Unit 2: Differentiation – Definition and Fundamental Properties

DAY	LESSON & OBJECTIVES	ASSIGNMENTS
1	**2.1 Rates of Change and the Tangent Line Problem** • Interpret rates of change over an interval or at a single point by graphical and numerical methods • Write equations of tangent lines and normal lines	
2	**2.2 Tangent Lines and the Derivative** • Use limit definition of the derivative, proper notation to find the general form of a derivative • Analyze function behavior using the derivative	
3	**2.3 Understanding the Derivative and Linear Approximations** • Explore the concept of local linearity • Use the tangent line to investigate function behavior • Estimate derivatives graphically and from tables	
4		
5	**2.4 Differentiability and Continuity** • Understand the relationship between differentiability and continuity	
6		
7	**AP STYLE QUIZ**	
8	**2.5 Basic Differentiation Rules** • Find derivatives using basic rules of differentiation for polynomial, power, sine, cosine, tangent, exponential and logarithmic functions	
9		
10	**2.6 Product and Quotient Rules** • Apply the product and quotient rules algebraically for polynomial, power, sine, cosine, tangent, exponential and logarithmic functions	
11		
12	**2.7 Velocity and Other Rates of Change** • Solve basic rectilinear motion problems involving position, speed, velocity and acceleration • Interpret the effect of a one-unit change	
13		
14	**AP STYLE TEST #2**	
15		

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MATHEMATICAL PRACTICES		
TOPICS	**PRACTICE**	**SKILL**
2.1	Connecting Representations	**2.B:** Identify mathematical information from graphical, symbolic, numerical, and/or verbal representations.
2.3; 2.5; 2.6; 2.7; 2.8; 2.9	Implementing Mathematical Processes	**1.E:** Apply appropriate mathematical rules or procedures, with and without technology.
2.2; 2.10	Connecting Representations	**1.D:** Identify an appropriate mathematical rule or procedure based on the relationship between concepts (*e.g., rate of change and accumulation*) or processes (*e.g., differentiation and its invere process, anti-differentiation*) to solve problems.
2.2	Communication and Notation	**4.C:** Use appropriate mathematical symbols and notation (e.g., Represent a derivative using $f'(x), y'$, and $\frac{dy}{dx}$)
2.4	Justification	**3.E:** Provide reasons or rationales for solutions or conclusions.

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TOPIC	Lesson Topic	Learning Objectives	Essential Knowledge	Mathematical Practices
2.1	Defining Average and Instantaneous Rates of Change at a Point	CHA-2.A CHA-2.B	CHA-2.A.1 CHA-2.B.1	2.B
2.2	Defining the Derivative of a Function and Using Derivative Notation	CHA-2.B CHA-2.C	CHA-2.B.2 CHA-2.B.3 CHA-2.B.4 CHA-2.C.1	1.D 4.C
2.3	Estimating Derivatives of a Function at a Point	CHA-2.D	CHA-2.D.1 CHA-2.D.2	1.E
2.4	Connecting Differentiability and Continuity: Determining When Derivatives Do and Do Not Exist	FUN-2.A	FUN-2.A.1 FUN-2.A.2	3.E
2.5	Applying the Power Rule	FUN-3.A	FUN-3.A.1	1.E
2.6	Derivative Rules: Constant, Sum, Difference, and Constant Multiple	FUN-3.A	FUN-3.A.2 FUN-3.A.3	1.E
2.7	Derivatives of cos x, sin x, e^x, and ln x	FUN-3.A LIM-3.A	FUN-3.A.4 LIM-3.A.1	1.E
2.8	The Product Rule	FUN-3.B	FUN-3.B.1	1.E
2.9	The Quotient Rule	FUN-3.B	FUN-3.B.2	1.E
2.10	Finding the Derivatives of Tangent, Cotangent, Secant, and/or Cosecant Functions	FUN-3.B	FUN-3.B.3	1.D

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	AB	BC
AP EXAM WEIGHTING	**10% - 12%**	**4% - 7%**
PACING GUIDE	**13 - 14 days**	**9 - 10 days**
Topic 2.1	**Defining Average and Instantaneous Rates of Change at a Point**	
Enduring Understanding	**CHA-2:** Derivatives allow us to determine rates of change at an instant by applying limits to knowledge about rates of change over intervals.	
Learning Objective	**Essential Knowledge**	
CHA-2.A: Determine average rates of change using difference quotients. **CHA-2.B:** Represent the derivative of a function as the limit of a difference quotient.	**CHA-2.A.1:** 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. **CHA-2.B.1:** The instantaneous rate of change of a function at $x = a$ 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 the limit exists. These are equivalent forms of the definition of the derivative and are denoted $f'(a)$.	
Topic 2.2	**Defining the Derivative of a Function and Using Derivative Notation**	
Enduring Understanding	**CHA-2:** Derivatives allow us to determine rates of change at an instant by applying limits to knowledge about rates of change over intervals.	
Learning Objective	**Essential Knowledge**	
CHA-2.B: Represent the derivative of a function as the limit of a difference quotient. **CHA-2.C:** Determine the equation of a line tangent to a curve at a given point.	**CHA-2.B.2:** 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. **CHA-2.B.3:** For $y = f(x)$, notations for the derivative include $\frac{dy}{dx}$, $f'(x)$, and y'. **CHA-2.B.4:** The derivative can be represented graphically, numerically, analytically, and verbally.	

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Topic 2.3	Estimating Derivatives of a Function at a Point
Enduring Understanding	**CHA-2:** Derivatives allow us to determine rates of change at an instant by applying limits to knowledge about rates of change over intervals.
Learning Objective	**Essential Knowledge**
CHA-2.D: Estimate derivatives.	**CHA-2.D.1:** The derivative at a point can be estimated from information given in tables or graphs. **CHA-2.D.2:** Technology can be used to calculate or estimate the value of a derivative of a function at a point.
Topic 2.4	**Connecting Differentiability and Continuity: Determining When Derivatives Do and Do Not Exist**
Enduring Understanding	**FUN-2:** Recognizing that a function's derivative may also be a function allows us to develop knowledge about the related behaviors of both.
Learning Objective	**Essential Knowledge**
FUN-2.A: Explain the relationship between differentiability and continuity.	**LIM-2.A.1:** If a function is differentiable at a point, then it is continuous at that point. In particular, if a point is not in the domain of f, then it is not in the domain of f'. **LIM-2.A.2:** A continuous function may fail to be differentiable at a point in its domain.
Topic 2.5	**Applying the Power Rule**
Enduring Understanding	**FUN-3:** Recognizing opportunities to apply derivative rules can simplify differentiation.
Learning Objective	**Essential Knowledge**
FUN-3.A: Calculate derivatives of familiar functions.	**FUN-3.A.1:** Direct application of the definition of the derivative and specific rules can be used to calculate the derivate for functions of the form $f(x) = x^r$.

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Topic 2.6	Derivative Rules: Constant, Sum, Difference, and Constant Multiple
Enduring Understanding	**FUN-3:** Recognizing opportunities to apply derivative rules can simplify differentiation.
Learning Objective	**Essential Knowledge**
FUN-3.A: Calculate derivatives of familiar functions.	**FUN-3.A.2:** Sums, differences, and constant multiples of functions can be differentiated using derivative rules. **FUN-3.A.3:** The power rule combined with sum, difference, and constant multiple properties can be used to find the derivative for polynomial functions.
Topic 2.7	**Derivatives of cos x, sin x, e^x, and ln x**
Enduring Understanding	**FUN-3:** Recognizing opportunities to apply derivative rules can simplify differentiation.
Learning Objective	**Essential Knowledge**
FUN-3.A: Calculate derivatives of familiar functions.	**FUN-3.A.4:** Specific rules can be used to find the derivatives for sine, cosine, exponential, and logarithmic functions.
Enduring Understanding	**LIM-3:** Reasoning with definitions, theorems, and properties can be used to determine a limit.
LIM-3.A: Interpret a limit as a definition of a derivative.	**LIM-3.A.1:** In some cases, recognizing an expression for the definition of the derivative of a function whose derivative is known offers a strategy for determining a limit.

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Topic 2.8	The Product Rule
Enduring Understanding	**FUN-3:** Recognizing opportunities to apply derivative rules can simplify differentiation.
Learning Objective	**Essential Knowledge**
FUN-3.B: Calculate derivatives of products and quotients of differentiable functions.	**FUN-3.B.1:** Derivatives of products of differentiable functions can be found using the product rule.
Topic 2.9	**The Quotient Rule**
Enduring Understanding	**FUN-3:** Recognizing opportunities to apply derivative rules can simplify differentiation.
Learning Objective	**Essential Knowledge**
FUN-3.B: Calculate derivatives of products and quotients of differentiable functions.	**FUN-3.B.2:** Derivatives of quotients of differentiable functions can be found using the quotient rule.
Topic 2.10	**Finding the Derivatives of Tangent, Cotangent, Secant, and/or Cosecant Functions**
Enduring Understanding	**FUN-3:** Recognizing opportunities to apply derivative rules can simplify differentiation.
Learning Objective	**Essential Knowledge**
FUN-3.B: Calculate derivatives of products and quotients of differentiable functions.	**FUN-3.B.3:** Rearranging tangent, cotangent, secant, and cosecant functions using identities allows differentiation using derivative rules.