COURSE DESCRIPTION
This is a professional level, moderated, online course in the use of The Geometer’s Sketchpad software for teaching advanced algebra and precalculus. In addition to instruction in how to use the software, the course will offer participants pedagogical guidance on how to implement the use of Sketchpad® in their classrooms and promote a discussion of how dynamic mathematics software affects the teaching and learning of mathematics. The course runs for six weeks with a scheduled start and end date and is structured into six weeklong units. While participants have flexibility within each week, the course is synchronous, meaning that participants are expected to begin and complete the activities for each week during the week they are assigned. This course is primarily intended for teachers.

COURSE OBJECTIVES
After participants complete this course, they will be comfortable using Sketchpad both as an investigation tool and as a demonstration tool. Participants will be able to:

- Transform function plots geometrically and algebraically
- Represent trigonometric functions and connect them to the unit circle
- Construct geometric and algebraic models that produce conic sections
- Plot functions in polar coordinates
- Model complex numbers and operations geometrically and algebraically
- Work with vectors and matrices
- Use parametric equations in two and three dimensions
- Create and explore sequences and series using iteration
- Appreciate the pedagogical implications of exploring mathematics in a dynamic environment

INTENDED AUDIENCE
This course is intended for secondary and college mathematics teachers and instructors of pre-service teachers. Any current or prospective teacher can learn how to use Sketchpad to supplement the advanced high school mathematics curriculum.

PREREQUISITES
Participants should be familiar with advanced algebra concepts. They should also be comfortable using computers and must have access to the Internet and The Geometer’s Sketchpad Version 5.
METHODS OF INSTRUCTION
Each week follows the same structure in which participants complete these activities:

- Interact with a dynamic sketch that introduces the week’s mathematical focus
- Watch four videos
- Download PDF files of Sketchpad activities and associated sketches
- Complete tutorial and activities offline using Sketchpad
- Participate in an asynchronous discussion forum
- Complete a project using Sketchpad
- Reflect by responding to specific prompts in an online journal

Some weeks include optional activities or videos for enrichment or additional support.

GRADE BREAKDOWN
In order to receive credit for the course, participants must complete all weekly activities, turn in all six projects, respond to all six journal prompts, and participate in the class discussion forum at least twice each week. Assessment is project-based and all six weeks are weighted equally.

The two units offered for this course are based upon the expectation that each week will require about five hours of work (at least two hours for online activities—visual media, discussion forums, and the journal—and at least three hours for offline Sketchpad activities and the project).

The moderator will evaluate and provide feedback for submitted work and class participation. Grades will be assigned on a standard percent scale based on the following breakdown:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sketchpad activities</td>
<td>20%</td>
</tr>
<tr>
<td>Discussion forums</td>
<td>20%</td>
</tr>
<tr>
<td>Journal entries</td>
<td>20%</td>
</tr>
<tr>
<td>Weekly projects</td>
<td>40%</td>
</tr>
</tbody>
</table>

REQUIRED TEXTS AND MATERIALS
All written material will be provided as PDF files. Participants are not required to purchase any books or materials other than The Geometer’s Sketchpad Version 5. Participants may reproduce any materials provided in this course to use with their own students. All activities come from “Exploring Precalculus with The Geometer’s Sketchpad” or “Exploring Conic Sections with The Geometer’s Sketchpad.”
SESSION-BY-SESSION SUMMARY

**Week 1: Transforming Functions**
Using Sketchpad's graphing and transformation tools, participants explore function transformations in the coordinate plane.

Visual Media:
- JavaSketch, “Translations and Dilations of a Function”
- Interview of teachers, “Using Sketchpad in Precalculus”
- Video demonstration, “How to Make a Slider in Sketchpad”
- Video demonstration, “Dynamic Algebra”
- Video demonstration, “Working with Pages”

Activities:
- Tutorial 1: Constructing Triangles
- Tutorial 5: Dynamic Algebra
- Translation of Functions
- Dilation of Functions
- Reflection of Functions
- Composition of Functions (optional)

Fitting a Function to Data Project:
Find a function to model real-world data using transformations on a parent function.

Journal Prompt:
How might Sketchpad influence your approach to teaching transformation of functions?

**Week 2: Trigonometry**
Participants explore radians, trigonometric functions, and the unit circle in Sketchpad, as well as parametric equations.

Visual Media:
- JavaSketch, “Circular and Linear Motion”
- Interview of teachers, “Using Sketchpad in Trigonometry”
- Video demonstration, “Sine Wave Tracer”
- Video demonstration, “Defining Circular Functions”
- Video demonstration, “Creating Custom Tools”

Activities:
- Tutorial 8: Constructing Squares
- Tutorial 11: Sine Wave Tracer
- Introduction to Radians
- Trigonometry Tracers
- Triangles and Squares: The Law of Cosines
- Sums of Sinusoidal Functions (optional)

Transforming Trigonometric Functions Project:
Create a dynamic sketch for exploring and demonstrating the general equation for a trigonometric function.

Journal Prompt:
How can Sketchpad affect student understanding of trigonometric functions?
Week 3: Conic Sections
Participants create geometric and algebraic constructions of conic sections and explore their properties.

Visual Media:
- JavaSketch, “Congruent Triangles Linkage”
- Interview of teachers, “Using Sketchpad for Conics”
- Video demonstration, “How to Model a Falling Ladder”
- Video demonstration, “Define an Ellipse using Circular Functions”
- Video demonstration, “Using Mathematical Symbols”

Activities:
- Tutorial 3: Angles in a Triangle
- The Concentric Circles Construction
- The Folded Circle Construction
- The Expanding Circle Construction
- Analytic Conics
- Exploring the Roots of Quadratics (optional)

Congruent Triangles Construction Project:
Build the “Congruent Triangles Linkage” and present a proof of why it forms an ellipse.

Journal Prompt:
How might students connect the geometric construction of an ellipse (or other conic section) with its analytic representation?

Week 4: Polar Coordinates and Complex Numbers
Participants work with polar graphs and learn to use geometric models of complex numbers and operations.

Visual Media:
- JavaSketch, “In Search of Buried Treasure”
- Interview of teachers, “Using Sketchpad for Polar Coordinates”
- Video demonstration, “Working with Polar Coordinates in Sketchpad”
- Video demonstration, “A Quick Visual Tour of Imaginary Numbers with Sketchpad”
- Video demonstration, “Making Hide/Show Buttons”

Activities:
- Introduction to Polar Coordinates
- Cartesian Graphs and Polar Graphs
- Multiplication of Complex Numbers
- Transformations in the Complex Plane
- Powers of Complex Numbers
- A Geometric Approach to Euler’s Identity (optional)

Buried Treasure Project:
Build a model to represent a set of directions to a buried treasure and use complex numbers to prove why the location of the starting point is irrelevant.

Journal Prompt:
How can using geometric representations of complex numbers and operations deepen and augment student understanding?
Week 5: Vectors, Matrices, and Parametric Functions

Participants work with vectors and matrices using prepared models with custom tools, and focus on using parametric functions in two and three dimensions.

Visual Media:
- JavaSketch, “Vector Projection”
- Interview of teachers, “Using Sketchpad for Vectors and Matrices”
- Video demonstration, “Building Custom Tools with Sketchpad”
- Video demonstration, “Using Parametric Functions”
- Video demonstration, “Using the 3D Perspective Toolkit”

Activities:
- Vector Operations
- Matrix Transformations
- Matrix Products
- Parametric Functions
- Coordinates in Three Dimensions
- Parametric Functions in Three Dimensions (optional)

Parametric Curves Project:
Use parametric functions in either two dimensions (rectangular or polar coordinates) or three dimensions (rectangular, cylindrical, or spherical coordinates) to create a parametric curve.

Journal Prompt:
How can using prepared Sketchpad models expand what students are able to explore, and how might analyzing how the models are built support their understanding?

Week 6: Sequences and Series

Participants iterate algebraic calculations and geometric constructions to model sequences and series.

Visual Media:
- JavaSketch, “Visualizing a Geometric Series”
- Interview of Teacher, “Using Sketchpad for Sequences and Series”
- Video demonstration, “Using Numeric Iteration”
- Video demonstration, “Modeling Sequences and Series with Geometric Iteration”
- Video demonstration, “Making Animation Buttons”

Activities:
- Tutorial 9: Pythagorean Theorem
- Generating Arithmetic and Geometric Sequences Numerically
- A Sequence Approach to Logs
- Area Models of Geometric Series
- A Geometric Series Coil
- A Geometric Series Staircase (optional)

Final Project:
Create a dynamic sketch with animation that can be used as a demonstration in an advanced algebra or precalculus class.

Journal Prompt:
What does dynamic mathematics mean to you and how might the dynamic nature of Sketchpad change the way students learn and understand mathematics?