

Dual-Enrolled Calculus (Math 173 and 174)

Pacing Guide

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Calculus I (Math 173)

First 4 1/2 weeks: Chapter P and Chapter 1

Second 4 1/2 weeks: Chapter 2 and Sections 3.1 - 3.3

Third 4 1/2 weeks: Sections 3.4 - 3.9 and 4.1 - 4.3

Fourth 4 1/2 weeks: Sections 4.1 - 4.6 and 5.1 - 5.5

Calculus II (Math 174)

First 4 1/2 weeks: Sections 5.6 - 5.7, 6.1 - 6.2, 7.1 - 7.4, 8.1 - 8.3

Second 4 1/2 weeks: Remainder of Chapter 8

Third 4 1/2 weeks: Chapter 9

Fourth 4 1/2 weeks: Whatever part of Chapter 10 that can be worked in around senior trip, snow days, etc.

On the following pages:

The Standards of Learning (correlated with our current textbook and listed at the end of this document), Essential Understandings/Questions and Essential Knowledge/Skills are copied from the Virginia Department of Education websites.

The Student Learning Outcomes are from Lord Fairfax Community College.

Math 173
Dual-enrolled Calculus I

 <http://apcentral.collegeboard.com/apc/public/repository/ap-calculus-course-description.pdf>

"Prerequisites

Before studying calculus, all students should complete four years of secondary mathematics designed for college-bound students: courses in which they study algebra, geometry, trigonometry, analytic geometry and elementary functions. These functions include linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric and piecewise-defined functions. In particular, before studying calculus, students must be familiar with the properties of functions, the algebra of functions and the graphs of functions. Students must also understand the language of functions (domain and range, odd and even, periodic, symmetry, zeros, intercepts and so on) and know the values of the trigonometric functions at the numbers $0, \pi/6, \pi/4, \pi/3, \pi/2$, and their multiples."

The following is from

http://www.collegeboard.com/student/testing/ap/calculus_ab/topic.html?calcab

**I. Functions, Graphs, and Limits****A. Analysis of Graphs**

With the aid of technology, graphs of functions are often easy to produce. The emphasis is on the interplay between the geometric and analytic information and on the use of calculus both to predict and to explain the observed local and global behavior of a function.

B. Limits of Functions (incl. one-sided limits)

- An intuitive understanding of the limiting process.
- Calculating limits using algebra.
- Estimating limits from graphs or tables of data.

C. Asymptotic and Unbounded Behavior

- Understanding asymptotes in terms of graphical behavior.
- Describing asymptotic behavior in terms of limits involving infinity.
- Comparing relative magnitudes of functions and their rates of change. (For example, contrasting exponential growth, polynomial growth, and logarithmic growth.)

D. Continuity as a Property of Functions

- An intuitive understanding of continuity. (The function values can be made as close as desired by taking sufficiently close values of the domain.)
- Understanding continuity in terms of limits.
- Geometric understanding of graphs of continuous functions (Intermediate Value Theorem and Extreme Value Theorem).

II. Derivatives**A. Concept of the Derivative**

- Derivative presented graphically, numerically, and analytically.
- Derivative interpreted as an instantaneous rate of change.
- Derivative defined as the limit of the difference quotient.
- Relationship between differentiability and continuity.

B. Derivative at a Point

- Slope of a curve at a point. Examples are emphasized, including points at which there are vertical tangents and points at which there are no tangents.
- Tangent line to a curve at a point and local linear approximation.
- Instantaneous rate of change as the limit of average rate of change.
- Approximate rate of change from graphs and tables of values.

C. Derivative as a Function

- Corresponding characteristics of graphs of f and f' .
- Relationship between the increasing and decreasing behavior of f and the sign of f' .
- The Mean Value Theorem and its geometric consequences.
- Equations involving derivatives. Verbal descriptions are translated into equations involving derivatives and vice versa.

D. Second Derivatives

- Corresponding characteristics of the graphs of f , f' , and f'' .
- Relationship between the concavity of f and the sign of f'' .
- Points of inflection as places where concavity changes.

E. Applications of Derivatives

- Analysis of curves, including the notions of monotonicity and concavity.
- Optimization, both absolute (global) and relative (local) extrema.
- Modeling rates of change, including related rates problems.
- Use of implicit differentiation to find the derivative of an inverse function.
- Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed, and acceleration.
- Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations.

F. Computation of Derivatives

- Knowledge of derivatives of basic functions, including power, exponential, logarithmic, trigonometric, and inverse trigonometric functions.
- Basic rules for the derivative of sums, products, and quotients of functions.
- Chain rule and implicit differentiation.

III. Integrals**A. Interpretations and Properties of Definite Integrals**

- Definite integral as a limit of Riemann sums.
- Definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval:

- Basic properties of definite integrals. (Examples include additivity and linearity.)

B. Applications of Integrals

Appropriate integrals are used in a variety of applications to model physical, biological, or economic situations. Although only a sampling of applications can be included in any specific course, students should be able to adapt their knowledge and techniques to solve other similar application problems. Whatever applications are chosen, the emphasis is on using the integral of a rate of change to give accumulated change or using the method of setting up an approximating Riemann sum and representing its limit as a definite integral. To provide a common foundation, specific applications should include finding the area of a region, the volume of a solid with known cross sections, the average value of a function, and the distance traveled by a particle along a line.

C. Fundamental Theorem of Calculus

- Use of the Fundamental Theorem to evaluate definite integrals.
- Use of the Fundamental Theorem to represent a particular antiderivative, and the analytical and graphical analysis of functions so defined.

D. Techniques of Antidifferentiation

- Antiderivatives following directly from derivatives of basic functions.
- Antiderivatives by substitution of variables (including change of limits for definite integrals).

E. Applications of Antidifferentiation

- Finding specific antiderivatives using initial conditions, including applications to motion along a line.
- Solving separable differential equations and using them in modeling. In particular, studying the equation for exponential growth.

F. Numerical Approximations to Definite Integrals

Use of Riemann sums (using left, right, and midpoint evaluation points) and trapezoidal sums to approximate definite integrals of functions represented algebraically, graphically, and by tables of values.

http://www.collegeboard.com/student/testing/ap/calculus_ab/calc.html?calcab



"The use of a graphing calculator is considered an integral part of the AP Calculus course, and is permissible on parts of the AP Calculus Exams. Students should use this technology on a regular basis so that they become adept at using their graphing calculators. Students should also have experience with the basic paper-and-pencil techniques of calculus and be able to apply them when technological tools are unavailable or inappropriate."

<http://apcentral.collegeboard.com/apc/public/repository/ap-calculus-course-description.pdf>

Goals

- Students should be able to work with functions represented in a variety of ways: graphical, numerical, analytical or verbal. They should understand the connections among these representations.
- Students should understand the meaning of the derivative in terms of a rate of change and local linear approximation and should be able to use derivatives to solve a variety of problems.
- Students should understand the meaning of the definite integral both as a limit of Riemann sums and as the net accumulation of change and should be able to use integrals to solve a variety of problems.
- Students should understand the relationship between the derivative and the definite integral as expressed in both parts of the Fundamental Theorem of Calculus.
- Students should be able to communicate mathematics and explain solutions to problems both verbally and in written sentences.
- Students should be able to model a written description of a physical situation with a function, a differential equation or an integral.
- Students should be able to use technology to help solve problems, experiment, interpret results and support conclusions.
- Students should be able to determine the reasonableness of solutions, including sign, size, relative accuracy and units of measurement.
- Students should develop an appreciation of calculus as a coherent body of knowledge and as a human accomplishment.

Lord Fairfax Community College
Student Learning Outcomes

After completing this course, the student should be able to:

1. Do limit computations and understand the theory.
2. Express the derivative as a limit.
3. Calculate instantaneous speed with acceleration.
4. Determine continuity and one-sided limits.
5. Calculate limits at infinity.
6. Apply techniques of differentiation including the chain rule.
7. Calculate trigonometric limits.
8. Solve problems involving the derivative of trigonometric functions.
9. Apply the tools for applications of derivatives: Rolle's and Mean Value Theorems.
10. Determine relative maxima and minima, find inflection points, find where functions are increasing/decreasing, determine concavity, and graph functions using these.
11. Determine absolute maxima and minima and solve applications using these.
12. Calculate the differential and do approximations using this.
13. Solve problems involving related rates.
14. Find the area and the definite integral.
15. Use the properties of the definite integral.
16. Evaluate the definite integral and use the Fundamental Theorem of Calculus.
17. Use the Mean Value Theorem for integrals.
18. Determine the indefinite integral.
19. Perform integration by substitution.

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #1 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
First 4 1/2 weeks	The student should be able to do limit computations and understand the theory.	<p>APC.2 The student will define and apply the properties of limits of functions. Limits will be evaluated graphically and algebraically. This will include</p> <p>a) limits of a constant;</p> <p>b) limits of a sum, product, and quotient;</p> <p>c) one-sided limits; and</p> <p>d) limits at infinity, infinite limits, and non-existent limits. *</p> <p>*AP Calculus BC will include l'Hopital's Rule, which will be used to find the limits of functions whose limits yield the indeterminate forms: $0/0$ and ∞ / ∞.</p> <p>APC.4 The student will investigate asymptotic and unbounded behavior in functions. This will include</p> <p>a) describing and understanding asymptotes in terms of graphical behavior and limits involving infinity;</p> <p>and</p> <p>b) comparing relative magnitudes of functions and the rates of change.</p>	<p>Analysis of graphs. With the aid of technology, graphs of functions are often easy to produce. The emphasis is on the interplay between the geometric and analytic information and on the use of calculus both to predict and to explain the observed local and global behavior of a function.</p> <p>Limits of functions (including one-sided limits)</p> <ul style="list-style-type: none"> • An intuitive understanding of the limiting process. • Calculating limits using algebra. • Estimating limits from graphs or tables of data.

Current Textbook: Calculus, Eighth Edition by Larson and Hostetler
 Sections: 1.2, 1.3, 1.4, 1.5, 3.5, 3.6, 8.7, 8.8, 9.1

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #2 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
First 4 1/2 weeks	The student should be able to express the derivative as a limit.	APC.5 The student will investigate derivatives presented in graphic, numerical, and analytic contexts and the relationship between continuity and differentiability. The derivative will be defined as the limit of the difference quotient and interpreted as an instantaneous rate of change.	II. Derivatives Concept of the derivative • Derivative presented graphically, numerically and analytically. • Derivative interpreted as an instantaneous rate of change. • Derivative defined as the limit of the difference quotient. • Relationship between differentiability and continuity.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 2.1, 2.2, 2.3, 3.6, 4.3, 5.3

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #3 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
<p>First 4 1/2 weeks</p> <p>Current Textbook: <u>Calculus</u>, Eighth Edition Sections: 2.1, 2.2, 2.3, 3.6</p>	<p>The student should be able to calculate instantaneous speed with acceleration.</p>	<p>APC.6 The student will investigate the derivative at a point on a curve. This will include</p> <p>a) finding the slope of a curve at a point, including points at which the tangent is vertical and points at which there are no tangents;</p> <p>b) using local linear approximation to find the slope of a tangent line to a curve at the point;</p> <p>c) defining instantaneous rate of change as the limit of average rate of change; and</p> <p>d) approximating rate of change from graphs and tables of values.</p> <p>by Larson and Hostetler</p>	<p>Applications of derivatives</p> <ul style="list-style-type: none"> • Analysis of curves, including the notions of monotonicity and concavity. + Analysis of planar curves given in parametric form, polar form and vector form, including velocity and acceleration. • Optimization, both absolute (global) and relative (local) extrema. • Modeling rates of change, including related rates problems. • Use of implicit differentiation to find the derivative of an inverse function. • Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration. • Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations. + Numerical solution of differential equations using Euler's method. + L'Hospital's Rule, including its use in determining limits and convergence of improper integrals and series.

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #4 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
First 4 1/2 weeks Current Textbook: Calculus, Eighth Edition by Larson and Hostetler Sections: 1.2, 1.3, 1.4, 1.5, 2.1, 3.5, 4.3, 5.3, 8.7, 8.8	The student should be able to determine continuity and one-sided limits.	<p>APC.3 The student will use limits to define continuity and determine where a function is continuous or discontinuous. This will include</p> <p>a) continuity in terms of limits;</p> <p>b) continuity at a point and over a closed interval;</p> <p>c) application of the Intermediate Value Theorem and the Extreme Value Theorem; and</p> <p>d) geometric understanding and interpretation of continuity and discontinuity.</p>	<p>Limits of functions (including one-sided limits)</p> <ul style="list-style-type: none"> • An intuitive understanding of the limiting process. • Calculating limits using algebra. • Estimating limits from graphs or tables of data. <p>Asymptotic and unbounded behavior</p> <ul style="list-style-type: none"> • Understanding asymptotes in terms of graphical behavior. • Describing asymptotic behavior in terms of limits involving infinity. • Comparing relative magnitudes of functions and their rates of change (for example, contrasting exponential growth, polynomial growth and logarithmic growth). <p>Continuity as a property of functions</p> <ul style="list-style-type: none"> • An intuitive understanding of continuity. (The function values can be made as close as desired by taking sufficiently close values of the domain.) • Understanding continuity in terms of limits.

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #5 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
First 4 1/2 weeks	The student should be able to calculate limits at infinity.	<p>APC.2 The student will define and apply the properties of limits of functions. Limits will be evaluated graphically and algebraically. This will include</p> <p>a) limits of a constant; b) limits of a sum, product, and quotient; c) one-sided limits; and d) limits at infinity, infinite limits, and non-existent limits. *</p> <p>*AP Calculus BC will include l'Hopital's Rule, which will be used to find the limit of functions whose limits yield the indeterminate forms: $0/0$ and ∞ / ∞.</p>	<p>Limits of functions (including one-sided limits)</p> <ul style="list-style-type: none"> • An intuitive understanding of the limiting process. • Calculating limits using algebra. • Estimating limits from graphs or tables of data. <p>Asymptotic and unbounded behavior</p> <ul style="list-style-type: none"> • Understanding asymptotes in terms of graphical behavior. • Describing asymptotic behavior in terms of limits involving infinity. • Comparing relative magnitudes of functions and their rates of change (for example, contrasting exponential growth, polynomial growth and logarithmic growth). <p>Continuity as a property of functions</p> <ul style="list-style-type: none"> • An intuitive understanding of continuity. (The function values can be made as close as desired by taking sufficiently close values of the domain.) • Understanding continuity in terms of limits. • Geometric understanding of graphs of continuous functions (Intermediate Value Theorem and Extreme Value Theorem).

Current Textbook.

Calculus, Eighth Edition by Larson and Hostetler

Sections: 1.2, 1.3, 1.4, 1.5, 3.5, 8.7, 8.8

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #6 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
First 4 1/2 weeks	The student should be able to apply techniques of differentiation including the chain rule.	<p>APC.9 The student will apply formulas to find derivatives. This will include</p> <p>a) derivatives of algebraic, trigonometric, exponential, logarithmic, and inverse trigonometric functions;</p> <p>b) derivations of sums, products, quotients, inverses, and composites (chain rule) of elementary functions;</p> <p>c) derivatives of implicitly defined functions; and</p> <p>d) higher order derivatives of algebraic, trigonometric, exponential, and logarithmic, functions. *</p> <p>* AP Calculus BC will also include finding derivatives of parametric, polar, and vector functions.</p>	<p>Derivative at a point</p> <ul style="list-style-type: none"> • Slope of a curve at a point. Examples are emphasized, including points at which there are vertical tangents and points at which there are no tangents. • Tangent line to a curve at a point and local linear approximation. • Instantaneous rate of change as the limit of average rate of change. • Approximate rate of change from graphs and tables of values. <p>Derivative as a function</p> <ul style="list-style-type: none"> • Corresponding characteristics of graphs of f and f'. • Relationship between the increasing and decreasing behavior of f and the sign of f'. • The Mean Value Theorem and its geometric interpretation. • Equations involving derivatives. Verbal descriptions are translated into equations involving derivatives and vice versa. <p>Computation of derivatives</p> <ul style="list-style-type: none"> • Knowledge of derivatives of basic functions, including power, exponential, logarithmic, trigonometric and inverse trigonometric functions. • Derivative rules for sums, products and quotients of functions. • Chain rule and implicit differentiation.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 2.2, 2.3, 2.4, 2.5, 2.6, 3.8, 5.1, 5.4, 5.5, 5.6

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #7 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
First 4 1/2 weeks	The student should be able to calculate trigonometric limits.	<p>APC.2 The student will define and apply the properties of limits of functions. Limits will be evaluated graphically and algebraically. This include</p> <p>a) limits of a constant; b) limits of a sum, product, and quotient; c) one-sided limits; and d) limits at infinity, infinite limits, and non-existent limits. *</p> <p>*AP Calculus BC will include l'Hopital's Rule, which will be used to find the limit of functions whose limit yield the indeterminate forms: $0/0$ and ∞/∞.</p> <p>APC.4 The student will investigate asymptotic and unbounded behavior in functions. This will include</p> <p>a) describing and understanding asymptotes in terms of graphical behavior and limits involving infinity; and b) comparing relative magnitudes of functions and their rates of change.</p>	<p>Limits of functions (including one-sided limits)</p> <ul style="list-style-type: none"> • An intuitive understanding of the limiting process. • Calculating limits using algebra. • Estimating limits from graphs or tables of data. <p>Asymptotic and unbounded behavior</p> <ul style="list-style-type: none"> • Understanding asymptotes in terms of graphical behavior. • Describing asymptotic behavior in terms of limits involving infinity. • Comparing relative magnitudes of functions and their rates of change (for example, contrasting exponential growth, polynomial growth and logarithmic growth). <p>Continuity as a property of functions</p> <ul style="list-style-type: none"> • An intuitive understanding of continuity. (The function values can be made as close as desired by taking sufficiently close values of the domain.) • Understanding continuity in terms of limits. • Geometric understanding of graphs of continuous functions (Intermediate Value Theorem and Extreme Value Theorem).

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 1.2, 1.3, 1.4, 1.5, 3.5, 3.6, 8.7, 8.8, 9.1

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #8 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Second 4 1/2 weeks	The student should be able to solve problems involving the derivative of trigonometric functions.	<p>APC.8 The student will apply the derivative to solve problems. This will include</p> <p>a) analysis of curves and the ideas of concavity and monotonicity;</p> <p>b) optimization involving global and local extrema;</p> <p>c) modeling of rates of change and related rates;</p> <p>d) use of implicit differentiation to find the derivative of an inverse function;</p> <p>e) interpretation of the derivative as a rate of change in applied contexts, including velocity, speed, and acceleration; and</p> <p>f) differentiation of non-logarithmic functions, using the technique of logarithmic differentiation. *</p> <p>* AP Calculus BC will also apply the derivative to solve problems. This will include finding derivatives of parametric, polar, and vector functions.</p>	<p>Derivative as a function</p> <ul style="list-style-type: none"> • Equations involving derivatives. Verbal descriptions are translated into equations involving derivatives and vice versa. <p>Applications of derivatives</p> <ul style="list-style-type: none"> • Optimization, both absolute (global) and relative (local) extrema. • Modeling rates of change, including related rates problems. • Use of implicit differentiation to find the derivative of an inverse function. • Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration. • Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 2.6, 3.1, 3.6, 3.7, 3.8, 6.1, 6.2, 8.8

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #9 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Second 4 1/2 weeks	The student should be able to apply the tools for applications of derivatives: Rolle's and Mean Value Theorems.	<p>APC.7 The student will analyze the derivative of a function as a function in itself. This will include</p> <p>a) comparing corresponding characteristics of the graphs of f, f', and f'';</p> <p>b) defining the relationship between the increasing and decreasing behavior of f and the sign of f';</p> <p>c) translating verbal descriptions into equations involving derivatives and vice versa;</p> <p>d) analyzing the geometric consequences of the Mean Value Theorem;</p> <p>e) defining the relationship between the concavity of f and the sign of f''; and</p> <p>f) identifying points of inflection as places where concavity changes and finding points of inflection.</p>	<p>Derivative as a function</p> <ul style="list-style-type: none"> • Corresponding characteristics of graphs of f and f'. • Relationship between the increasing and decreasing behavior of f and the sign of f'. • The Mean Value Theorem and its geometric interpretation. • Equations involving derivatives. Verbal descriptions are translated into equations involving derivatives and vice versa. <p>Applications of derivatives</p> <ul style="list-style-type: none"> • Analysis of curves, including the notions of monotonicity and concavity. • Optimization, both absolute (global) and relative (local) extrema. • Modeling rates of change, including related rates problems. • Use of implicit differentiation to find the derivative of an inverse function. • Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration. • Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 3.1, 3.2, 3.3, 3.4, 3.6

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #10 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Second 4 1/2 weeks	The student should be able to determine relative maxima and minima, find inflection points, find where functions are increasing/decreasing, determine concavity, and graph functions using these.	<p>APC.7The student will analyze the derivative of a function as a function itself. This will include</p> <p>b) defining the relationship between the increasing and decreasing behavior of f and the sign of f';</p> <p>d) analyzing the geometric consequences of the Mean Value Theorem;</p> <p>e) defining the relationship between the concavity of f and the sign of f''; and</p> <p>f) identifying points of inflection as places where concavity changes and finding points of inflection.</p> <p>APC.8The student will apply the derivative to solve problems. This will include</p> <p>a) analysis of curves and the ideas of concavity and monotonicity;</p> <p>b) optimization involving global and local extrema;</p> <p>c) modeling of rates of change and related rates;</p> <p>d) use of implicit differentiation to find the derivative of an inverse function;</p> <p>e) interpretation of the derivative as a rate of change in applied contexts, including velocity, speed, and acceleration; and</p> <p>f) differentiation of non-logarithmic functions, using the technique of logarithmic differentiation. *</p>	<p>Derivative as a function</p> <ul style="list-style-type: none"> • Corresponding characteristics of graphs of f and f'. • Relationship between the increasing and decreasing behavior of f and the sign of f'. • The Mean Value Theorem and its geometric interpretation. • Equations involving derivatives. Verbal descriptions are translated into equations involving derivatives and vice versa. <p>Second derivatives</p> <ul style="list-style-type: none"> • Corresponding characteristics of the graphs of f, f', and f''. • Relationship between the concavity of f and the sign of f''. • Points of inflection as places where concavity changes. <p>Applications of derivatives</p> <ul style="list-style-type: none"> • Analysis of curves, including the notions of monotonicity and concavity. • Optimization, both absolute (global) and relative (local) extrema. • Modeling rates of change, including related rates problems. • Use of implicit differentiation to find the derivative of an inverse function. • Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration. • Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 2.6, 3.1, 3.2, 3.3, 3.6, 3.7, 3.8, 6.1, 6.2, 8.8

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #11 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Second 4 1/2 weeks	The student should be able to determine absolute maxima and minima and solve applications using these.	<p>APC.7The student will analyze the derivative of a function as a function in itself. This will include</p> <p>b) defining the relationship between the increasing and decreasing behavior of f and the sign of f';</p> <p>d) analyzing the geometric consequences of the Mean Value Theorem;</p> <p>e) defining the relationship between the concavity of f and the sign of f''; and</p> <p>f) identifying points of inflection as places where concavity changes and finding points of inflection.</p> <p>APC.8The student will apply the derivative to solve problems. This will include</p> <p>a) analysis of curves and the ideas of concavity and monotonicity;</p> <p>b) optimization involving global and local extrema;</p> <p>c) modeling of rates of change and related rates;</p> <p>d) use of implicit differentiation to find the derivative of an inverse function;</p> <p>e) interpretation of the derivative as a rate of change in applied contexts, including velocity, speed, and acceleration; and</p> <p>f) differentiation of non-logarithmic functions, using the technique of logarithmic differentiation. *</p>	<p>Second derivatives</p> <ul style="list-style-type: none"> • Corresponding characteristics of the graphs of f, f' and f''. • Relationship between the concavity of f and the sign of f''. • Points of inflection as places where concavity changes. <p>Applications of derivatives</p> <ul style="list-style-type: none"> • Analysis of curves, including the notions of monotonicity and concavity. • Optimization, both absolute (global) and relative (local) extrema. • Modeling rates of change, including related rates problems. • Use of implicit differentiation to find the derivative of an inverse function. • Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration. • Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 2.6, 3.1, 3.2, 3.3, 3.4, 3.6, 3.7, 3.8, 6.1, 6.2, 8.8

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #12 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Third 4 1/2 weeks	The student should be able to calculate the differential and do approximations using this.	<p>APC.8 The student will apply the derivative to solve problems. This will include</p> <p>a) analysis of curves and the ideas of concavity and monotonicity;</p> <p>b) optimization involving global and local extrema;</p> <p>c) modeling of rates of change and related rates;</p> <p>d) use of implicit differentiation to find the derivative of an inverse function;</p> <p>e) interpretation of the derivative as a rate of change in applied contexts, including velocity, speed, and acceleration; and</p> <p>f) differentiation of non-logarithmic functions, using the technique of logarithmic differentiation. *</p>	<p>Applications of derivatives</p> <ul style="list-style-type: none"> • Analysis of curves, including the notions of monotonicity and concavity. • Optimization, both absolute (global) and relative (local) extrema. • Modeling rates of change, including related rates problems. • Use of implicit differentiation to find the derivative of an inverse function. • Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration. • Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations. <p>Computation of derivatives</p> <ul style="list-style-type: none"> • Knowledge of derivatives of basic functions, including power, exponential, logarithmic, trigonometric and inverse trigonometric functions. • Derivative rules for sums, products and quotients of functions. • Chain rule and implicit differentiation.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 2.6, 3.1, 3.6, 3.7, 3.8, 6.1, 6.2, 8.8

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #13 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Second 4 1/2 weeks	The student should be able to solve problems involving related rates.	APC.8 The student will apply the derivative to solve problems. This will include a) analysis of curves and the ideas of concavity and monotonicity; b) optimization involving global and local extrema; c) modeling of rates of change and related rates; d) use of implicit differentiation to find the derivative of an inverse function; e) interpretation of the derivative as a rate of change in applied contexts, including velocity, speed, and acceleration; and f) differentiation of non-logarithmic functions, using the technique of logarithmic differentiation. *	Applications of derivatives • Analysis of curves, including the notions of monotonicity and concavity. • Optimization, both absolute (global) and relative (local) extrema. • Modeling rates of change, including related rates problems. • Use of implicit differentiation to find the derivative of an inverse function. • Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration. • Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations. Computation of derivatives • Knowledge of derivatives of basic functions, including power, exponential, logarithmic, trigonometric and inverse trigonometric functions. • Derivative rules for sums, products and quotients of functions. • Chain rule and implicit differentiation.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 2.6, 3.1, 3.6, 3.7, 3.8, 6.1, 6.2, 8.8

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #14 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Fourth 4 1/2 weeks	The student should be able to find the area and the definite integral.	<p>APC.12 The student will identify the properties of the definite integral. This will include additivity and linearity, the definite integral as an area, and the definite integral as a limit of a sum as well as the fundamental theorem:</p> $\frac{d}{dx} \int_a^x f(t) dt = f(x)$	<p>Interpretations and properties of definite integrals</p> <ul style="list-style-type: none"> • Definite integral as a limit of Riemann sums. • Definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval: $\int_a^b f'(x) dx = f(b) - f(a)$ <ul style="list-style-type: none"> • <i>Basic properties of definite integrals</i> (examples include additivity and linearity).

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Section: 4.3

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #15 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Fourth 4 1/2 weeks	The student should be able to use the properties of the definite integral.	<p>APC.12 The student will identify the properties of the definite integral. This will include additivity and linearity, the definite integral as an area, and the definite integral as a limit of a sum as well as the fundamental theorem:</p> $\frac{d}{dx} \int_a^x f(t) dt = f(x)$ <p>APC.13 The student will use the Fundamental Theorem of Calculus to evaluate definite integrals, represent a particular antiderivative, and facilitate the analytical and graphical analysis of functions so defined.</p> $\int_a^b f'(x) dx = f(b) - f(a)$	<p>III. Integrals Interpretations and properties of definite integrals</p> <ul style="list-style-type: none"> • Definite integral as a limit of Riemann sums. • Definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval: $\int_a^b f'(x) dx = f(b) - f(a)$ <ul style="list-style-type: none"> • <i>Basic properties of definite integrals</i> (examples include additivity and linearity).

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 4.3, 4.4, 4.5

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #16 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Fourth 4 1/2 weeks	The student should be able to evaluate the definite integral and use the Fundamental Theorem of Calculus.	APC.13 The student will use the Fundamental Theorem of Calculus to evaluate definite integrals, represent a particular antiderivative, and facilitate the analytical and graphical analysis of functions so defined.	Fundamental Theorem of Calculus $\int_a^b f'(x) dx = f(b) - f(a)$ <ul style="list-style-type: none"> • Use of the Fundamental Theorem to evaluate definite integrals. • Use of the Fundamental Theorem to represent a particular antiderivative, and the analytical and graphical analysis of functions so defined.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 4.3, 4.4, 4.5

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #17 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Fourth 4 1/2 weeks	The student should be able to use the Mean Value Theorem for integrals.	<p>APC.15 The student will use integration techniques and appropriate integrals to model physical, biological, and economic situations. The emphasis will be on using the integral of a rate of change to give accumulated change or on using the method of setting up an approximating Riemann sum and representing its limit as a definite integral. Specific applications will include</p> <ul style="list-style-type: none"> a) the area of a region; b) the volume of a solid with known cross-section; c) the average value of a function; and d) the distance traveled by a particle along a line. * <p>* AP Calculus BC will include finding the area of a region (including a region bounded by polar curves) and finding the length of a curve (including a curve given in parametric form).</p>	$\int_a^b f(x) dx = f(c)(b - a)$ <p>Applications of integrals. Appropriate integrals are used in a variety of applications to model physical, biological or economic situations. Although only a sampling of applications can be included in any specific course, students should be able to adapt their knowledge and techniques to solve other similar application problems. Whatever applications are chosen, the emphasis is on using the method of setting up an approximating Riemann sum and representing its limit as a definite integral. To provide a common foundation, specific applications should include finding the area of a region, the volume of a solid with known cross sections, the average value of a function, the distance traveled by a particle along a line, and accumulated change from a rate of change.</p>

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 7.1, 7.2, 7.3, 7.4

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #18 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Fourth 4 1/2 weeks	The student should be able to determine the indefinite integral.	<p>APC.11 The student will find antiderivatives directly from derivatives of basic functions and by substitution of variables (including change of limits for definite integrals).</p> <p>* AP Calculus BC will also include finding antiderivatives by parts and simple partial fractions (nonrepeating linear factors only), and finding improper integrals as limits of definite integrals.</p> <p>* AP Calculus BC will also solve logistic differential equations and use them in modeling.</p>	<p>Techniques of antidifferentiation</p> <ul style="list-style-type: none"> • Antiderivatives following directly from derivatives of basic functions. + Antiderivatives by substitution of variables (including change of limits for definite integrals), parts, and simple partial fractions (nonrepeating linear factors only). + Improper integrals (as limits of definite integrals). <p>Applications of antidifferentiation</p> <ul style="list-style-type: none"> • Finding specific antiderivatives using initial conditions, including applications to motion along a line. • Solving separable differential equations and using them in modeling (including the study of the equation $y' = ky$ and exponential growth). + Solving logistic differential equations and using them in modeling.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 4.1, 4.2, 4.5, 5.2, 5.4, 5.5, 5.7, 6.3, 8.1, 8.2, 8.3, 8.4, 8.5

Dual-Enrolled Calculus I (Math 173)

Time Frame	SLO #19 (not SOL)/ Competency	Essential Understandings/ Questions (VDOE Calculus Standards of Learning, 2001)	Essential Knowledge/Skills (from AP Course Outline)
Fourth 4 1/2 weeks	The student should be able to perform integration by substitution.	APC.11 The student will find antiderivatives directly from derivatives of basic functions and by substitution of variables (including change of limits for definite integrals). * * AP Calculus BC will also include finding antiderivatives by parts and simple partial fractions (nonrepeating linear factors only), and finding improper integrals as limits of definite integrals. * AP Calculus BC will also solve logistic differential equations and use them in modeling.	Techniques of antidifferentiation • Antiderivatives following directly from derivatives of basic functions. + Antiderivatives by substitution of variables (including change of limits for definite integrals), parts, and simple partial fractions (nonrepeating linear factors only). + Improper integrals (as limits of definite integrals). Applications of antidifferentiation • Finding specific antiderivatives using initial conditions, including applications to motion along a line. • Solving separable differential equations and using them in modeling (including the study of the equation $y' = ky$ and exponential growth). + Solving logistic differential equations and using them in modeling.

Current Textbook:

Calculus, Eighth Edition by Larson and Hostetler

Sections: 4.1, 4.2, 4.5, 5.2, 5.4, 5.5, 5.7, 6.3, 8.1, 8.2, 8.3, 8.4, 8.5

Note: Virginia Standards of Learning are no longer published for AP Calculus.

From the VDOE AP Calculus Standards of 2001, but correlated with our current textbook:

APC.1 The student will define and apply the properties of elementary functions, including algebraic, trigonometric, exponential, and composite functions and their inverses, and graph these functions, using a graphing calculator. Properties of functions will include domains, ranges, combinations, odd, even, periodicity, symmetry, asymptotes, zeros, upper and lower bounds, and intervals where the function is increasing or decreasing.

Sections: P.1 through P.4; 1.1, 3.3

APC.2 The student will define and apply the properties of limits of functions. Limits will be evaluated graphically and algebraically. This will include

- limits of a constant;
- limits of a sum, product, and quotient;
- one-sided limits; and
- limits at infinity, infinite limits, and non-existent limits. *

*AP Calculus BC will include l'Hopital's Rule, which will be used to find the limit of functions whose limits yield the indeterminate forms: $0/0$ and ∞/∞ .

Sections: 1.2, 1.3, 1.4, 1.5, 3.5, 8.7, 8.8

APC.3 The student will use limits to define continuity and determine where a function is continuous or discontinuous. This will include

- continuity in terms of limits;
- continuity at a point and over a closed interval;
- application of the Intermediate Value Theorem and the Extreme Value Theorem; and
- geometric understanding and interpretation of continuity and discontinuity.

Sections: 1.4, 2.1, 4.3, 5.3

APC.4 The student will investigate asymptotic and unbounded behavior in functions. This will include

- describing and understanding asymptotes in terms of graphical behavior and limits involving infinity; and
- comparing relative magnitudes of functions and their rates of change.

Sections: 1.5, 3.6, 9.1

APC.5 The student will investigate derivatives presented in graphic, numerical, and analytic contexts and the relationship between continuity and differentiability. The derivative will be defined as the limit of the difference quotient and interpreted as an instantaneous rate of change.

Sections: 2.1, 2.2, 2.3, 3.6, 4.3, 5.3

APC.6 The student will investigate the derivative at a point on a curve. This will include

- finding the slope of a curve at a point, including points at which the tangent is vertical and points at which there are no tangents;
- using local linear approximation to find the slope of a tangent line to a curve at the point;
- defining instantaneous rate of change as the limit of average rate of change; and
- approximating rate of change from graphs and tables of values.

Sections: 2.1, 2.2, 2.3, 3.6

APC.7 The student will analyze the derivative of a function as a function in itself. This will include

- comparing corresponding characteristics of the graphs of f , f' , and f'' ;
- defining the relationship between the increasing and decreasing behavior and the sign of f' ;
- translating verbal descriptions into equations involving derivatives and vice versa;
- analyzing the geometric consequences of the Mean Value Theorem;
- defining the relationship between the concavity and the sign of f'' ; and
- identifying points of inflection as places where concavity changes and finding points of inflection.

Sections: 3.1, 3.2, 3.3, 3.4, 3.6

APC.8 The student will apply the derivative to solve problems. This will include

- analysis of curves and the ideas of concavity and monotonicity;
- optimization involving global and local extrema;
- modeling of rates of change and related rates;
- use of implicit differentiation to find the derivative of an inverse function;
- interpretation of the derivative as a rate of change in applied contexts, including velocity, speed, and acceleration; and
- differentiation of non-logarithmic functions, using the technique of logarithmic differentiation. *

* AP Calculus BC will also apply the derivative to solve problems. This will include

- analysis of planar curves given in parametric form, polar form, and vector form, including velocity and acceleration vectors;
- numerical solution of differential equations, using Euler's method;
- l'Hopital's Rule to test the convergence of improper integrals and series; and
- geometric interpretation of differential equations via slope fields and the relationship between slope fields and the solution curves for the differential equations.

Sections: 2.6, 3.1, 3.6, 3.7, 3.8, 6.1, 6.2, 8.8

APC.9 The student will apply formulas to find derivatives. This will include

- derivatives of algebraic, trigonometric, exponential, logarithmic, and inverse trigonometric functions;
- derivations of sums, products, quotients, inverses, and composites (chain rule) of elementary functions;
- derivatives of implicitly defined functions; and
- higher order derivatives of algebraic, trigonometric, exponential, and logarithmic, functions. *

* AP Calculus BC will also include finding derivatives of parametric, polar, and vector functions.

Sections: 2.2, 2.3, 2.4, 2.5, 2.6, 3.8, 5.1, 5.4, 5.5, 5.6

APC.10 The student will use Riemann sums and the Trapezoidal Rule to approximate definite integrals of functions represented algebraically, graphically, and by a table of values and will interpret the definite integral as the accumulated rate of change of a quantity over an interval interpreted as the change of the quantity over the interval

$$\int_a^b f'(x) dx = f(b) - f(a).$$

Riemann sums will use left, right, and midpoint evaluation points over equal subdivisions.

Sections: 4.1, 4.3, 4.6

APC.11 The student will find antiderivatives directly from derivatives of basic functions and by substitution of variables (including change of limits for definite integrals).
 * AP Calculus BC will also include finding antiderivatives by parts and simple partial fractions (nonrepeating linear factors only), and finding improper integrals as limits of definite integrals.
 * AP Calculus BC will also solve logistic differential equations and use them in modeling.

Sections: 4.1, 4.2, 4.5, 5.2, 5.4, 5.5, 5.7, 6.3, 8.1, 8.2, 8.3, 8.4, 8.5

APC.12 The student will identify the properties of the definite integral. This will include additivity and linearity, the definite integral as an area, and the definite integral as a limit of a sum as well as the fundamental theorem:

$$\frac{d}{dx} \int_a^x f(t) dt = f(x).$$

Sections: 4.3

APC.13 The student will use the Fundamental Theorem of Calculus to evaluate definite integrals, represent a particular antiderivative, and the analytical and graphical analysis of functions so defined.

Sections: 4.4, 4.5

APC.14 The student will find specific antiderivatives, using initial conditions (including applications to motion along a line). Separable differential equations will be solved and used in modeling (in particular, the equation $y' = ky$ and exponential growth).

Sections: 6.2, 6.3

APC.15 The student will use integration techniques and appropriate integrals to model physical, biological, and economic situations. The emphasis will be on using the integral of a rate of change to give accumulated change or on using the method of setting up an approximating Riemann sum and representing its limit as a definite integral. Specific applications will include

- the area of a region;
- the volume of a solid with known cross-section;
- the average value of a function; and
- the distance traveled by a particle along a line. *

* AP Calculus BC will include finding the area of a region (including a region bounded by polar curves) and finding the length of a curve (including a curve given in parametric form).

Sections: 7.1, 7.2, 7.3, 7.4

APC.16 The student will define a series and test for convergence of a series in terms of the limit of the sequence of partial sums. This will include

- geometric series with applications;
- harmonic series;
- alternating series with error bound;
- terms of series as areas of rectangles and their relationship to improper integrals, including the integral test and its use in testing the convergence of p-series; and
- ratio test for convergence and divergence. *

* For those students who are enrolled in AP Calculus BC.

Sections: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6

APC.17 The student will define, restate, and apply Taylor series. This will include

- Taylor polynomial approximations with graphical demonstration of convergence;
- Maclaurin series and the general Taylor series centered at a ;
- Maclaurin series for the functions e^x , $\sin x$, $\cos x$, and $1/(1-x)$;
- formal manipulation of Taylor series and shortcuts to computing Taylor series, including substitution, differentiation, antidifferentiation, and the formation of new series from known series;
- functions defined by power series;
- radius and interval of convergence of power series; and
- Lagrange error bound of a Taylor polynomial. *

* For those students who are enrolled in AP Calculus BC

Sections: 9.7, 9.8, 9.9, 9.10