A Comparison of Expectations in OAC Calculus and Grade 12 Advanced Functions and Introductory Calculus

Items related to expected use of graphing technology appear in bold italics.

Content Area	OAC Calculus	Advanced Functions and Introductory Calculus
Investigating the Graphs of Polynomial Functions	NOT IN THE COURSE (Part of the MAT4A1 course)	• ***determine, through investigation, using graphing calculators or graphing software, various properties of the graphs of polynomial*** • describe the nature of change in polynomial functions of degree greater than two, using finite differences in tables of values; • compare the nature of change observed in polynomial functions of higher degree with that observed in linear and quadratic functions; • sketch the graph of a polynomial function whose equation is given in factored form; • determine an equation to represent a given graph of a polynomial function, using methods appropriate to the situation (e.g., using the zeros of the function; ***using a trial-and-error process on a graphing calculator or graphing software***; using finite differences).
Manipulating Algebraic Expressions	NOT IN THE COURSE (Part of the MAT4A1 course)	• demonstrate an understanding of the remainder theorem and the factor theorem; • factor polynomial expressions of degree greater than two, using the factor theorem; • determine, by factoring, the real or complex roots of polynomial equations of degree greater than two; • ***determine the real roots of non-factorable polynomial equations by interpreting the graphs of the corresponding functions, using graphing calculators or graphing software;*** • write the equation of a family of polynomial functions, given the real or complex zeros [e.g., a polynomial function having non-repeated zeros 5, –3, and –2 will be defined by the equation $f(x) = k(x - 5)(x + 3)(x + 2)$, for $k \in$ R]; • describe intervals and distances, using absolute-value notation; • solve factorable polynomial inequalities; • ***solve non-factorable polynomial inequalities by graphing the corresponding functions, using graphing calculators or graphing software and identifying intervals above and below the x-axis;*** • solve problems involving the abstract extensions of algorithms

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Understanding the Nature of Exponential Growth and Decay	NOT IN THE COURSE (Part of the MAT4A1 course)	• ***identify, through investigations, using graphing calculators or graphing software, the key properties of exponential functions of the form a^x ($a > 0$, $a \neq 1$) and their graphs*** • describe the graphical implications of changes in the parameters *a*, *b*, and *c* in the equation $y = ca^x + b$; • compare the rates of change of the graphs of exponential and non-exponential functions (e.g., those with equations $y = 2x$, $y = x^2$, $y = x^{½}$ and $y = 2^x$); • describe the significance of exponential growth or decay within the context of applications represented by various mathematical models (e.g., tables of values, graphs); • pose and solve problems related to models of exponential functions drawn from a variety of applications, and communicate the solutions with clarity and justification.
Defining and Applying Logarithmic Functions	NOT IN THE COURSE (Part of the MAT4A1 course)	• define the logarithmic function $\log_a x$ ($a > 1$) as the inverse of the exponential function a^x, and compare the properties of the two functions; • express logarithmic equations in exponential form, and vice versa; • simplify and evaluate expressions containing logarithms; • solve exponential and logarithmic equations, using the laws of logarithms; • solve simple problems involving logarithmic scales (e.g., the Richter scale, the pH scale, the decibel scale).
Understanding the Composition of Functions	NOT IN THE COURSE (Part of the MAT4A1 course)	• identify composition as an operation in which two functions are applied in succession; • demonstrate an understanding that the composition of two functions exists only when the range of the first function overlaps the domain of the second; • determine the composition of two functions expressed in function notation; • decompose a given composite function into its constituent parts; • describe the effect of the composition of inverse functions [i.e., $f(f^{-1}(x)) = x$].

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Understanding Rates of Change	Similar content as the new course.	• pose problems and formulate hypotheses regarding rates of change within applications drawn from the natural and social sciences; • calculate and interpret average rates of change from various models (e.g., equations, tables of values, graphs) of functions drawn from the natural and social sciences; • estimate and interpret instantaneous rates of change from various models (e.g., equations, tables of values, graphs) of functions drawn from the natural and social sciences; • explain the difference between average and instantaneous rates of change within applications and in general; • make inferences from models of applications and compare the inferences with the original hypotheses regarding rates of change.
Understanding the Graphical Definition of the Derivative	Similar content as the new course.	• demonstrate an understanding that the slope of a secant on a curve represents the average rate of change of the function over an interval, and that the slope of the tangent to a curve at a point represents the instantaneous rate of change of the function at that point; • demonstrate an understanding that the slope of the tangent to a curve at a point is the limiting value of the slopes of a sequence of secants; • demonstrate an understanding that the instantaneous rate of change of a function at a point is the limiting value of a sequence of average rates of change; • demonstrate an understanding that the derivative of a function at a point is the instantaneous rate of change or the slope of the tangent to the graph of the function at that point.
Connecting Derivatives and Their Graphs	Similar content as the new course.	• describe the key features of a given graph of a function, including intervals of increase and decrease, critical points, points of inflection, and intervals of concavity; • identify the nature of the rate of change of a given function, and the rate of change of the rate of change, as they relate to the key features of the graph of that function; • sketch, by hand, the graph of the derivative of a given graph.

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Understanding The First Principles Definition of the Derivative	Similar content as the new course with the following exceptions: • derivatives developed from first principles also included more complex functions • more time devoted to the development and use of the properties of limits	• determine the limit of a polynomial, a rational, or an exponential function; • demonstrate an understanding that limits can give information about some behaviours of graphs of functions [e.g., $\lim_{x \to 5} \frac{x^2-25}{x-5}$ predicts a hole at (5, 10)]; • identify examples of discontinuous functions and the types of discontinuities they illustrate; • determine the derivatives of polynomial and simple rational functions from first principles, using the definitions of the derivative function, $f(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$ and $f(a) = \lim_{x \to a} \frac{f(x) - f(a)}{x - a}$; • identify examples of functions that are not differentiable.
Determining Derivatives	Similar content as the new course with the following exceptions: • proof of all the differentiation rules also stressed • higher order derivatives (third, fouth,…) also stressed	• justify the constant, power, sum-and-difference, product, quotient, and chain rules for determining derivatives; • determine the derivatives of polynomial and rational functions, using the constant, power, sum-and-difference, product, quotient, and chain rules for determining derivatives; • determine second derivatives; • determine derivatives, using implicit differentiation in simple cases (e.g., $4x^2 + 9y^2 = 36$).
Determining the Derivatives of Exponential and Logarithmic Functions	Similar content as the new course	• identify e as $\lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$ and approximate the limit, using informal methods; • define ln x as the inverse function of e^x; • determine the derivatives of the exponential functions a^x and e^x and the logarithmic functions $\log_a x$ and ln x; • determine the derivatives of combinations of the basic polynomial, rational, exponential, and logarithmic functions, using the rules for sums, differences, products, quotients, and compositions of functions.

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Using Differential Calculus to Solve Problems	Similar content as the new course	• determine the equation of the tangent to the graph of a polynomial, a rational, an exponential, or a logarithmic function, or of a conic; • solve problems of rates of change drawn from a variety of applications (including distance, velocity, and acceleration) involving polynomial, rational, exponential, or logarithmic functions; • solve optimization problems involving polynomial and rational functions; • solve related-rates problems involving polynomial and rational functions.
Sketching the Graphs of Functions	Similar content as the new course with the following exception • approximating solutions to equations f(x) = 0 by Newton's Method also stressed	• determine, from the equation of a rational function, the intercepts and the positions of the vertical and the horizontal or oblique asymptotes to the graph of the function; • determine, from the equation of a polynomial, a rational, or an exponential function, the key features of the graph of the function, using the techniques of differential calculus, and sketch the graph by hand; • determine, from the equation of a simple combination of polynomial, rational, or exponential functions (e.g., $f(x) = \frac{e^x}{x}$), the key features of the graph of the combination of functions, using the techniques of differential calculus, and sketch the graph by hand; • sketch the graphs of the first and second derivative functions, given the graph of the original function; • sketch the graph of a function, given the graph of its derivative function.
Using Calculus Techniques to Analyse Models of Functions	Less emphasis on the use of modeling. More emphasis on function analysis in non-contextual situations	• determine the key features of a mathematical model of an application drawn from the natural or social sciences, using the techniques of differential calculus; • compare the key features of a mathematical model with the features of the application it represents; • predict future behaviour within an application by extrapolating from a mathematical model of a function; • pose questions related to an application and answer them by analysing mathematical models, using the techniques of differential calculus; • communicate findings clearly and concisely, using an effective integration of essay and mathematical forms.

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Trigonometry, Trigonometric Functions and Differential Calculus	• related and co-related angles • addition and subtraction formulas • double angle formulas • trigonometric identities • solving trigonometric equations • trigonometric limits • trigonometric functions and their derivatives • applications • curve sketching	NOT IN THE COURSE
Antiderivatives and Area Under a Curve	• determining antiderivatives of functions • simple differential equations • determining the area under a curve	NOT IN THE COURSE