# High School AP Calculus BC Curriculum

**Course Description:** AP Calculus BC is designed for the serious and motivated college bound student planning to major in math, science, or engineering. This course is an extension of the previous Calculus class and will prepare students to take the BC test. It consists of an intense treatment of topics in Calculus with heavy emphasis on their theoretical basis. These topics include a continuation of application of integration, integration techniques, L’Hopital’s Rule, and improper integrals. *Graphing calculators are required See instructors for recommendations.

**Scope and Sequence:**

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<tr>
<th>Timeframe</th>
<th>Unit</th>
<th>Instructional Topics</th>
</tr>
</thead>
</table>
| 12-15 class     | Integration Techniques| Topic 1: Integration by Parts  
Topic 2: Partial Fractions  
Topic 3: Logistics  
Topic 4: Trig Substitutions  
Topic 5: Improper Integrals |
| periods         |                       |                                                                                      |
| 9-10 class      | Sequences and Series  | Topic 1: Limits of Sequences  
Topic 2: Nth Term Test and Telescoping Series  
Topic 3: Geometric Series  
Topic 4: Integral Test and P-Series  
Topic 5: Direct and Limit Comparison Tests  
Topic 6: Alternating Series Tests  
Topic 7: Ratio and Root Tests |
| periods         | Taylor Series         | Topic 1: Taylor Polynomials  
Topic 2: Lagrange Error Bound  
Topic 3: Power Series |
| 10-12 class     |                       |                                                                                      |
| periods         |                       |                                                                                      |
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| 8-10 class periods             | Polar Equations                  | Topic 1: Polar Graphing               | Topic 2: Motion                          | Topic 3: Area               |
Unit 7: Integration Techniques

Subject: AP Calculus BC  
Grade: 11, 12  
Name of Unit: Integration Techniques  
Length of Unit: Depending on the class 12-15 class periods  
Overview of Unit: This unit develops techniques of integration not covered in AB Calculus including partial fraction, integration by parts, and trig substitutions. Logistics are covered here as an application of partial fractions. L’Hopital’s Rule is covered more completely than in AB and it is used in evaluating improper integrals.

Priority Standards for unit:
- **EK 3.2D1**: (BC) An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration.
- **EK 3.2D2**: (BC) Improper integrals can be determined using limits of definite integrals.
- **EK 3.3B4**: Many functions do not have closed form antiderivatives.
- **EK 3.3B5**: Techniques for finding antiderivatives include algebraic manipulation such as long division and completing the square, substitution of variables (BC) integration by parts, and nonrepeating linear partial fractions.
- **EK 3.5A1**: Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay, (BC) and logistic growth.
- **EK 3.5B2**: The model for logistic growth that arises from the statement “The rate of change of a quantity is jointly proportional to the size of the quantity and the difference between the quantity and the carrying capacity” is \( \frac{dy}{dt} = ky(a - y) \).

Essential Questions:
1. How do you apply integration techniques to evaluate integrals?  
2. How do you evaluate improper integrals?

Enduring Understanding/Big Ideas:
1. You must make sure to include integration by parts, partial fractions, and trig substitutions.  
2. Replace the questionable bound with a variable, and take the limit of the integral as that variable approaches the questionable number.
**Unit Vocabulary:**

<table>
<thead>
<tr>
<th>Academic Cross-Curricular Words</th>
<th>Content/Domain Specific</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Improper Integrals</td>
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<tr>
<td></td>
<td>Integration by Parts</td>
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<tr>
<td></td>
<td>Partial Fractions</td>
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<td></td>
<td>Logistic Growth</td>
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</tbody>
</table>

**Resources for Vocabulary Development:** Lecture, text, and internet resources.
Engaging Experience 1
Title: Integration by Parts
Suggested Length of Time: 2 class periods
Standards Addressed
Priority:

- **EK 3.3B5**: Techniques for finding antiderivatives include algebraic manipulation such as long division and completing the square, substitution of variable

Detailed Description/Instructions: Students will use integration by parts to evaluate integrals using teacher assigned problems. It is important to know some problems must use several applications of Integration by Parts, and the circular applications of Integration by Parts.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Topic 2: Partial Fractions

Engaging Experience 1
Title: Partial Fractions
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

- EK 3.3B5: Techniques for finding antiderivatives include algebraic manipulation such as long division and completing the square, substitution of variables.

Detailed Description/Instructions: Students will use Partial Fractions to evaluate integrals using teacher assigned problems.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Engaging Experience 1

Title: Logistics

Suggested Length of Time: 1 class period

Standards Addressed

Priority:

- **EK 3.5A1:** Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay.

Detailed Description/Instructions: Students will apply logistic growth model to solve population growth problems using teacher assigned problems.

Bloom’s Levels: Analyze

Webb’s DOK: 4
Topic 4: Trig Substitutions

Engaging Experience 1
Title: Trig Substitutions
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

- **EK 3.2D1: (BC)** An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration.
- **EK 3.2D2: (BC)** Improper integrals can be determined using limits of definite integrals.

Detailed Description/Instructions: Students will use trig substitutions to evaluate integrals with teacher assigned practice problems

Bloom’s Levels: Analyze

Webb’s DOK: 4
Topic 5: Improper Integrals

Engaging Experience 1
Title: Improper Integrals
Suggested Length of Time: 1 class period
Standards Addressed:

    Priority:

    • EK 3.2D1: (BC) An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration.
    • EK 3.2D2: (BC) Improper integrals can be determined using limits of definite integrals.

Detailed Description/Instructions: Students will evaluate improper integrals using teacher assigned practice problems.

Bloom’s Levels: Analyze

Webb’s DOK: 4
<table>
<thead>
<tr>
<th>Topic</th>
<th>Engaging Experience Title</th>
<th>Description</th>
<th>Suggested Length of Time</th>
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</thead>
<tbody>
<tr>
<td>Integration by Parts</td>
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<td>Students will use integration by parts to evaluate integrals using teacher assigned problems. It is important to know some problems must use several applications of Integration by Parts, and the circular applications of Integration by Parts.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Partial Fractions</td>
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<td>Students will use Partial Fractions to evaluate integrals using teacher assigned problems.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Logistics</td>
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<td>Students will apply logistic growth model to solve population growth problems using teacher assigned problems.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Trig Substitutions</td>
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<td>Students will use trig substitutions to evaluate integrals with teacher assigned practice problems.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Improper Integrals</td>
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<td>Students will evaluate improper integrals using teacher assigned practice problems.</td>
<td>1 class period</td>
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</tbody>
</table>
Unit 8: Sequences and Series

Subject: AP Calculus BC
Grade: 11, 12
Name of Unit: Sequences and Series
Length of Unit: 9-10 class periods

Overview of Unit: This unit explores sequences and series, concentrating on determining the convergence of various series. It is important to develop the skills learned in this unit so that these skills can be applied in the Taylor Series unit.

Priority Standards for unit:

- **EK 4.1A1**: The \( n \)th partial sum is defined as the sum of the first \( n \) terms of a sequence.
- **EK 4.1A2**: An infinite series of numbers converges to a real number \( S \) (or has sum \( S \)), if and only if the limit of its sequence of partial sums exists and equals \( S \).
- **EK 4.1A3**: Common series of numbers include geometric series, the harmonic series, and \( p \)-series.
- **EK 4.1A4**: A series may be absolutely convergent, conditionally convergent, or divergent.
- **EK 4.1A5**: If a series converges absolutely, then it converges.
- **EK 4.1A6**: In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the \( n \)th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.
- **EK 4.1B1**: If \( a \) is a real number and \( r \) is a real number such that \(|r|<1\), then the geometric series
  \[
  \sum_{n=0}^{\infty} ar^n = \frac{a}{1 - r}
  \]
- **EK 4.1B2**: If an alternating series converges by the alternating series test, then the alternating series error bound can be used to estimate how close a partial sum is to the value of the infinite series.
- **EK 4.1B3**: If a series converges absolutely, then any series obtained from it by regrouping or rearranging the terms has the same value.

Essential Questions:
1. How do you determine if a sequence converges?
2. How do you determine if a series converges?
Enduring Understanding/Big Ideas:
1. Sequences converge if there is a limit as n goes to infinity.
2. Students must be able to apply Nth term test, Geometric Series Test, Telescoping Series, Alternating Series Test, P Series Test, Integral Test, Limit Comparison Test, Comparison Test, Ratio Test, and Root Test.

Unit Vocabulary:

<table>
<thead>
<tr>
<th>Academic Cross-Curricular Words</th>
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<tbody>
<tr>
<td></td>
<td>Partial Sum</td>
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<tr>
<td></td>
<td>Telescoping Series</td>
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<td></td>
<td>Geometric Series</td>
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<td></td>
<td>Alternating Series</td>
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<td>Absolute Convergence</td>
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<td></td>
<td>Conditional Convergence</td>
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<td></td>
<td>Divergence</td>
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</tbody>
</table>

Resources for Vocabulary Development: Lecture, text, and internet resources.
Engaging Experience 1
Title: Finding Limits of Sequences
Suggested Length of Time: 1 class period
Standards Addressed

**Priority:**

- **EK 4.1A1:** The $n$th partial sum is defined as the sum of the first $n$ terms of a sequence.

**Detailed Description/Instructions:** Students will work problems involving finding the limits of sequences. Teachers should remind students that a sequence is merely a function defined on the set of natural numbers so we are just repeating what we did in AB Calculus.

**Bloom’s Levels:** Analyze

**Webb’s DOK:** 2
Topic 2: Nth Term Test and Telescoping Series

Engaging Experience 1
Title: Nth term test
Suggested Length of Time: ½ of a class period
Standards Addressed

Priority:

- **EK 4.1A1**: The $n$th partial sum is defined as the sum of the first $n$ terms of a sequence.
- **EK 4.1A6**: In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the $n$th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.

Detailed Description/Instructions: Students will work on assigned problems. Teacher should make a point that if the $n$th term goes to anything except zero the series will diverge. This is the first behavior students should explore.

Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: Telescoping Series
Suggested Length of Time: ½ of a class period
Standards Addressed

Priority:

- **EK 4.1A1**: The $n$th partial sum is defined as the sum of the first $n$ terms of a sequence.
- **EK 4.1B3**: If a series converges absolutely, then any series obtained from it by regrouping or rearranging the terms has the same value.

Detailed Description/Instructions: Students will practice problems. Students should show expansions of several terms to convince themselves that many terms are eliminated.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Topic 3: Geometric Series

Engaging Experience 1
Title: Geometric Series
Suggested Length of Time: ½ of a class period
Standards Addressed

*Priority:*

- **EK 4.1A3:** Common series of numbers include geometric series, the harmonic series, and *p*-series.
- **EK 4.1B1:** If *a* is a real number and *r* is a real number such that |*r*|<1, then the geometric series

\[
\sum_{n=0}^{\infty} ar^n = \frac{a}{1 - r}
\]

Detailed Description/Instructions: Explore the bouncing ball problem. A ball bounces a fraction of the previous bounce. Students find the total vertical distance the ball travels.

*Bloom’s Levels:* Analyze

*Webb’s DOK:* 3
Engaging Experience 1
Title: Integral Test and P-Series Test
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

- **EK 4.1A3**: Common series of numbers include geometric series, the harmonic series, and \( p \)-series.
- **EK 4.1A6**: In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the \( n \)th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.

Detailed Description/Instructions: Students will work problems after explanation. The teacher should first introduce the integral test, areas under a sequence is just a rectangular approximation of the area under a curve. The integral test leads to the more specific cases of the \( p \)-series.

**Bloom’s Levels**: Analyze

**Webb’s DOK**: 3
**Topic 5: Direct and Limit Comparison Tests**

**Engaging Experience 1**

**Title:** Direct Comparison Test  
**Suggested Length of Time:** ½ of a class period  
**Standards Addressed**  
*Priority*  
- **EK 4.1A3:** Common series of numbers include geometric series, the harmonic series, and $p$-series.  
- **EK 4.1A6:** In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the $n$th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.

**Detailed Description/Instructions:** Students will do assigned problems. Teacher should be very specific about the conditions for applying direct comparison test.  
**Bloom’s Levels:** Analyze  
**Webb’s DOK:** 3

**Engaging Experience 2**

**Title:** Limit Comparison  
**Suggested Length of Time:** ½ of a class period  
**Standards Addressed**  
*Priority:*  
- **EK 4.1A6:** In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the $n$th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.

**Detailed Description/Instructions:** Students will do teacher assigned problems. Remind students of the conditions that must be met for the limit comparison test.
**Bloom’s Levels:** Analyze  
**Webb’s DOK:** 3
Topic 6: Alternating Series Tests

Engaging Experience 1
Title: Alternating Series Test
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

- EK 4.1A6: In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the \( n \)th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.

Detailed Description/Instructions: Students will do teacher assigned problems. Teacher must remind students of how one shows a function is decreasing, and \( n \)th term goes to 0. Just showing one is not sufficient.

Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: Absolute and Conditional Convergence
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

- EK 4.1A4: A series may be absolutely convergent, conditionally convergent, or divergent.
- EK 4.1A5: If a series converges absolutely, then it converges.

Detailed Description/Instructions: Students will do teacher assigned problems. Proving a series is absolutely convergent is often easier than using the Alternating Series Test. Give examples when and when not to choose this route.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Topic 7: Ratio and Root Tests

Engaging Experience 1
Title: Ratio Test
Suggested Length of Time: ½ of a class period
Standards Addressed
Priority:

- EK 4.1A6: In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the $n$th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.

Detailed Description/Instructions: Students will do teacher assigned problems. This test is very important. It will be used in Taylor Series.
Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: The Root Test
Suggested Length of Time: ½ of a class period
Standards Addressed
Priority:

- EK 4.1A6: In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the $n$th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.

Detailed Description/Instructions: Students will do teacher assigned problems.
Bloom’s Levels: Analyze
Webb’s DOK: 3
<table>
<thead>
<tr>
<th>Topic</th>
<th>Engaging Experience Title</th>
<th>Description</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Limits of Sequences</td>
<td>Finding Limits of Sequences</td>
<td>Students will work problems involving finding the limits of sequences. Teachers should remind students that a sequence is merely a function defined on the set of natural numbers so we are just repeating what we did in AB Calculus.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Nth Term Test and Telescoping Series</td>
<td>Nth term test</td>
<td>Students will work on assigned problems. Teacher should make a point that if the nth term goes to anything except zero the series will diverge. This is the first behavior students should explore.</td>
<td>½ of a class period</td>
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<tr>
<td>Nth Term Test and Telescoping Series</td>
<td>Telescoping Series</td>
<td>Students will practice problems. Students should show expansions of several terms to convince themselves that many terms are eliminated.</td>
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<tr>
<td>Geometric Series</td>
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<td>Explore the bouncing ball problem. A ball bounces a fraction of the previous bounce. Students find the total vertical distance the ball travels.</td>
<td>½ of a class period</td>
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<td>Integral Test and P-Series</td>
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<td>Students will work problems after explanation. The teacher should first introduce the integral test, areas under a sequence is just a rectangular approximation of the area under a curve. The integral test leads to the more specific cases of the p-series.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Direct and Limit</td>
<td>Direct Comparison Test</td>
<td>Students will do assigned problems. Teacher should be very specific about the</td>
<td>½ of a class period</td>
</tr>
<tr>
<td>Tests</td>
<td>Test</td>
<td>Conditions</td>
<td>Time</td>
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<td>---------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Comparison Tests</td>
<td>Limit Comparison Test</td>
<td>Students will do teacher assigned problems. Remind students of the conditions that must be met for the limit comparison test.</td>
<td>½ of a class period</td>
</tr>
<tr>
<td>Alternating Series Tests</td>
<td>Alternating Series Test</td>
<td>Students will do teacher assigned problems. Teacher must remind students of how one shows a function is decreasing, and nth term goes to 0. Just showing one is not sufficient.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Alternating Series Tests</td>
<td>Absolute and Conditional Convergence</td>
<td>Students will do teacher assigned problems. Teacher must remind students of how one shows a function is decreasing, and nth term goes to 0. Just showing one is not sufficient.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Ratio and Root Tests</td>
<td>Ratio Test</td>
<td>Students will do teacher assigned problems. This test is very important. It will be used in Taylor Series.</td>
<td>½ of a class period</td>
</tr>
<tr>
<td>Ratio and Root Tests</td>
<td>The Root Test</td>
<td>Students will do teacher assigned problems.</td>
<td>½ of a class period</td>
</tr>
</tbody>
</table>
Unit 9: Taylor Series

Subject: AP Calculus BC
Grade: 11, 12
Name of Unit: Taylor Series
Length of Unit: 10-12 class periods
Overview of Unit: Taylor polynomials approximate transcendental functions. Power Series and Taylor Series represent transcendental functions exactly on their interval of convergence. Students construct, apply composition of functions to these series, integrate, and derive these series to create additional Taylor Series representations.

Priority Standards for unit:

- **EK 4.2A1**: The coefficient of the $n$th-degree term in a Taylor polynomial centered at $x = a$ for the function $f$ is $\frac{f^{(n)}(a)}{n!}$.
- **EK 4.2A2**: Taylor polynomials for a function $f$ centered at $x = a$ can be used to approximate function values of $f$ near $x = a$.
- **EK 4.2A3**: In many cases, as the degree of a Taylor polynomial increases, the $n$th-degree polynomial will converge to the original function over some interval.
- **EK 4.2A4**: The Lagrange error bound can be used to bound the error of a Taylor polynomial approximation to a function.
- **EK 4.2A5**: In some situations, where the signs of a Taylor polynomial are alternating, the alternating series error bound can be used to bound the error of a Taylor polynomial approximation to the function.
- **EK 4.2B1**: A power series is a series of the form
  \[ \sum_{n=0}^{\infty} a_n(x - r)(x - r)^n \]
  where $n$ is a non-negative integer, $\{a_n\}$ is a sequence of real numbers, and $r$ is a real number.
- **EK 4.2B2**: The Maclaurin series for $\sin(x)$, $\cos(x)$, and $e^x$ provide the foundation for constructing the Maclaurin series for other functions.
- **EK 4.2B3**: The Maclaurin series for $\frac{1}{1-x}$ is a geometric series.
- **EK 4.2B4**: A Taylor polynomial for $f(x)$ is a partial sum of the Taylor series for $f(x)$.
- **EK 4.2B5**: A power series for a given function can be derived by various methods (e.g., algebraic processes, substitutions, using properties of geometric series, and operations on known series such as term-by-term integration or term-by-term differentiation).
• **EK 4.2C1**: If a power series converges, it either converges at a single point or has an interval of convergence.

• **EK 4.2C2**: The ratio test can be used to determine the radius of convergence of a power series.

• **EK 4.2C3**: If a power series has a positive radius of convergence, then the power series is the Taylor series of the function to which it converges over the open interval.

• **EK 4.2C4**: The radius of convergence of a power series obtained by term-by-term differentiation or term-by-term integration is the same as the radius of convergence of the original power series.

**Essential Questions:**
1. How do you represent a function with a power series?
2. How do you find intervals of convergence of a power series?
3. Why do we represent functions with power series?

**Enduring Understanding/Big Ideas:**
1. By using the Taylor Series process we create a power series that represents the function. It is important that students know Taylor series representations of \( \sin x \), \( \cos x \), \( e^x \), and \( \ln(x) \).
2. Usually we use the ratio test to determine the interval of convergence. It is important to test the endpoints unless it is geometric.
3. Power series polynomials give us a better approximation to functions than tangent lines.

**Unit Vocabulary:**

<table>
<thead>
<tr>
<th>Academic Cross-Curricular Words</th>
<th>Content/Domain Specific</th>
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</thead>
<tbody>
<tr>
<td>Taylor Polynomials</td>
<td>Taylor Series</td>
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<tr>
<td></td>
<td>Maclaurin Series</td>
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<td></td>
<td>Interval of Convergence</td>
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<td></td>
<td>Lagrange Error</td>
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<td></td>
<td>Power Series</td>
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<td></td>
<td>Radius of Convergence</td>
</tr>
</tbody>
</table>

**Resources for Vocabulary Development:** Lecture, text, and internet resources.
Topic 1: Taylor Polynomials

Engaging Experience 1

Title: Taylor Polynomials

Suggested Length of Time: 2 class periods

Standards Addressed

Priority:

- **EK 4.2A1**: The coefficient of the $n$th-degree term in a Taylor polynomial centered at $x = a$ for the function $f$ is $\frac{f^{(n)}(a)}{n!}$.

- **EK 4.2A2**: Taylor polynomials for a function $f$ centered at $x = a$ can be used to approximate function values of $f$ near of $f$ near $x = a$.

Detailed Description/Instructions: Students will manufacture polynomials to approximate various functions using teacher assigned problems. Teacher should show how well these polynomials mimic a given curve for instance the sine function.

Bloom’s Levels: Analyze

Webb’s DOK: 3
Topic 2: Lagrange Error Bound

Engaging Experience 1
Title: Lagrange Error
Suggested Length of Time: 1 class period
Standards Addressed

Priority:
- **EK 4.2A4**: The Lagrange error bound can be used to bound the error of a Taylor polynomial approximation to a function.

Detailed Description/Instructions: Students will find Lagrange Error using teacher assigned problems.
Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: Alternating Series
Suggested Length of Time: ½ of a class period
Standards Addressed

Priority:
- **EK 4.2A5**: In some situations, where the signs of a Taylor polynomial are alternating, the alternating series error bound can be used to bound the error of a Taylor polynomial approximation to the function.

Detailed Description/Instructions: Students will do teacher assigned problems. Students should realize that often the Lagrange error can be avoided if the resulting Taylor Polynomial resembles an alternating series.
Bloom’s Levels: Analyze
Webb’s DOK: 3
Engaging Experience 1
Title: Power Series
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

- **EK 4.2B2**: The Maclaurin series for \(\sin(x)\), \(\cos(x)\), and \(e^x\) provide the foundation for constructing the Maclaurin series for other functions.

- **EK 4.2B3**: The Maclaurin series for \(\frac{1}{1-x}\) is a geometric series.

Detailed Description/Instructions: Students will build a series to represent a function that is in the form of geometric series using teacher assigned problems. Teacher instruction should focus on the fact that these functions look like the sum of a geometric series.

Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: Deriving Functions from Power Series
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

- **EK 4.2B5**: A power series for a given function can be derived by various methods (e.g., algebraic processes, substitutions, using properties of geometric series, and operations on known series such as term-by-term integration or term-by-term differentiation).

Detailed Description/Instructions: Students will develop series by using calculus and algebra on previously derived power series with teacher assigned problems. Teachers should remind students that they are just operating on polynomials, so that anything that can be done to polynomials, can be done to a power series.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Topic 4: Intervals of Convergence

Engaging Experience 1
Title: Intervals of Convergence
Suggested Length of Time: ½ of a class period
Standards Addressed

Priority:

- **EK 4.2C1**: If a power series converges, it either converges at a single point or has an interval of convergence.
- **EK 4.2C2**: The ratio test can be used to determine the radius of convergence of a power series.
- **EK 4.2C3**: If a power series has a positive radius of convergence, then the power series is the Taylor series of the function to which it converges over the open interval.
- **EK 4.2C4**: The radius of convergence of a power series obtained by term-by-term differentiation or term-by-term integration is the same as the radius of convergence of the original power series.

Detailed Description/Instructions: Students will find intervals of convergence using the ratio test with teacher assigned problems. Teacher should remind students to test the endpoints.

Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: Intervals of Convergence of Derived Functions
Suggested Length of Time: ½ of a class period
Standards Addressed

Priority:

- **EK 4.2C1**: If a power series converges, it either converges at a single point or has an interval of convergence.
- **EK 4.2C2**: The ratio test can be used to determine the radius of convergence of a power series.
- **EK 4.2C3**: If a power series has a positive radius of convergence, then the power series is the Taylor series of the function to which it converges over the open interval.
- **EK 4.2C4**: The radius of convergence of a power series obtained by term-by-term differentiation or term-by-term integration is the same as the radius of convergence of the original power series.
**Detailed Description/Instructions:** Students will do teacher assigned problems. Teacher should remind students in this case one must only test the endpoints of the interval.

**Bloom’s Levels:** Analyze

**Webb’s DOK:** 3
Topic 5: Taylor Series

Engaging Experience 1
Title: Taylor Series
Suggested Length of Time: 2-3 class periods
Standards Addressed
   Priority:
       • EK 4.2B2: The Maclaurin series for sin(x), cos (x), and $e^x$ provide the foundation for constructing the Maclaurin series for other functions.

Detailed Description/Instructions: Students will represent, sine, cosine, $e^x$, and ln(x) with teacher assigned problems. Teachers should assure students these are representations that they should memorize.

Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: Deriving Additional Functions from Taylor Series
Suggested Length of Time: 1 class period
Standards Addressed
   Priority:
       • EK 4.2B5: A power series for a given function can be derived by various methods (e.g., algebraic processes, substitutions, using properties of geometric series, and operations on known series such as term-by-term integration or term-by-term differentiation).

Detailed Description/Instructions: Students will develop series by using calculus and algebra on previously derived power series with teacher assigned problems. Teachers should remind students that they are just operating on polynomials, so that anything that can be done to polynomials, can be done to a power series.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.) Choose any number 6 of the released BC calculus exams.

Rubric for Engaging Scenario: Use the grading rubric provided by AP
<table>
<thead>
<tr>
<th>Topic</th>
<th>Engaging Experience Title</th>
<th>Description</th>
<th>Suggested Length of Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taylor Polynomials</td>
<td>Taylor Polynomials</td>
<td>Students will manufacture polynomials to approximate various functions using teacher assigned problems. Teacher should show how well these polynomials mimic a given curve for instance the sine function.</td>
<td>2 class periods</td>
</tr>
<tr>
<td>Lagrange Error Bound</td>
<td>Lagrange Error</td>
<td>Students will find Lagrange Error using teacher assigned problems.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Lagrange Error Bound</td>
<td>Alternating Series</td>
<td>Students will do teacher assigned problems. Students should realize that often the Lagrange error can be avoided if the resulting Taylor Polynomial resembles an alternating series.</td>
<td>½ of a class period</td>
</tr>
<tr>
<td>Power Series</td>
<td>Power Series</td>
<td>Students will build a series to represent a function that is in the form of geometric series using teacher assigned problems. Teacher instruction should focus on the fact that these functions look like the sum of a geometric series.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Power Series</td>
<td>Deriving Functions from Power Series</td>
<td>Students will develop series by using calculus and algebra on previously derived power series with teacher assigned problems. Teachers should remind students that they are just operating on polynomials, so that anything that can be done to polynomials, can be done to a power series.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Intervals of Convergence</td>
<td>Intervals of Convergence</td>
<td>Students will find intervals of convergence using the ratio test with teacher assigned problems. Teacher should remind students to test the endpoints.</td>
<td>½ of a class period</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Intervals of Convergence</td>
<td>Intervals of Convergence of Derived Functions</td>
<td>Students will do teacher assigned problems. Teacher should remind students in this case one must only test the endpoints of the interval.</td>
<td>½ of a class period</td>
</tr>
<tr>
<td>Taylor Series</td>
<td>Taylor Series</td>
<td>Students will represent, sine, cosine, $e^x$, and ln$x$ with teacher assigned problems. Teachers should assure students these are representations that they should memorize.</td>
<td>2-3 class periods</td>
</tr>
<tr>
<td>Taylor Series</td>
<td>Deriving Additional Functions from Taylor Series</td>
<td>Students will develop series by using calculus and algebra on previously derived power series with teacher assigned problems. Teachers should remind students that they are just operating on polynomials, so that anything that can be done to polynomials, can be done to a power series.</td>
<td>1 class period</td>
</tr>
</tbody>
</table>
Unit 10: Parametric and Vector Defined Functions

Subject: AP Calculus BC
Grade: 11, 12
Name of Unit: Parametric and Vector Defined Functions
Length of Unit: 10-12 class periods
Overview of Unit: In this unit students will explore motion along a curve using parametric equations and vector valued functions.

Priority Standards for unit:
- **EK 2.1C7**: (BC) Methods for calculating derivatives of real-valued functions can be extended to vector-valued functions, parametric functions, and functions in polar coordinates.
- **EK 2.3C4**: (BC) Derivatives can be used to determine velocity, speed, and acceleration for a particle moving along curves given by parametric or vector-valued functions.
- **EK 2.3F2**: (BC) For differential equations, Euler’s method provides a procedure for approximating a solution or a point on a solution curve.
- **EK 2.3C2**: The derivative can be used to solve related rates problems, that is, finding a rate at which one quantity is changing by relating it to other quantities whose rates of change by relating it to other quantities whose rates of change are known.
- **EK 3.4D3**: (BC) The length of a planar curve defined by a function or by a parametrically defined curve can be calculated using a definite integral.

Essential Questions:
1. How do you differentiate vector valued and parametric functions?
2. How do you use parametric and vector valued function to model motion along a curve?
3. How do you determine the length of a curve?

Enduring Understanding/Big Ideas:
1. It’s really important students understand the difference between vector-valued and parametric functions. To differentiate vector-valued functions, just differentiate each component individually. To differentiate parametric equations, make sure students realize finding $\frac{dy}{dx}$ is really just an application of the chain rule.
2. Using parametrics or vector valued functions students can describe velocity and acceleration in component form. It is important that students recognize that velocity and acceleration are vector quantities and so have direction. Speed is a scalar.
3. Arclength on $[a, b] = \int_a^b \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2} \, dt$
### Unit Vocabulary:

<table>
<thead>
<tr>
<th>Academic Cross-Curricular Words</th>
<th>Content/Domain Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vector</td>
<td>Parametric Equations</td>
</tr>
<tr>
<td>Velocity</td>
<td>Vector-valued function</td>
</tr>
<tr>
<td>Speed</td>
<td>Surface of Revolution</td>
</tr>
</tbody>
</table>

**Resources for Vocabulary Development:** Lecture, text, and internet resources
Topic 1: Parametric Derivatives

Engaging Experience 1
Title: First and Second Derivatives
Suggested Length of Time: 1 class period
Standards Addressed
Priority:

- EK 2.1C7: (BC) Methods for calculating derivatives of real-valued functions can be extended to vector-valued functions, parametric functions, and functions in polar coordinates.

Detailed Description/Instructions: Students will apply the first and second derivatives from parametric equations with teacher assigned problems. Stress the difference between parametric representation and function representation and its inherent difficulties.

Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: Tangent Lines
Suggested Length of Time: 1 class period
Standards Addressed
Priority:

- EK 2.1C7: (BC) Methods for calculating derivatives of real-valued functions can be extended to vector-valued functions, parametric functions, and functions in polar coordinates.

Detailed Description/Instructions: Students will find tangent lines, vertical tangents, horizontal tangents with teacher assigned problems.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Topic 2: Parametrics and Motion

Engaging Experience 1
Title: Parametrics
Suggested Length of Time: 1 class period

Standards Addressed

Priority:

- **EK 2.3C4: (BC)** Derivatives can be used to determine velocity, speed, and acceleration for a particle moving along curves given by parametric or vector-valued functions.

- **EK 3.4C2: (BC)** The definite integral can be used to determine displacement, distance, and position of a particle moving along a curve given by parametric or vector-valued functions.

Detailed Description/Instructions: Students will use parametrics to study motion using teacher assigned problems.

Bloom’s Levels: Analyze

Webb’s DOK: 3
Topic 3: Parametrics and Length of Curve

Engaging Experience 1

Title: Length of a Plane Curve

Suggested Length of Time: 1 class period

Standards Addressed

Priority:

- EK 3.4D3: (BC) The length of a planar curve defined by a function or by a parametrically defined curve can be calculated using a definite integral.

Detailed Description/Instructions: Students will find the length of a plane curve using teacher assigned problem.

Bloom’s Levels: Analyze

Webb’s DOK: 3
**Topic 4: Vectors Derivatives and Integration**

Engaging Experience 1  
**Title:** Derivatives of Vector Valued Functions  
**Suggested Length of Time:** 1 class period  
**Standards Addressed**  
*Priority:*  
- EK 2.1C7: (BC) Methods for calculating derivatives of real-valued functions can be extended to vector-valued functions, parametric functions, and functions in polar coordinates.  

**Detailed Description/Instructions:** Students will find the derivative of Vector Valued Functions using teacher assigned problems.  
**Bloom’s Levels:** Analyze  
**Webb’s DOK:** 3

Engaging Experience 2  
**Title:** Integration of Vector Valued functions  
**Suggested Length of Time:** 1 class period  
**Standards Addressed**  
*Priority:*  
- EK 3.4C2: (BC) The definite integral can be used to determine displacement, distance, and position of a particle moving along a curve given by parametric or vector-valued functions.  

**Detailed Description/Instructions:** Students will integrate vector-valued functions using teacher assigned problems.  
**Bloom’s Levels:** Analyze  
**Webb’s DOK:** 3
Engaging Experience 1
Title: Vectors and Motion
Suggested Length of Time: 1 class period
Standards Addressed
   Priority:
   • EK 2.3C4: (BC) Derivatives can be used to determine velocity, speed, and acceleration for a particle moving along curves given by parametric or vector-valued functions.

Detailed Description/Instructions: Students will study motion along a curve using vector valued functions with teacher assigned problems. It is good to note the similarities and differences between parametric functions and vector valued functions.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

AP 2006 #3
Or
AP 2009#3
Or

a. Prove that the tangent to a circle is perpendicular to its radius using Vector Valued Functions.
b. Prove that the acceleration of a particle moving on a circle is toward the center using Vector Valued Functions

Rubric for Engaging Scenario: AP provided scoring guides for the first two. Rubric to be determined for last.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Engaging Experience Title</th>
<th>Description</th>
<th>Suggested Length of Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parametric Derivatives</td>
<td>First and Second Derivatives</td>
<td>Students will apply the first and second derivatives from parametric equations with teacher assigned problems. Stress the difference between parametric representation and function representation and its inherent difficulties.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Parametric Derivatives</td>
<td>Tangent Lines</td>
<td>Students will find tangent lines, vertical tangents, horizontal tangents with teacher assigned problems.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Parametrics and Motion</td>
<td>Parametrics</td>
<td>Students will use parametrics to study motion using teacher assigned problems.</td>
<td></td>
</tr>
<tr>
<td>Parametrics and Length of Curve</td>
<td>Length of a Plane Curve</td>
<td>Students will find the length of a plane curve using teacher assigned problem.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Vectors Derivatives and Integration</td>
<td>Derivatives of Vector Valued Functions</td>
<td>Students will find the derivative of Vector Valued Functions using teacher assigned problems.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Vectors Derivatives and Integration</td>
<td>Integration of Vector Valued functions</td>
<td>Students will integrate vector-valued functions using teacher assigned problems.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Vectors and Motion</td>
<td>Vectors and Motion</td>
<td>Students will study motion along a curve using vector valued functions with teacher assigned problems. It is good to note the similarities and differences between parametric functions and vector valued functions.</td>
<td>1 class period</td>
</tr>
</tbody>
</table>
Unit 11: Polar Equations

Subject: AP Calculus BC
Grade: 11, 12
Name of Unit: Polar Equations
Length of Unit: 8-10 class periods
Overview of Unit: Students will use calculus to graph polar equations. Students will apply derivatives and position to describe motion along a polar curve. Students will find the areas within a curve and between curves.

Priority Standards for unit:
- **EK 2.1C7: (BC)** Methods for calculating derivatives of real-valued functions can be extended to vector-valued functions, parametric functions, and functions in polar coordinates.
- **EK 2.2A4: (BC)** For a curve given by a polar equation \( r = f(\theta) \), derivatives of \( r, x, \) and \( y \) with respect to \( \theta \) and first and second derivatives of \( y \) with respect to \( x \) can provide information about the curve.
- **EK 3.4D1:** Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals.

Essential Questions:
1. How do you determine the behavior of a polar curve with \( \frac{dr}{d\theta}, \frac{dx}{d\theta}, \frac{dy}{d\theta}, \) and \( \frac{dy}{dx} \)?
2. How do you find the area bounded by a polar curve or between polar curves?

Enduring Understanding/Big Ideas:
1. It is important to know the sign of \( r, x, \) and \( y \) along with the signs of \( \frac{dr}{d\theta}, \frac{dx}{d\theta}, \frac{dy}{d\theta}, \) and \( \frac{dy}{dx} \)
   to determine the behavior of a point on the polar curve.
2. It is important students understand that we are finding the area within a curve and not the area under a curve, so we are working with sectors not infinitesimally narrow rectangles. Intersections of these curves are also challenging.
**Unit Vocabulary:**

<table>
<thead>
<tr>
<th>Academic Cross-Curricular Words</th>
<th>Content/Domain Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector</td>
<td>Limacom</td>
</tr>
<tr>
<td>Arc Length</td>
<td>Cardioid</td>
</tr>
<tr>
<td>Common Area</td>
<td>Lemniscate</td>
</tr>
<tr>
<td>Symmetry</td>
<td>Rose</td>
</tr>
<tr>
<td></td>
<td>Tangent to the pole</td>
</tr>
<tr>
<td></td>
<td>Relative Extrema</td>
</tr>
</tbody>
</table>

**Resources for Vocabulary Development:** Lecture, text, and internet resources.
Topic 1: Polar Graphing

Engaging Experience 1
Title: Plotting Points
Suggested Length of Time: 1 class period
Standards Addressed
Priority:

- EK 2.2A4: (BC) For a curve given by a polar equation \( r = f(\theta) \), derivatives of \( r \), \( x \), and \( y \) with respect to \( \theta \) and first and second derivatives of \( y \) with respect to \( x \) can provide information about the curve.

Detailed Description/Instructions: Students will graph polar equations by plotting points using teacher assigned problems.
Bloom’s Levels: Apply
Webb’s DOK: 2

Engaging Experience 2
Title: Polar Graphs using Calculus
Suggested Length of Time: 1 class period
Standards Addressed
Priority:

- EK 2.1C7: (BC) Methods for calculating derivatives of real-valued functions can be extended to vector-valued functions, parametric functions, and functions in polar coordinates.
- EK 2.2A4: (BC) For a curve given by a polar equation \( r = f(\theta) \), derivatives of \( r \), \( x \), and \( y \) with respect to \( \theta \) and first and second derivatives of \( y \) with respect to \( x \) can provide information about the curve.

Detailed Description/Instructions: Students will use derivatives to find extreme points, horizontal tangents, vertical tangents, and tangents to the pole to produce polar graphs
Bloom’s Levels: Analyze
Webb’s DOK: 3
Engaging Experience 1
Title: Motion on a Polar Graph
Suggested Length of Time: 1 class period

Standards Addressed
Priority:

- **EK 2.2A4: (BC)** For a curve given by a polar equation \( r = f(\theta) \), derivatives of \( r \), \( x \), and \( y \) with respect to \( \theta \) and first and second derivatives of \( y \) with respect to \( x \) can provide information about the curve.

Detailed Description/Instructions: Students will use derivatives, \( dr/d\theta, dx/d\theta, dy/d\theta \) to describe motion along a polar curve using teacher assigned problems. Teacher should stress the importance of \( r \) and \( dr/d\theta \) having the same sign for the particle to move away from the pole and opposite signs to move toward the pole.

Bloom’s Levels: Analyze
Webb’s DOK: 3
Topic 3: Area

Engaging Experience 1
Title: Intersection of Polar Curves
Suggested Length of Time: 1 class period
Standards Addressed:

Priority:

• EK 3.4D1: Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals.

Detailed Description/Instructions: Students will find the intersection of Polar Graphs using teacher assigned problems. It is important to realize that you can get to the same point many ways in polar, therefore it is not sufficient to merely set the equations equal to each other. The graphing calculator is often helpful to check your results.

Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 2
Title: Area inside a Polar Curve
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

• EK 3.4D1: Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals.

Detailed Description/Instructions: Students will find the area within a polar curve using teacher assigned problems. It is important that students realize that this is not the area under a curve, that we are actually adding sectors instead of rectangles.

Bloom’s Levels: Analyze
Webb’s DOK: 3

Engaging Experience 3
Title: Shared Areas
Suggested Length of Time: 1 class period
Standards Addressed

Priority:

• EK 2.1C7: (BC) Methods for calculating derivatives of real-valued functions can be extended to vector-valued functions, parametric functions, and functions in polar coordinates.
**Detailed Description/Instructions:** Students will find shared areas using teacher assigned problems.

**Bloom’s Levels:** Analyze

**Webb’s DOK:** 3
Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

BC 2005 Test #2

Rubric for Engaging Scenario: AP Scoring Guide
<table>
<thead>
<tr>
<th>Topic</th>
<th>Engaging Experience Title</th>
<th>Description</th>
<th>Suggested Length of Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polar Graphing</td>
<td>Plotting Points</td>
<td>Students will graph polar equations by plotting points using teacher assigned problems.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Polar Graphing</td>
<td>Polar Graphs using Calculus</td>
<td>Students will use derivatives to find extreme points, horizontal tangents, vertical tangents, and tangents to the pole to produce polar graphs.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Motion</td>
<td>Motion on a Polar Graph</td>
<td>Students will use derivatives, $dr/d\theta$, $dx/d\theta$, $dy/d\theta$ to describe motion along a polar curve using teacher assigned problems. Teacher should stress the importance of $r$ and $dr/d\theta$ having the same sign for the particle to move away from the pole and opposite signs to move toward the pole.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Area</td>
<td>Intersection of Polar Curves</td>
<td>Students will find the intersection of Polar Graphs using teacher assigned problems. It is important to realize that you can get to the same point many ways in polar, therefore it is not sufficient to merely set the equations equal to each other. The graphing calculator is often helpful to check your results.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Area</td>
<td>Area inside a Polar Curve</td>
<td>Students will find the area within a polar curve using teacher assigned problems. It is important that students realize that this is not the area under a curve, that we are actually adding sectors instead of rectangles.</td>
<td>1 class period</td>
</tr>
<tr>
<td>Area</td>
<td>Shared Areas</td>
<td>Students will find shared areas using teacher assigned problems.</td>
<td>1 class period</td>
</tr>
</tbody>
</table>
Unit of Study Terminology

**Appendices:** All Appendices and supporting material can be found in this course’s shell course in the District’s Learning Management System.

**Assessment Leveling Guide:** A tool to use when writing assessments in order to maintain the appropriate level of rigor that matches the standard.

**Big Ideas/Enduring Understandings:** Foundational understandings teachers want students to be able to discover and state in their own words by the end of the unit of study. These are answers to the essential questions.

**Engaging Experience:** Each topic is broken into a list of engaging experiences for students. These experiences are aligned to priority and supporting standards, thus stating what students should be able to do. An example of an engaging experience is provided in the description, but a teacher has the autonomy to substitute one of their own that aligns to the level of rigor stated in the standards.

**Engaging Scenario:** This is a culminating activity in which students are given a role, situation, challenge, audience, and a product or performance is specified. Each unit contains an example of an engaging scenario, but a teacher has the ability to substitute with the same intent in mind.

**Essential Questions:** Engaging, open-ended questions that teachers can use to engage students in the learning.

**Priority Standards:** What every student should know and be able to do. These were chosen because of their necessity for success in the next course, the state assessment, and life.

**Supporting Standards:** Additional standards that support the learning within the unit.

**Topic:** These are the main teaching points for the unit. Units can have anywhere from one topic to many, depending on the depth of the unit.

**Unit of Study:** Series of learning experiences/related assessments based on designated priority standards and related supporting standards.

**Unit Vocabulary:** Words students will encounter within the unit that are essential to understanding. Academic Cross-Curricular words (also called Tier 2 words) are those that can be found in multiple content areas, not just this one. Content/Domain Specific vocabulary words are those found specifically within the content.

**Symbols:**

- ![Symbol](image1.png) This symbol depicts an experience that can be used to assess a student’s 21st Century Skills using the rubric provided by the district.
- ![Symbol](image2.png) This symbol depicts an experience that integrates professional skills, the development of professional communication, and/or the use of professional mentorships in authentic classroom learning activities.