

Department of Education and Early Childhood Development

Calculus Pathway

Pre-Calculus 110, Pre-Calculus A & B 120, and Calculus 120

2020-2021 Prioritized Curriculum

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Background and Rationale

Due to the reduced learning time presented by school closures for COVID-19 and the uncertainty of what the 2020-2021 year will bring, the Department of Education and Early Childhood Development (EECD) is releasing a prioritized curriculum for select high school courses. This document provides a list of required outcomes that will frame the learning expectations for students and offer time for effective teaching practices.

A team of New Brunswick chemistry, mathematics and physics educators – high school teachers, post-secondary instructors from New Brunswick Community College and University of New Brunswick, and Learning Specialists from EECD worked together to identify and curate a list of **Required Outcomes** for the 2020-2021 school year. Any outcomes that were not identified as being *required* were categorised as “**Remaining Outcomes**” and can be set aside for future learning.

The *Required Outcomes* outlined in this document have been identified as the best representation of instructional outcomes to engage learners and contribute to student readiness for post-secondary mathematics and science studies and/or future life pursuits.

Identification of the *Required Outcomes* is but one of the necessary elements which will support learners in the province. Teachers will also consider how to engage students in deep and meaningful ways within the framework of the new learning environments (online, blended, and/or face-to-face).

Message from our post-secondary partners

Students entering university Calculus having completed Pre-Calculus A & B 120 should have a good understanding of:

- Functions, graphs and properties.
- Straight lines in the plane, their equations and their intersections. Parallel and perpendicular lines. Concepts of length and distance; Pythagorean theorem.
- Algebra: Polynomial factoring, solutions of linear and nonlinear equations; exponentials and radicals; logarithms and properties; circle and trigonometry.
- Rates of change.
- The set of real numbers.
- Some knowledge of interval notation.

Pre-Calculus 110

The curriculum document can be accessed [here](#).

Required Outcomes	Remaining Outcomes
<p>AN1: Demonstrate an understanding of the absolute value of real numbers.</p> <p>AN2: Solve problems that involve operations on radicals and radical expressions with numerical and variable radicands.</p> <p>AN3: Solve problems that involve radical equations (limited to square roots).</p> <p>AN4: Determine equivalent forms of rational expressions (limited to numerators and denominators that are monomials, binomials or trinomials).</p> <p>AN5: Perform operations on rational expressions (limited to numerators and denominators that are monomials, binomials or trinomials).</p> <p>AN6: Solve problems that involve rational equations (limited to numerators and denominators that are monomials, binomials or trinomials).</p> <p>RF1: Factor polynomial expressions of the form: $ax^2 + bx + c$, $a \neq 0$.</p> <p>RF2: Graph and analyze absolute value functions (<u>limited to linear functions</u>) to solve problems.</p> <p>RF3: Analyze quadratic functions of the form $y = a(x - p)^2 + q$ and determine the vertex, domain and range, direction of opening, axis of symmetry, x- and y-intercepts.</p> <p>RF4: Analyze quadratic functions of the form $y = ax^2 + bx + c$ to identify characteristics of the corresponding graph, including vertex, domain and range, direction of opening, axis of symmetry, x and y-intercepts, and to solve problems.</p> <p>RF5: Solve problems that involve quadratic equations.</p>	<p>T1: Demonstrate an understanding of angles in standard position $[0^\circ \text{ to } 360^\circ]$.</p> <p>T2: Solve problems, using the three primary trigonometric ratios for angles from 0° to 360° in standard position.</p> <p>RF1: Factor polynomial expressions of the form: $a^2x^2 - b^2y^2$, $a \neq 0, b \neq 0$, $a(f(x))^2 + b(f(x)) + c$, $a \neq 0$, and $a^2(f(x))^2 - b^2(g(y))^2$, $a \neq 0, b \neq 0$.</p> <p>RF2: Graph and analyze absolute value functions (<u>quadratic functions</u>) to solve problems.</p> <p>RF6: Solve, algebraically and graphically, problems that involve systems of linear-quadratic and quadratic-quadratic equations in two variables.</p> <p>RF7: Solve problems that involve linear inequalities and quadratic inequalities in two variables.</p> <p>RF8: Solve problems that involve quadratic inequalities in one variable.</p>

Pre-Calculus A 120

The curriculum document can be accessed [here](#).

Required Outcomes	Remaining Outcomes
<p>Note: <u>RF1 to RF4</u> should be integrated as foundational knowledge when graphing and analyzing functions defined in outcomes RF6 & RF9.</p> <p>RF1: Demonstrate an understanding of the effects of horizontal and vertical translations on the graphs of functions and their related equations.</p> <p>RF2: Demonstrate an understanding of the effects of horizontal and vertical stretches on the graphs of functions and their related equations.</p> <p>RF3: Apply translations and stretches to the graphs and equations of functions.</p> <p>RF4: Demonstrate an understanding of the effects of reflections on the graphs of functions and their related equations, including reflections through the x-axis, y-axis, line $y = x$.</p> <p>RF5: Demonstrate an understanding of inverses of relations.</p> <p>RF6: Graph and analyze radical functions (limited to functions involving one radical).</p> <p>RF7: Demonstrate an understanding of exponential functions.</p> <p>RF8: Demonstrate an understanding of logarithms.</p> <p>RF9: Graph and analyze exponential and logarithmic functions.</p> <p>RF10: Demonstrate an understanding of the product, quotient and power laws of logarithms.</p> <p>T1: Demonstrate an understanding of angles in standard position, expressed in degrees and radians.</p> <p>T2: Develop and apply the equation of the unit circle.</p> <p>T3: Solve problems, using the six trigonometric ratios for angles expressed in radians and degrees.</p> <p>T4: Graph and analyze the trigonometric functions sine, cosine and tangent to solve problems.</p>	<p>Note: <u>RF1 to RF4</u> can be explored through graphing a variety of functions $y = f(x)$.</p> <p>RF11: Solve problems that involve exponential and logarithmic equations.</p> <p>T5: Solve, algebraically and graphically, first and second degree trigonometric equations with the domain expressed in degrees and radians.</p> <p>T6: Prove trigonometric identities, using reciprocal identities, quotient identities, Pythagorean identities, sum or difference identities (restricted to sine, cosine and tangent), double-angle identities (restricted to sine, cosine and tangent).</p>

Pre-Calculus B 120

The curriculum document can be accessed [here](#).

Required Outcomes	Remaining Outcomes
<p>RF3: Demonstrate an understanding of factoring polynomials of degree greater than 2 (limited to polynomials of degree ≤ 5 with integral coefficients). Note: with a focus on cubic functions.</p> <p>RF4: Graph and analyze polynomial functions (limited to polynomial functions of degree ≤ 5). Note: with a focus on cubic functions.</p> <p>RF5: Graph and analyze reciprocal functions (limited to the reciprocal of linear and quadratic functions).</p> <p>RF6: Graph and analyze rational functions (limited to numerators and denominators that are monomials, binomials or trinomials).</p> <p>RF7: Demonstrate an understanding of operations on, and compositions of, functions.</p> <p>L1: Determine the limit of a function at a point both graphically and analytically.</p> <p>L2: Explore one-sided limits graphically and analytically.</p> <p>L3: Analyze the continuity of a function.</p> <p>L4: Explore limits which involve infinity.</p>	<p>RF1: Analyze arithmetic sequences and series to solve problems.</p> <p>RF2: Analyze geometric sequences and series to solve problems.</p> <p>RF8: Assemble a function toolkit comparing various types of functions and compositions of them.</p> <p>PCB1: Apply the fundamental counting principle to solve problems.</p> <p>PCB2: Determine the number of permutations of n elements taken r at a time to solve problems.</p> <p>PCB3: Determine the number of combinations of n different elements taken r at a time to solve problems.</p> <p>PCB4: Expand powers of a binomial in a variety of ways, including using the binomial theorem (restricted to exponents that are natural numbers).</p>

Calculus 120

The curriculum document can be accessed [here](#).

Required Outcomes	Remaining Outcomes
<p>C1: Explore the concepts of average and instantaneous rate of change.</p> <p>C2: Determine the derivative of a function by applying the definition of derivative.</p> <p>C3: Apply derivative rules to determine the derivative of a function, including: Constant Rule; Power Rule; Constant Multiple Rule; Sum Rule; Difference Rule; Product Rule; Quotient Rule.</p> <p>C4: Find derivatives of trigonometric functions.</p> <p>C5: Apply the Chain Rule to determine the derivative of a function.</p> <p>C7: Find limits and derivatives of exponential and logarithmic functions.</p> <p>C8: Use calculus techniques to sketch the graph of a function.</p> <p>C9: Use calculus techniques to solve optimization problems.</p>	<p>C6: Solve problems involving inverse trigonometric functions.</p> <p>C10: Use linearization (and Newton's Method - optional) to solve problems.</p> <p>C11: Solve problems involving related rates.</p> <p>C12: Determine the definite integral of a function.</p> <p>C13: Determine the antiderivative of a function.</p> <p>C14: Solve problems that involve the application of the integral of a function from a variety of fields, including the physical and biological Sciences, economics and business.</p>