Black Horse Pike Regional School District Curriculum

ENGAGING STUDENTS ● FOSTERING ACHIEVEMENT ● CULTIVATING 21ST CENTURY GLOBAL SKILLS

Course Name: Calculus
Course Number: 034100

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: Calculus **Grade Level(s):** 12	**Unit Summary**: **In this unit, the students will get a preview of Calculus as a whole. They will find limits graphically and numerically, evaluate limits analytically, explore continuity and one-sided limits as well as limits at infinity.** (Ch. P.1, P.3, 1.2, 1.3, 1.4, 1.5, 3.5, 2.1, 2.2)
Essential Question(s): ● *What are limits?* ● *How do you determine the existence of a limit?* ● *How do you check if a function is continuous?* ● *How can we describe limits as they approach infinity?* ● *How do we create a graph and examine functions to illustrate the use of the Intermediate Value Theorem?*	**Enduring Understanding(s):** Students will be able to: ● Understand what calculus is and how it compares to precalculus ● analyze graphs with the aid of technology. Since 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. ● work with limits of functions (including one-sided limits). They will have an intuitive understanding of the limiting process. They will be able to calculate limits using algebra and estimate limits from graphs or tables of data. They will also develop strategies for finding limits that include rationalization and cancellation through factorization ● understand asymptotic and unbounded behavior in terms of graphical behavior, and limits involving infinity. ● compare relative magnitudes of functions and their rates of change (for example, contrasting exponential growth, polynomial growth, and logarithmic growth). ● learn about continuity as a property of functions. ● develop an intuitive understanding of continuity. (The function values can be made as close as desired by taking sufficiently close values of the domain). ● learn to understand continuity in terms of limits. ● gain a geometric understanding of graphs of continuous functions (Intermediate Value Theorem and Extreme Value Theorem). ● Use the precise ϵ–δ definition to find limits

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify in the New Jersey Student Learning Standards that are applicable

Learning Target	
1. ***NJSLS.F-IF.A.1*** *- [Standard] - Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).* **2.** ***NJSLS.F-IF.B.5*** *- [Standard] - Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.* **3.** ***NJSLS.F-IF.C.7*** *- [Standard] - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* **4.** ***NJSLS.F-IF.B.6*** *- [Standard] - Calculate and interpret the average RATE OF CHANGE of a function (presented symbolically or as a table) over a specified interval. Estimate the RATE OF CHANGE from a graph.*	**1.** ***NJSLS.F-IF.A.1*** **2.** ***NJSLS.F-IF.B.5*** **3.** ***NJSLS.F-IF.C.7*** **4.** ***NJSLS.F-IF.B.6***

Inter-Disciplinary Connections:

Word problems included in text. Each textbook has a plethora of inter-disciplinary questions at the conclusion of each lesson.

Students will engage with the following text, resources and tools:

Texts:

- Calculus of a Single Variable, Seventh Edition - By Larson, Hostetler and Edwards

Online Resources incorporated through the year, include but not limited to:

- Albert io – online AP exam practice resource
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Calculators:

- TI – 84 Plus

The following 21st century skills and the 8 mathematical practices are embedded throughout the course and are evident in daily lessons, assignments, activities, assessments and projects:

21st Century skills:	**Mathematical Practices:**
• Critical thinking • Creativity • Collaboration • Communication • Information literacy • Technology literacy • Media literacy • Flexibility • Leadership • Initiative • Productivity • Social skills	• Make sense of problems and persevere in solving them • Reason abstractly and quantitatively • Construct viable arguments and critique the reasoning of others • Model with mathematics • Use appropriate tools strategically • Attend to precision • Look for and make use of structure • Look for and express regularity in repeated reasoning

Students will write:

Writing/Open Ended questions:
Larson Calculus 7th Edition, Houghton Mifflin Company:

***All "Getting at the Concept" highlighted questions at the conclusion of each section and**
Foerster Calculus Concepts and Application, Key Curriculum Press
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PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will uncover and build skills through various classroom activities. Investigating algebra activities, modeling examples, using real-life application, using note-taking strategies, and using SMARTBoard technologies will all be explored. Other learning experiences could include alternative lesson openers, math and history applications, problem-solving workshops, interdisciplinary applications and extra examples of problem solving.

Suggested warm-up activities, instructional strategies/activities, and assignments:

Big Ideas: Preparation for Calculus

- **Informal investigation of the concepts of calculus such as describing limits, derivatives and integrals graphically, numerically, algebraically and verbally.**

Big Ideas: Limits and their properties

- **Finding limits graphically and numerically o Discuss the formal definition of a limit o Find a limit using a graph o Find a limit algebraically using substitution and other methods**
- **Evaluating limits analytically o Discuss limits that don't exist o Estimate a limit using a graphical or numerical approach o Use an analytic approach to solving limits using rationalization and cancellation by factorization o Discuss the Squeeze Theorem and how it applies to y=sinx/x**
- **Describe continuity and one-sided limits o Removable vs. non-removable discontinuity o Infinite discontinuities and step discontinuities o Find limits from the left and right**
- **Evaluate infinite limits o Apply the Highest Exponent Rule to determine:**
  - **Horizontal Asymptotes/the limit as x approaches infinity**
- **Use the Intermediate Value Theorem and understand its consequences o Find the instantaneous rate of change on an interval of the average rate of change**

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS.

Formative Assessments:

The effectiveness of the instructional program will be based on teacher observations, students doing quality of work together, questioning strategies, self and peer assessment, student record-keeping, quizzes, performance tasks, diagnostic tests, and homework.

Accommodations/Modifications:

- **Use manipulatives to represent shapes.**
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- **Break problems into smaller pieces.**
- **Have students keep an organized binder.**
- **Allow students to use calculator.**
- **Review needed skills prior to the lesson.**
- **Provide checklists for solving problems.**
- **Provide index cards to make flashcards for vocabulary with visuals.**
- **Have students highlight important words in the directions.**

Summative Assessments:

Section tests, Benchmark Tests, End of Course Test

Accommodations/Modifications:

Section tests, Benchmarks and End of Course tests may have:

- **prompts**
- **examples**
- **bolded directions**
- **extra space between problems to show work**
- **chunked (given one page at a time) to keep students focused ● use of a calculator**
- **parts of assessment read aloud**

Performance Assessments:

Projects and display of student work

Accommodations/Modifications:

Projects, if given, should include:

- **a comprehensive guide**
- **rubric**
- **a visual example for students to follow as a reference**

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PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

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<tr>
<td>Course/Unit Title:
Calculus

Grade Level(s):
12</td>
<td>Unit Summary:
Students will explore derivatives through the tangent line problem graphically, analytically and numerically. They will learn the basic rules of differentiation and rates of change. They will perform the Product and Quotient and Chain rules and find higher order derivatives. Students will use the L'Hopital's rule for indeterminate forms, perform implicit differentiation and solve related rates. (Ch. 2.3, 2.4, 2.5, 2.6, 5.1, 5.4, 5.5, 5.8)</td>
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<td>Essential Question(s):
● What is the definition of a derivative at a point?
● Given a graph of a function how can we sketch the graph of the derivative function?
● How can we use the derivative to work with displacement, distance, speed, and velocity?
● How can we use the power/chain/product/quotient rules to find the derivative of functions?</td>
<td>Enduring Understanding(s):
Students will be able to:
● understand the concept of the Derivative.
● present it graphically, numerically, and analytically.
● interpret the derivative as an instantaneous rate of change.
● learn that the derivative is defined as the limit of the difference quotient.
● learn the relationship between differentiability and continuity.
● solve for the derivative at a point.
● study and work with 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.
● solve problems involving tangent line to a curve at a point and local linear approximation, instantaneous rate of change as the limit of average rate of change, and approximate the rate of change from graphs and tables of values.
● solve problems where the derivative is a function.
● analyze corresponding characteristics of graphs of ƒ and ƒ ', and the relationship between the increasing and decreasing behavior of ƒ and the sign of ƒ '
● solve problems using The Mean Value Theorem and analyze its geometric consequences.
● Use implicit differentiation for exponential functions and functions involving complex chain/product/quotient rule combinations
● Solve related rates word problems

solve equations involving derivatives, and interpret verbal descriptions and translate them into equations involving derivatives and vice versa</td>
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PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

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21st Century skills:	**Mathematical Practices:**
• Critical thinking • Creativity • Collaboration • Communication • Information literacy • Technology literacy • Media literacy • Flexibility • Leadership • Initiative • Productivity • Social skills	• Make sense of problems and persevere in solving them • Reason abstractly and quantitatively • Construct viable arguments and critique the reasoning of others • Model with mathematics • Use appropriate tools strategically • Attend to precision • Look for and make use of structure • Look for and express regularity in repeated reasoning

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PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will uncover and build skills through various classroom activities. Investigating algebra activities, modeling examples, using real-life application, using note-taking strategies, and using SMARTBoard technologies will all be explored. Other learning experiences could include alternative lesson openers, math and history applications, problem-solving workshops, interdisciplinary applications and extra examples of problem solving.

Suggested warm-up activities, instructional strategies/activities, and assignments:

Big Ideas: Differentiation

- **Explore the derivative and the tangent line problem o Secant line and tangent line o Average rate of change vs. instantaneous rate of change**
- **Apply differentiation rules and rates of change o Define derivative using limits o Basic rules of differentiation and basic trigonometric rules o Differentiability and continuity**
- **Use the product, quotient, chain and power rules to solve higher order derivatives o Apply basic rules to all types of functions o Differentiate using power, product, quotient, chain and higher order derivatives o Apply differentiation to the position, velocity and acceleration functions**
- **Apply implicit differentiation for exponential functions and functions involving complex chain/product/quotient rule combinations o Define explicit and implicit differentiation o Set the parameters for when implicit differentiation is applicable o Solve equations where y cannot be isolated using the above methods**
- **Solve word problems involving related rates o Discuss systems in motion where more than one variable is changing at a time o Develop a systematic method for solving related rates o Solve a variety of related rates problems involving real world quantities**
- **L'Hopital's rule**
  - **o Review limits and horizontal asymptotes by using L'Hopital's rule to solve indeterminate forms**

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS.

Formative Assessments:

The effectiveness of the instructional program will be based on teacher observations, students doing quality of work together, questioning strategies, self and peer assessment, student record-keeping, quizzes, performance tasks, diagnostic tests, and homework.

Accommodations/Modifications:

- **Use manipulatives to represent shapes.**
- **Provide several manipulatives to measure length and area of figures.**
- **Provide guided notes/handouts.**
- **Break problems into smaller pieces.**
- **Have students keep an organized binder.**
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- **Have students highlight important words in the directions.**

Summative Assessments:

Section tests, Benchmark Tests, End of Course Test

Accommodations/Modifications:

Section tests, Benchmarks and End of Course tests may have:

- **prompts**
- **examples**
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Projects and display of student work

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Projects, if given, should include:

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<table>
<tr><td>Course/Unit Title:
Calculus

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12</td><td>Unit Summary:
Students will locate extrema on an interval, use Rolle's Theorem and the Mean Value Theorem. They will use the First and Second Derivative Test to find intervals of increase, decrease and concavity, inflection points, critical points and extreme values. Students will explore limits at infinity and analyze various types of functions. They will solve optimization problems and find differentials. Students will use L'Hôpital's Rule to solve problems.
(Ch. 3.1, 3.2, 3.3, 3.4, 3.6, 3.7, 3.9, 7.7)</td></tr>
<tr><td>Essential Question(s):
● How can we use the First and Second Derivative of a function to determine characteristics of a function?
● What is the Mean Value Theorem and its application?
● How can we maximize or minimize real world quantities given a strict set of parameters?
● How can we use differentials to compare a tangent line to the graph of f at any given x?</td><td>Enduring Understanding(s):
Students will be able to:
● Students will solve problems involving Second Derivatives.
● analyze corresponding characteristics of the graphs of ƒ , ƒ ', and ƒ ''.
● explore the relationship between the concavity of ƒ and the sign of ƒ '
● understand that points of inflection as places where concavity changes.
● solve applications of derivatives problems. They will be able to analyze curves, including the notions of monotonicity and concavity. They will solve optimization problems involving both absolute (global) and relative (local) extrema.
● learn to interpret the derivative as a rate of change in varied applied contexts, including velocity, speed, and acceleration.
● solve problems and understand the geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations.</td></tr>
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PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

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Suggested warm-up activities, instructional strategies/activities, and assignments:

Big Ideas: Applications of Differentiation

- **Extrema on an interval o Define extreme values including local and global maximums/minimums on an open and closed interval**
- **Rolle's/Mean Value Theorems o Compare the two theorems**
  - **o State the application of the theorems**
- **Intervals of Increase/Decrease and the First Derivative Test o Define the first derivative test, critical numbers, intervals of increase/decrease o Use sign analysis to determine areas of increase/decrease, max/mins and saddles**
- **Concavity and the Second Derivative Test o Define the second derivative test, points of inflection, intervals of concavity o Use sign analysis to determine intervals of concavity and points of inflection**
- **Graph Analysis o Apply the first and second derivative tests o Find all asymptotes (if any) o Find all intercepts (x and y)**
  - **o Find domain and range o Infinite limits**
- **Optimization o Apply the first derivative test to solve real world problems**
- **Differentials and Linear Approximations o Define differential o Use the formula to find linear approximations**
  - **o Compare the value of the differential dy with the actual change in y**
- **L'Hôpital's Rule**
  - **o Evaluate limits in various indeterminate forms.**
  - **o Applying L'Hôpital's rule more than once.**

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Accommodations/Modifications:

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<tr>
<td>Course/Unit Title:
Calculus

Grade Level(s):
12</td>
<td>Unit Summary:
Students will find antiderivatives and indefinite integrals. They will estimate the area under the curve using Riemann sums to find the definite integral. Students will learn and apply the Fundamental Theorem of Calculus Parts 1 and 2. They will perform techniques of integration using u-substitution and various other rules. (Ch. 4.1, 4.2, 4.3, 4.4, 4.5, 5.1, 5.4, 5.5, 5.8, 6.1)</td>
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<td>Essential Question(s):
● What is an antiderivative?
● What is the relationship between a derivative and an integral?
● How do you use Riemann sums to estimate the area under the curve?
● What is the Fundamental Theorem of Calculus and how does it apply to the definite integral?</td>
<td>Enduring Understanding(s):
Students will be able to:
● have a working knowledge of Integrals.
● learn Interpretations and properties of definite integrals [such as definite integral as a limit of Riemann Sums, and definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval $\int_a^b f'(x)dx = f(b) - f(b)$].
● solve problems using the basic properties of definite integrals (examples include additivity and linearity).
● solve applications of integrals. They will learn that appropriate integrals are used in a variety of applications to model physical, biological, or economic situations.
● 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 using the integral of a rate of change to give accumulated change, 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.
● learn Fundamental Theorem of Calculus.
● use the Fundamental Theorem to evaluate definite integrals, represent a particular antiderivative, and the analytical and graphical analysis of functions so defined.
● learn techniques of antidifferentiation following directly from derivatives of basic functions, and by substitution of variables (including change of limits for definite integrals).

find numerical approximations to definite integrals by using Riemann Sums (using left, right, and midpoint evaluation points) to approximate definite integrals of functions represented algebraically, graphically, and by tables of values.</td>
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PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

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- Creativity
- Collaboration
- Communication
- Information literacy
- Technology literacy
- Media literacy
- Flexibility
- Leadership
- Initiative
- Productivity
- Social skills

Mathematical Practices:

- Make sense of problems and persevere in solving them
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DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will uncover and build skills through various classroom activities. Investigating algebra activities, modeling examples, using real-life application, using note-taking strategies, and using SMARTBoard technologies will all be explored. Other learning experiences could include alternative lesson openers, math and history applications, problem-solving workshops, interdisciplinary applications and extra examples of problem solving.

Suggested warm-up activities, instructional strategies/activities, and assignments:

Big Ideas: Integration

- **Antiderivatives and the indefinite integral**
  - **Define all basic integration rules**
  - **Apply the properties of indefinite integrals**
- **Area and Reimann Sums o Approximate the area under the curve using left and right rectangles, and Riemann sums.**
- **Definite integral and the Fundamental Theorem of Calculus o Define the definite integral as the limit of a Reimann sum o Evaluate the area under a curve using the Fundamental Theorem of Calculus part 1 o Evaluate the derivative of an integral using the Fundamental Theorem of Calculus part 2**
- **Integration Techniques o Evaluate indefinite and definite integrals using u-substitution**

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS.

Formative Assessments:

The effectiveness of the instructional program will be based on teacher observations, students doing quality of work together, questioning strategies, self and peer assessment, student record-keeping, quizzes, performance tasks, diagnostic tests, and homework

Accommodations/Modifications:

- **Use manipulatives to represent shapes.**
- **Provide several manipulatives to measure length and area of figures.**
- **Provide guided notes/handouts.**
- **Break problems into smaller pieces.**
- **Have students keep an organized binder.**
- **Allow students to use calculator.**
- **Review needed skills prior to the lesson.**
- **Provide checklists for solving problems.**
- **Provide index cards to make flashcards for vocabulary with visuals.**
- **Have students highlight important words in the directions.**

Summative Assessments:

Section tests, Benchmark Tests, AP Test, End of Course Test

Accommodations/Modifications:

Section tests, Benchmarks and End of Course tests may have:

- **prompts**
- **examples**
- **bolded directions**
- **extra space between problems to show work**
- **chunked (given one page at a time) to keep students focused ● use of a calculator**
- **parts of assessment read aloud**

Performance Assessments:

Projects and display of student work

Accommodations/Modifications:

Projects, if given, should include:

- **a comprehensive guide**
- **rubric**
- **a visual example for students to follow as a reference**