SALINE AREA SCHOOLS
COURSE OUTCOMES

INTRODUCTION TO CALCULUS

1. Review Algebraic Techniques
   a. Evaluate absolute value and distance
   b. Simplify expressions involving exponents and radicals
   c. Factor polynomials involving negative and rational exponents
   d. Simplify and perform operations with fractions and rational expressions
   e. Understand the basic properties of elementary functions and their graphs
   f. Solve and write linear equations

2. Evaluate limits and determine the continuity of a function
   a. Evaluate finite, infinite, and one-sided limits
   b. Distinguish between types of non-existent limits
   c. Know and interpret the definition of continuity

3. Differentiate elementary functions
   a. Know and apply the definition of a derivative
   b. Understand and apply the rules of differentiation for sums, products, quotients, and composites
   c. Differentiate implicitly-defined functions
   d. Know the relationship between differentiability and continuity

4. Apply the concept of derivatives to solve problems
   a. Sketch the graph of any given function using the techniques of curve sketching
   b. Solve optimization problems
   c. Analyze and solve related-rates problems
   d. Extend the concepts of derivatives to problems involving business and economics

5. Integrate elementary functions
   a. Know the basic integration formulas
   b. Find the anti-derivative of elementary functions using substitution and change of variables
   c. Evaluate definite integrals using the Fundamental Theorem and properties of definite integrals
   d. Find the area under the curve and the area between two curves
   e. Find the volume of solids of revolution
   f. Find the average value of a functions

6. Examine trigonometric ratios
   a. Review basic trigonometric definitions and identities
   b. Graph trigonometric functions
   c. Differentiate trigonometric functions
   d. Integrate trigonometric functions

*7. Examine exponential and logarithmic functions
   a. Review exponential and logarithmic functions and their properties
   b. Differentiate exponential and logarithmic functions
   c. Integrate exponential and logarithmic functions
   d. Apply the rules of integration and differentiation of exponential and logarithmic functions to solve real-world problems

* as time permits

SALINE AREA SCHOOLS
COURSE OUTCOMES

AP CALCULUS AB

The Course
AP Calculus AB consists of a full high school academic year of work (2 credits) that is comparable to first year calculus courses taught in colleges and universities.

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 those that are linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric and piecewise defined. 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 of numbers such as 0, $\pi/6$, $\pi 4$, $\pi/3$ and $\pi/2$.

At Saline High School, these prerequisites can be met by completing the academic study in the college--prep mathematics curriculum up through Honors Advanced Algebra III and Honors Trigonometry or Advanced Algebra III and Trigonometry with the permission of the Mathematics Department.

Philosophy
Advanced Placement Calculus AB is primarily concerned with preparing the student for the Advanced Placement Examination in Mathematics AB administered each May by the College Board by developing the students' understanding of the concepts of calculus and providing experiences with its methods and applications. The course emphasizes a muiti-representational approach to calculus, with concepts, results and problems being expressed geometrically, numerically, analytically and verbally.

It is expected that **all** students who take this AP course will seek college credit, advanced placement, or both, from institutions of higher learning by sitting for and passing the Advanced Placement Examination. Students who are not interested in seeking college credit should elect the one semester Introduction to Calculus course.

Objectives

In this course, broad concepts and widely applicable methods are emphasized. The focus of the course is neither manipuiation nor memorization of an extensive taxonomy of functions, curves, theorems or problem types. Although facility with manipulation and computational competence are important outcomes of the course, they are not the core of the course. Through the use of unifying themes of derivatives, integrals, limits, approximation, and applications and modelling, the course becomes a cohesive whole rather than a collection of unrelated topics. These themes are developed using all the functions listed in the prerequisites.

1. Students should be able to work with functions represented in a variety of ways**:** **graphical, analytical (formula), numerical (table of values) or verbal**. They should understand the connections among these various representations.

2. Students should be able to understand the meaning of the derivative in terms of a **rate of change** and in terms of **local linear approximations** (the tangent line) and should be able to use the derivative to solve a variety of problems.

3. Students should be able to understand the meaning of the definite integral both as the **limit of Riemann sums** and as the **net accumulation of a rate of change** and be able to use integrals to solve a variety of problems.

4. Students should understand the relationship between the derivative and the definite integral as expressed by both the **First Fundamental Theorem of Calculus and the Second Fundamental Theorem of Calculus.**

5. Students should be able to communicate mathematics **in well written sentences** and should be able to **explain solutions** to problems.

6. Students should be able to model a written description of a physical situation with **a function**, **a differential equation or an integral**.

7. Students should be able to **use technology** to help solve problems, experiment, interpret results, and verify conclusions.

8. Students should be able to determine the reasonableness of solutions, including sign, size, relative accuracy and **units of measurement**.

9. Students should develop an appreciation of calculus as a coherent body of knowledge and as a human accomplishment.

Topical Outline
This outline of topics is intended to indicate the scope of the course, but it is not necessarily the order in which topics are taught. Although the AP Exam in Mathematics AB is based on the topics listed in this topical outline, teachers may enrich the course with additional topics.

1. Functions, Graphs and Limits

Analysis of Graphs
- With the aid of technology, produce the graphs of functions.
- Understand the interplay between the geometric and analytic information.
- Use calculus to predict and to explain observed local and global behavior of a function.

Limits of Functions (including one-sided limits)
- Develop an intuitive understanding of the limiting process.
- Calculate limits using algebra.
- Estimate limits from graphs or tables of data.

Asymptotic and Unbounded Behavior
- Understand asymptotes in terms of graphical behavior.
- Describe asymptotic behavior in terms of limits involving infinity.
- Compare relative magnitudes of exponential, polynomial and logarithmic functions and their growth rates.

Continuity as a Property of Functions
- Develop an intuitive understanding of continuity.
- Understand continuity in terms of limits.
- Understand and apply the Intermediate Value Theorem to a continuous function.
- Understand and apply the Extreme Value Theorem to a continuous function.

2. Derivatives

Concept of the Derivative
- Interpret the derivative as the slope of a tangent line.
- Interpret the derivative as an instantaneous rate of change.
- Define the derivative as the limit of a difference quotient.
- Compute the derivative geometrically, numerically and analytically.
- Understand the relationship between differentiability and continuity.

Derivative at a Point
- Interpret the derivative at a point as the slope of the tangent line at that point.
- Distinguish between points at which there are vertical tangents and points at which there are no tangents.
- Use the tangent line as a locally linear approximation to the function.
- Interpret instantaneous rate of change as the limit of average rate of change.
- Approximate rates of change from graphs and tables of values.

Derivative as a Function
- Understand the relationship between the graphs of a function and its derivative function.
- Use the first derivative test to analyze a function for increasing and decreasing.
- Use the Mean Value Theorem and understand its geometric consequences.
- Translate verbal descriptions into differential equations and vice versa.

Second Derivatives
- Understand the relationship between the graphs of a function and its second derivative function.
- Use the second derivative test to analyze a function for concavity.
- Use the second derivative test to analyze a function for points of inflection.

Applications of the Derivative
- Use the first and second derivative to analyze the graphical behavior of a function.
- Use calculus to solve local optimization problems.
- Use calculus to solve global optimization problems.
- Use calculus to model rates of chance. including related rates.

Computation of Derivatives
- Compute the derivatives of basic functions, including constant and power functions.
- Compute the derivative of logarithmic and exponential functions.
- Compute the derivative of trigonometric and inverse trigonometric functions.
- Compute the derivative of sums, products and quotients of functions.
- Compute the derivative of composite functions and absolute value functions using the chain rule.
- Compute the derivative of implicitly defined functions using implicit differentiation.
- Use implicit differentiation to find the derivative of an inverse function.

3. Integrals

Interpretations and Properties of Definite Integrals
- Interpret the definite integral as the area under a curve.
- Interpret the definite integral as the accumulation of a rate of change.
- Evaluate the definite integral using a limit of a Riemann sum over equal subdivisions.
- Use the basic properties of definite integrals.

Applications of Definite Integrals

- Use the definite integral to find the accumulation of a rate of change.
- Use the definite integral to find the area of a region bounded by two curves.
- Use the definite integral to find the volume of a solid with a known cross section.
- Use the definite integral to find the average value of a function.
- Use the definite integral to find the distance traveled by a particle in linear motion.

Fundamental Theorem of Calculus

- Use the Fundamental Theorem to evaluate definite integrals.
- Analyze functions defined by a definite integral using the Fundamental Theorem.

Techniques of Antidifferentiation

- Find anitderivatives that follow directly from the derivatitives of basic functions.
- Integrate by substitution (including change of variables).

Applications of Antidifferentiation

- Solve differential equations with boundary conditions (including separable differential equations).
- Use differential equations to model physical systems, including particie motion and exponential growth.

Numerical Approximations to Definite Integrals

- Approximate the definite integral using left, right and midpoint Riemann sums.
- Approximate the definite integral using the trapezoidal rule.

4. Graphing Calculators

The availability of a graphing calculator does not relieve the student of the need to be able to perform certain tasks analytically. Rather, it should be viewed as a tool that brings more realistic problems into reach of the student. Therefore, a portion of the AP Examination in Mathematics AB prohibits the use of calculators of any kind. On those portions of the exam that a graphing calculator is allowed, the student is required to be able to perform the following four tasks on the graphing calculator:

- Produce the graph of a function in an arbitrary viewing window.
- Find the zeros of a function.
- Evaluate the derivative of a function at a point numerically.
- Evaluate definite integrals numerically.

SALINE AREA SCHOOLS
COURSE OUTCOMES

AP CALCULUS BC

The Course
AP Calculus BC consists of a full high school academic year of work (2 credits) that is comparable to first year calculus courses taught in colleges and universities. The content of AP Calculus BC contains all topics included in AP Calculus AB plus additional topics, and is designed to qualify the student for advanced credit and advanced placement into a course that is one semester beyond that which is granted for AP Calculus AB.

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 those that are linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric and piecewise defined. 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 of numbers such as 0, $\pi/6$, $\pi/4$, $\pi/3$ and $\pi/2$.

At Saline High School, these prerequisites can be met by completing the academic study in the college-prep mathematics curriculum up through Honors Advanced Algebra III and Honors Trigonometry .

Philosophy
Advanced Placement Calculus BC is primarily concerned with preparing the student for the Advanced Placement Examination in Mathematics BC administered each May by the College Board by developing the students' understanding of the concepts of calculus and providing experiences with its methods and applications. The course emphasizes a multirepresentational approach to calculus, with concepts, results and problems being expressed geometrically, numerically, analytically and verbally.

It is expected that **all** students who take this AP course will seek college credit, advanced placement, or both, from institutions of higher learning by sitting for and passing the Advanced Placement Examination. Students who are not interested in seeking college credit should elect the one semester Introduction to Calculus course.

Objectives

In this course, broad concepts and widely applicable methods are emphasized. The focus of the course is neither manipulation nor memorization of an extensive taxonomy of functions, curves, theorems or problem types. Although facility with manipulation and computational competence are important outcomes of the course, they are not the core of the course. Through the use of unifying themes of derivatives, integrals, limits, approximation, and applications and modelling, the course becomes a cohesive whole rather than a collection of unrelated topics. These themes are developed using all the functions listed in the prerequisites.

1. Students should be able to work with functions represented in a variety of ways: **graphical, analytical (formula), numerical (table of values) or verbal.** They should understand the connections among these various representations.

2. Students should be able to understand the meaning of the derivative in terms of a **rate of change** and in terms of **local linear approximations** (the tangent line) and should be able to use the derivative to solve a variety of problems.

3. Students should be able to understand the meaning of the definite integral both as the **limit of Riemann sums** and as the **net accumulation of a rate of change** and be able to use integrals to solve a variety of problems.

4. Students should understand the relationship between the derivative and the definite integral as expressed by both the **First Fundamental Theorem of Calculus** and **the Second Fundamental Theorem of Calculus.**

5. Students should be able to communicate mathematics in **well-written sentences** and should be able to **explain solutions** to problems.

6. Students should be able to model a written description of a physical situation with a **function**, a **differential equation or an integral**.

7. Students should be able to **use technology** to help solve problems, experiment, interpret results, and verify conclusions.

8. Students should be able to determine the reasonableness of solutions, including sign, size, relative accuracy and **units of measurement**.

9. Students should develop an appreciation of calculus as a coherent body of knowledge and as a human accomplishment.

Topical Outline

This outline of topics is intended to indicate the scope of the course, but it is not necessarily the order in which topics are taught. Although the Advanced Placement Examination in Mathematics BC is based on the topics listed in this topical outline, teachers may enrich the course with additional topics.

1. Functions, Graphs and Limits

Analysis of Graphs

- With the aid of technology, produce the graphs of functions.
- Understand the interplay between the geometric and analytic information.
- Use calculus both to predict and to explain observed local and global behavior of a function.

Limits of Functions (including one-sided limits)

- Develop an intuitive understanding of the limiting process.
- Calculate limits using algebra.
- Estimate limits from graphs or tables of data.
- Use L'Hopital's Rule to evaluate limits of indeterminant forms.

Asymptotic and Unbounded Behavior

- Understand asymptotes in terms of graphical behavior.
- Describe asymptotic behavior in terms of limits involving infinity.
- Compare relative magnitudes of exponential, polynomial and logarithmic functions and their growth rates.

Continuity as a Property of Functions

- Develop an intuitive understanding of continuity.
- Understand continuity in terms of limits.
- Understand and apply the Intermediate Value Theorem to a continuous function.
- Understand and apply the Extreme Value Theorem to a continuous function.

Parametric, Polar and Vector Functions

- Analyze planar curves given in parametric, polar and vector form.

2. Derivatives

Concept of the Derivative

- Interpret the derivative as the slope of a tangent line.
- Interpret the derivative as an instantaneous rate of change.
- Define the derivative as the limit of a difference quotient.
- Compute the derivative geometrically, numerically and analytically.
- Understand the relationship between differentiability and continuity.

Derivative at a Point
- Interpret the derivative at a point as the slope of the tangent line at that point.
- Distinguish between points at which there are vertical tangents and points at which there are no tangents.
- Use the tangent line as a locally linear approximation to the function.
- Interpret instantaneous rate of change as the limit of average rate of change.
- Approximate rates of change from graphs and tables of values.

Derivative as a Function
- Understand the relationship between the graphs of a function and its derivative function.
- Use the first derivative test to analyze a function for increasing and decreasing.
- Use the Mean Value Theorem and understand its geometric consequences.
- Translate verbal descriptions into differential equations and vice versa.

- **Second Derivatives**
- Understand the relationship between the graphs of a function and its second derivative function.
- Use the second derivative test to analyze a function for concavity.
- Use the second derivative test to analyze a function for points of inflection.

Applications of the Derivative
- Use the first and second derivative to analyze the graphical behavior of a function.
- Analyze the graphical behavior of planar curves given in parametric, polar and vector form.
- Use calculus to solve local optimization problems.
- Use calculus to solve global optimization problems.
- Use calculus to model rates of change, including related rates.
- Interpret the rate of change in a variety of applied contexts, including linear motion problems.
- Analyze the motion of a particle in a plan, inlcuding velocity and acceleration vectors.

Computation of Derivatives
- Compute the derivatives of basic functions, including constant and power functions.
- Compute the derivative of logarithmic and exponential functions.
- Compute the derivative of trigonometric and inverse trigonometric functions.
- Compute the derivative of sums, products and quotients of functions.
- Compute the derivative of composite functions and absolute value functions using the chain rule.
- Compute the derivative of implicitly defined functions using implicit differentiation.
- Use implicit differentiation to find the derivative of an inverse function.
- Compute the derivatives of parametric, polar and vector functions.

3. Integrals

Interpretations and Properties of Definite Integrals

- Interpret the definite integral as the area under a curve.
- Interpret the definite integral as the accumulation of a rate of change.
- Evaluate the definite integral using a limit of a Riemann sum over equal subdivisions.
- Use the basic properties of definite integrals.

Applications of Definite Integrals

- Use the definite integral to find the accumulation of a rate of change.
- Use the definite integral to find the area of a region bounded by two curves.
- Use the definite integral to find the area of a region bounded by two polar curves.
- Use the definite integral to find the volume of a solid with a known cross section.
- Use the definite integral to find the average value of a function.
- Use the definite integral to find the distance traveled by a particle in linear motion.
- Use the definite integral to find the length of a curve in rectangular, polar or parametric form.

Fundamental Theorem of Calculus

- Use the Fundamental Theorem to evaluate definite integrals.
- Analyze functions defined by a definite integral using the Fundamental Theorem.

Techniques of Antidifferentiation

- Find anitderivatives that follow directly from the derivatitives of basic functions.
- Integrate by substitution (including change of variables).
- Integrate by parts.
- Integrate using partial fractions.
- Evaluate improper integrals as limits of definite integrals.

Applications of Antidifferentiation

- Solve differential equations with boundary conditions (including separable differential equations).
- Use differential equations to model physical systems, including particle motion and exponential growth.
- Solve the differential equations used in logistics growth problems
- Intepret differential equations geometrically using slope fields.
- Solve differential equations numerically using Euler's Method.

Numerical Approximations to Definite Integrals

- Approximate the definite integral using left, right and midpoint Riemann sums.
- Approximate the definite integral using the trapezoidal rule.

4. Polynomial Approximations and Series

- Understand a series as a sequence of partial sums.
- Understand convergence of a series in terms of the limit of the sequence of partial sums.
- Use technology to explore convergence and divergence of a series.

Series of Constants

- Recognize geometric series and apply its convergence theorem.
- Recognize harmonic series and apply its convergence theorem.
- Recognize alternating series, apply its convergence theorem and use the alternating series error bound.
- Use the integral test to test the convergence of a p-series.
- Recognize p-series and apply its convergence theorem.
- Apply the ratio test for convergence and divergence.
- Apply the comparison test for convergence and divergence.

Taylor Polynomials and Power Series

- Use Taylor Polynomials to approximate functions.
- Investigate convergence of Taylor Polynomials graphically.
- Use the Lagrange Error Bound for Taylor Polynomials.
- Represent functions using power series.
- Find the radius of convergence of a power series.
- Find the interval of convergence of a power series.
- Find Maclauren series and Taylor series for functions.
- Know the Maclauren series for certain elementary functions.
- Manipulate known power series to form new power series by substitution, differentiation and integration.

5. Graphing Calculators

The availability of a graphing calculator does not relieve the student of the need to be able to perform certain tasks analytically. Rather, it should be viewed as a tool that brings more realistic problems into reach of the student. Therefore, a portion of the AP Examination in Mathematics BC prohibits the use of calculators of any kind. On those portions of the exam that a graphing calculator is allowed, the student is required to be able to perform the following four tasks on the graphing calculator:

- Produce the graph of a function in an arbitrary viewing window.
- Find the zeros of a function.
- Evaluate the derivative of a function at a point numerically.
- Evaluate definite integrals numerically.

SALINE AREA SCHOOLS
COURSE OUTCOMES

AP PHYSICS C

The Course
AP Physics C consists of a full high school academic year of work (2 credits) that is comparable to first year physics courses taught in colleges and universities. The Physic C course ordinarily forms the first part of the college sequence that serves as the foundation in physics for students majoring in engineering or the physical sciences. The sequence is parallel to or is preceded by mathematics courses that include calculus. The subject matter of AP Physics C is principally mechanics.

Prerequisites
Before studying AP Physics, it is recommended that students complete the introductory physics course. This first year course permits the student to explore concepts in the laboratory and provides a richer experience in the process of science and better prepares them for more analytical approaches taken in the AP course. Students who have not taken an introductory physics course should have taken one of the following: Chemistry, AP Chemistry or AP Biology.

A previous or concurrent enrollment in a calculus class is also required for the study of AP Physics C. At Saline High School, either AP Calculus AB or AP Calculus BC will satisfy this requirement.

Philosophy
Advanced Placement Physics C is primarily concerned with preparing the student for the Advanced Placement Examination in Physics C (Mechanics) administered each May by the College Board by developing the students' understanding of the concepts of physics and providing experiences with its methods and applications. Strong emphasis is placed on solving a variety of challenging problems, some requiring calculus.

It is expected that **all** students who take this AP course will seek college credit, advanced placement, or both, from institutions of higher learning by sitting for and passing the Advanced Placement Examination. Students who are not interested in seeking college credit should elect the one semester introductory physics course.

Objectives
In this course, basic knowledge of the discipline of physics is emphasized, including its theories, techniques and generalizing principles. The students ability to ask physical questions and obtain solutions to physical questions using intuition, experimentation and formal logic is developed through a variety of problem solving opportunities. The overall goal is to foster students' appreciation, curiosity, creativity and reasoned skepticism of the physical world and the way it works.

1. Students should be able to read, understand and interpret physical information presented in verbal, mathematical and graphical form.

2. Students should be able to describe and explain the sequence of steps in the analysis of a particular physical phenomenon or problem, including:
   - Describe the idealized model to be used in the analysis, including simplifying assumptions where necessary.
   - State the principles or definitions that are applicable.
   - Specify relevant limitations on applications of these principles.
   - Carry out and describe the steps of the analysis, verbally or mathematically.
   - Interpret the results or conclusions, including discussion of the particular cases of special interest.

3. Students should be able to basic mathematical reasoning – arithemtic, algebraic, geometric, trigonometric or calculus, where appropriate – in a physical situation or problem.

4. Students should be able to perform experiements and interpret the results of observations, including making an assessment of experimental uncertainties.

Topical Outline
The outline of topics is intended to indicate the scope of the course, but it is not necessarily the order in which topics are taught. Although the Advanced Placement Examination in Physics C is based on the topics listed in this topical outline, teachers may enrich the course with additional topics.

1. **Kinematics**
   - Analyze vectors using vector algebra and vector components.
   - Solve motion problems in one dimension.
   - Solve motion problems in two dimensions, including projectile motion and circular motion.

2. **Newton's Laws of Motion**
   - Draw and analyze Free Body Diagrams.
   - Apply Newton's First Law to solve static equilibrium problems.
   - Apply Newton's Second Law to solve dynamics problems of a single particle.
   - Apply Newton's Third Law to solve systems of two or more bodies.
   - Analyze systems involving static and kinetic friction.

3. **Work, Energy and Power**
   - Apply the Work-Energy Theorem.
   - Define and compute power, potential energy and kinetic energy.
   - Apply the concept of conservation of energy.

4. **Systems of Particles and Linear Momentum**
   - Compute the center of mass of a discrete system.
   - Apply the Impulse-Momentum Theorem.
   - Apply conservation of linear momentum in one and two dimensions.
   - Analyze elastic, inelastic and completely inelastic collisions.

5. **Rotation**
   - Compute torques and solve rigid body equilibrium problems.
   - Solve rotational kinematics problems.
   - Define and compute moments of inertia.
   - Solve Rotational dynamics problems.
   - Define angular momentum and apply the law of Conservation of Angular Momentum.

6. **Oscillations**
   - Analyze mass-spring systems oscillating in simple harmonic motion.
   - Analyze the dynamics of a simple pendulum.

7. **Gravitation**
   - Apply Newton's Universal Law of Gravitation.
   - Analyze circular orbits.
   - Analyze general orbits using Keplar's Laws of Planetary Motion.