El Monte Union High School District
Course Outline

Course Title: Calculus BC AP

Department: Math

Grade level: 11 or 12 or passed Calculus AB AP

Length of course:
Semester ( ) Year (x)

This course meets one of the following requirements for graduation:

	Requirement	Department Approval:	Date
( )	English	___________________	_______
( )	Science	___________________	_______
( )	Social Science	___________________	_______
( )	Fine Arts	___________________	_______
(x)	Math	___________________	_______
( )	Health & Safety	___________________	_______
( )	Physical Education	___________________	_______
( )	Foreign Lanuage	___________________	_______

1- Prerequisite: Passed Calculus AB AP Exam or teacher's recommendation

2- a. Course Description:

- Calculus BC is a full-year course in the calculus of functions of a single variable. It includes all topics covered in Calculus AB plus additional topics described in the College Board course description. (Extracted from Page 5: AP Calculus Curriculum Framework)
- Topics covered include functions and graphs, limits and continuity, derivatives and applications, definite integrals and applications, anti-differentiation and Euler's Method, differential equations and slope fields, mathematical modeling, L'Hôpital's Rule, improper integrals, partial fractions, infinite series including power series and Taylor series, parametric, vector, and polar functions.

b. Goals of the Course:

- 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. (Extracted from Page 6: AP Calculus Curriculum Framework)
- This course utilizes technology through the use of graphing calculators. Critical thinking skills and problem solving skills are applied to both symbolic manipulation and real world situations. Because of the rigorous content and amount of work required to pass the course, students have to take responsibility for their time management in order to have assignments completed on time.
- Students are prepared to pass the Calculus BC AP Exam and thereby are permitted to enter college in the third semester of Calculus.

3- Material of Instruction

a. Text

- Title: Calculus, A Complete Course (Third Edition, 2007)
- Authors: Ross L. Finney, Franklin D. Demana, Bert K. Waits, and Daniel Kennedy
- Publisher: Pearson Custom Publishing

b. Supplemental Materials and Resources

- Multiple-Choice & Free-Response Questions in Preparation for the AP Calculus BC Examination, eighth Edition, David Lederman, D & S Marketing Systems, Inc.
- Released AP Multiple-Choice Questions Collection 1997, 1998, 2003, 2008, 2012, 2013,
- Released AP Free Response Questions Collection 1998-2017, College Board

c. Tools, Equipment, Technology

- Graphing calculator TI-89

4- Course Objectives

By the end of this course, the students will know the concepts necessary for the standard calculus sequence (second course in calculus series) including functions and graphs, limits and continuity, derivatives and applications, definite integrals and applications, anti-differentiation and Euler's Method, differential equations and slope fields, mathematical modeling, L'Hôpital's Rule, improper integrals, partial fractions, infinite series including power series and Taylor series, parametric, vector, and polar functions.

5- Standards (the College Board has grouped the concepts of calculus into four big ideas)

a. Big Idea 1: Limits

Enduring Understandings (Students will understand that . . .)	Learning Objectives (Students will be able to . . .)	Essential Knowledge (Students will know that . . .)
EU 1.1: The concept of a limit can be used to understand the behavior of functions.	**LO 1.1A(a):** Express limits symbolically using correct notation. **LO 1.1A(b):** Interpret limits expressed symbolically.	**EK 1.1A1:** Given a function f, the limit of $f(x)$ as x approaches c is a real number R if $f(x)$ can be made arbitrarily close to R by taking x sufficiently close to c (but not equal to c). If the limit exists and is a real number, then the common notation is $\lim_{x \to c} f(x) = R$.
		EXCLUSION STATEMENT (EK 1.1A1): *The epsilon-delta definition of a limit is not assessed on the AP Calculus AB or BC Exam. However, teachers may include this topic in the course if time permits.*
		EK 1.1A2: The concept of a limit can be extended to include one-sided limits, limits at infinity, and infinite limits.
		EK 1.1A3: A limit might not exist for some functions at particular values of x. Some ways that the limit might not exist are if the function is unbounded, if the function is oscillating near this value, or if the limit from the left does not equal the limit from the right.
		EXAMPLES OF LIMITS THAT DO NOT EXIST: $\lim_{x \to 0} \frac{1}{x^2} = \infty$; $\lim_{x \to 0} \sin\left(\frac{1}{x}\right)$ *does not exist*; $\lim_{x \to 0} \frac{\lvert x \rvert}{x}$ *does not exist*; $\lim_{x \to 0} \frac{1}{x}$ *does not exist*
	LO 1.1B: Estimate limits of functions.	**EK 1.1B1:** Numerical and graphical information can be used to estimate limits.

b. Big Idea 2: Derivatives

Enduring Understandings (Students will understand that . . .)	Learning Objectives (Students will be able to . . .)	Essential Knowledge (Students will know that . . .)
EU 2.1: The derivative of a function is defined as the limit of a difference quotient and can be determined using a variety of strategies.	**LO 2.1A**: Identify the derivative of a function as the limit of a difference quotient.	**EK 2.1A1**: The difference quotients $\frac{f(a+h)-f(a)}{h}$ and $\frac{f(x)-f(a)}{x-a}$ express the average rate of change of a function over an interval.
		EK 2.1A2: The instantaneous rate of change of a function at a point can be expressed by $\lim_{h\to 0}\frac{f(a+h)-f(a)}{h}$ or $\lim_{x\to a}\frac{f(x)-f(a)}{x-a}$, provided that the limit exists. These are common forms of the definition of the derivative and are denoted $f'(a)$.
		EK 2.1A3: The derivative of f is the function whose value at x is $\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$ provided this limit exists.
		EK 2.1A4: For $y=f(x)$, notations for the derivative include $\frac{dy}{dx}$, $f'(x)$, and y'.
		EK 2.1A5: The derivative can be represented graphically, numerically, analytically, and verbally.
	LO 2.1B: Estimate derivatives.	**EK 2.1B1**: The derivative at a point can be estimated from information given in tables or graphs.

c. Big Idea 3: Integrals and the Fundamental Theorem of Calculus

Enduring Understandings (Students will understand that . . .)	Learning Objectives (Students will be able to . . .)	Essential Knowledge (Students will know that . . .)
EU 3.1: Antidifferentiation is the inverse process of differentiation.	**LO 3.1A:** Recognize antiderivatives of basic functions.	**EK 3.1A1:** An antiderivative of a function f is a function g whose derivative is f.
		EK 3.1A2: Differentiation rules provide the foundation for finding antiderivatives.
EU 3.2: The definite integral of a function over an interval is the limit of a Riemann sum over that interval and can be calculated using a variety of strategies.	**LO 3.2A(a):** Interpret the definite integral as the limit of a Riemann sum. **LO 3.2A(b):** Express the limit of a Riemann sum in integral notation.	**EK 3.2A1:** A Riemann sum, which requires a partition of an interval I, is the sum of products, each of which is the value of the function at a point in a subinterval multiplied by the length of that subinterval of the partition.
		EK 3.2A2: The definite integral of a continuous function f over the interval $[a, b]$, denoted by $\int_a^b f(x)dx$, is the limit of Riemann sums as the widths of the subintervals approach 0. That is, $\int_a^b f(x)dx = \lim_{\max \Delta x_i \to 0} \sum_{i=1}^{n} f\left(x_i^*\right)\Delta x_i$ where x_i^* is a value in the ith subinterval, Δx_i is the width of the ith subinterval, n is the number of subintervals, and $\max \Delta x_i$ is the width of the largest subinterval. Another form of the definition is $\int_a^b f(x)dx = \lim_{n \to \infty} \sum_{i=1}^{n} f\left(x_i^*\right)\Delta x_i$, where $\Delta x_i = \frac{b-a}{n}$ and x_i^* is a value in the ith subinterval.
		EK 3.2A3: The information in a definite integral can be translated into the limit of a related Riemann sum, and the limit of a Riemann sum can be written as a definite integral.

d. Big Idea 4: Series

Enduring Understandings (Students will understand that . . .)	Learning Objectives (Students will be able to . . .)	Essential Knowledge (Students will know that . . .)
EU 4.1: The sum of an infinite number of real numbers may converge.	**LO 4.1A:** Determine whether a series converges or diverges.	**EK 4.1A1:** The *n*th partial sum is defined as the sum of the first *n* terms of a sequence.
		EK 4.1A2: An infinite series of numbers converges to a real number S (or has sum S), if and only if the limit of its sequence of partial sums exists and equals S.
		EK 4.1A3: Common series of numbers include geometric series, the harmonic series, and *p*-series.
		EK 4.1A4: A series may be absolutely convergent, conditionally convergent, or divergent.
		EK 4.1A5: If a series converges absolutely, then it converges.
		EK 4.1A6: In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the *n*th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test.
		EXCLUSION STATEMENT (EK 4.1A6): *Other methods for determining convergence or divergence of a series of numbers are not assessed on the AP Calculus AB or BC Exam. However, teachers may include these topics in the course if time permits.*

6- Units of Study:

a. Big Idea 1: Limits

2. **Limits and Continuity** **(California Standards 1.0, 2.0, 3.0)**
   - 2.1 Rates of Change and Limits
   - 2.2 Limits Involving Infinity
   - 2.3 Continuity
   - 2.4 Rates of Change and Tangent Lines

b. Big Idea 2: Derivatives

3. **Derivatives** **(California Standards 4.0, 5.0, 6.0, 7.0)**
   - 3.1 Derivative of a Function
   - 3.2 Differentiability
   - 3.3 Rules for Differentiation
   - 3.4 Velocity and Other Rates of Change
   - 3.5 Derivatives of Trigonometric Functions
   - 3.6 Chain Rule
   - 3.7 Implicit Differentiation
   - 3.8 Derivatives of Inverse Trigonometric Functions
   - 3.9 Derivatives of Exponential and Logarithmic Functions

4. **Applications of Derivatives** **(California Standards 8.0, 9.0, 10.0, 11.0, 12.0)**
   - 4.1 Extreme Values of Functions
   - 4.2 Mean Value Theorem
   - 4.3 Connecting f' with f'' with the Graph of f
   - 4.4 Modeling and Optimization
   - 4.5 Linearization
   - 4.6 Related Rates

c. Big Idea 3: Integrals and the Fundamental Theorem of Calculus

5. **The Definite Integral** **(California Standards 13.0, 15.0)**
   - 5.1 Estimating with Finite Sums
   - 5.2 Definite Integrals
   - 5.3 Definite Integrals and Antiderivatives
   - 5.4 Fundamental Theorem of Calculus
   - 5.5 Trapezoidal Rule

6. **Differential Equations and Mathematical Modeling** **(California Standard 17.0, 18.0, 19.0, 20.0, 21.0, 27.0)**

   - 6.1 Antiderivatives and Slope Fields & Euler' Method
   - 6.2 Antiderivatives by Substitution
   - 6.3 Antiderivatives and by Parts
   - 6.4 Exponential Growth and Decay
   - 6.5 Population Growth

7. **Applications of Definite Integrals** **(California Standards 14.0, 16.0)**

7.1 Integral as Net Change
7.2 Areas in the Plane
7.3 Volumes
7.4 Lengths of Curves

8. **Sequences, L'Hôpital's Rule, Improper Integrals** **(California Standards 19.0, 22.0)**

8.1 L'Hôpital's Rule
8.2 Relative Rates of Growth
8.3 Improper Integrals
8.4 Partial Fractions and Integral Tables

10 **Parametric, Vector, and Polar Functions** **(This is not a California Standard, but it is included to comply with the College Board Standard for Calculus BC AP)**

10.1 Parametric Functions
10.2 Vectors in the Plane
10.3 Polar Functions

d. Big Idea 4: Series

8. **Sequences, L'Hôpital's Rule, Improper Integrals**

8.1 L'Hôpital's Rule

9. **Infinite Series** **(California Standards 23.0, 24.0, 25.0, 26.0, 27.0)**

9.1 Power Series
9.2 Taylor Series
9.3 Taylor's Theorem
9.4 Radius of Convergence
9.5 Testing Convergence at Endpoints

7- Activities:

- Lecture
- Discussion
- Exploration with Graphing calculator
- Students will have daily assignments. They will be assessed using daily quizzes and weekly tests as well as the final exams.

8- Time:

Ch1-Ch5: Review
Ch6: (Week 1-4)
Ch7: (Week 5-8)
Ch8: (Week 9-10)
Ch9: (Week 11-19)
Ch10: (Week 20-23)
AP Exam Preparation (Week 24-34)
AP Exam (Week 35-36)
After AP Exam (Week 37-38)

9- Minimal Attainment to pass:

10% Homework
30% Quizzes
60% Tests

Students must attain a minimum of 60% on all assignments and tests to pass the course.