scheuermann, October.

Approved by the MDCC, 8-0-0, October 4.

Approved by the Department of Mathematics, 12-0-0, November 7.

2014 Updated with new textbook information by K. Kruczek and T. Bennett, May.

2015 Updated with new textbook information and content reduced, assuming the adoption of MAT 112, October.