

## BIG IDEAS

The **concept of a limit** is foundational in developing calculus.

Differential calculus develops the concept of instantaneous **rate of change** of one quantity in relation to another.

Integral calculus develops the concept of finding the **sum of an infinite series**.

Derivatives and integrals have an **inverse relationship**.

## Learning Standards

Curricular Competencies	Content
<p><i>Students are expected to be able to do the following:</i></p> <p><b>Reasoning and analyzing</b></p> <ul style="list-style-type: none"> <li>• Use <b>reasoning and logic</b> to analyze and apply mathematical ideas</li> <li>• <b>Estimate</b> reasonably</li> <li>• Demonstrate <b>fluent and flexible thinking</b> of number</li> <li>• Use tools or technology to analyze relationships and test conjectures</li> <li>• <b>Model</b> mathematics in contextualized experiences</li> </ul> <p><b>Understanding and solving</b></p> <ul style="list-style-type: none"> <li>• Develop, demonstrate, and apply <b>conceptual understanding</b> of mathematical ideas</li> <li>• <b>Visualize</b> to explore and illustrate mathematical concepts and relationships</li> <li>• Apply <b>flexible strategies</b> to solve problems in both abstract and contextualized situations</li> <li>• Engage in problem-solving <b>experiences</b> that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures</li> </ul> <p><b>Communicating and representing</b></p> <ul style="list-style-type: none"> <li>• Communicate mathematical thinking in <b>many ways</b></li> <li>• Use mathematical vocabulary and language to contribute to mathematical <b>discussions</b></li> <li>• <b>Represent</b> mathematical ideas in a variety of ways</li> <li>• Explain and justify mathematical ideas</li> </ul>	<p><i>Students are expected to know the following:</i></p> <ul style="list-style-type: none"> <li>• concept of the <b>derivative</b></li> <li>• <b>limits</b></li> <li>• <b>derivatives</b></li> <li>• <b>applications</b> of derivatives</li> <li>• concept of the <b>integral</b></li> <li>• <b>integrals</b></li> <li>• applications of <b>integration</b></li> </ul>

Learning Standards (continued)

Curricular Competencies	Content
<p><b>Connecting and reflecting</b></p> <ul style="list-style-type: none"> <li>• <b>Reflect</b> on mathematical thinking</li> <li>• Use mathematics to support personal choices</li> <li>• Connect mathematical concepts to each other and to <b>other areas and personal interests</b></li> <li>• <b>Incorporate</b> First Peoples worldviews and perspectives to <b>make connections</b> to mathematical concepts</li> </ul>	

Big Ideas – Elaborations	MATHEMATICS — Calculus Grade 12
<p><b>concept of a limit:</b></p> <ul style="list-style-type: none"> <li>• Differentiation and integration are defined using limits.</li> </ul> <p><b>rate of change:</b></p> <ul style="list-style-type: none"> <li>• developing rate of change from average to instantaneous</li> </ul> <p><b>sum of an infinite series:</b></p> <ul style="list-style-type: none"> <li>• The <math>\int f(x)dx</math> is the infinite sum of infinitesimal pieces <math>f(x)dx</math> and can be related to the graph of <math>f(x)</math> and area associated with its curve.</li> </ul> <p><b>inverse relationship:</b></p> <ul style="list-style-type: none"> <li>• The fundamental theorem of calculus shows the relationship between integrals and antiderivatives.</li> </ul>	

Curricular Competencies – Elaborations

**reasoning and logic:**

- inductive and deductive reasoning
- predicting, generalizing, drawing conclusions through experiences including puzzles, games, and coding

**Estimate:**

- being able to defend the reasonableness of an estimate across mathematical contexts

**fluent and flexible thinking:**

- includes using known facts and benchmarks; partitioning; applying whole number strategies to rational numbers and algebraic expressions

**Model:**

- using concrete materials and dynamic interactive technology
- representing a situation graphically and/or symbolically

**conceptual understanding:**

- developed through playing with ideas, inquiry, and problem solving

**Visualize:**

- includes dynamic visualizations such as graphical relationships, simulations

**flexible strategies:**

- from a repertoire of strategies, choosing an appropriate strategy to solve problems (e.g., guess and check, model, solve a simpler problem, use a chart, use diagrams, role-play)

**experiences:**

- includes context, strategies and approaches, language across cultures

**many ways:**

- including oral, written, visual, use of technology

**discussions:**

- developing a mathematical community in the classroom through discourse — partner talks, small-group discussions, teacher-student conferences

**Represent:**

- concretely, pictorially, symbolically, including using models, tables, graphs, words, numbers, symbols

**Reflect:**

- sharing the mathematical thinking of self and others, including evaluating strategies and solutions, extending, posing new problems and questions

**other areas and personal interests:**

- to develop a sense of how mathematics helps us understand ourselves and the world around us (e.g., daily activities, local and traditional practices, the environment, popular media and news events, social justice, cross-curricular integration)

Curricular Competencies – Elaborations

**Incorporate:**

- Collaborate with local First Peoples Elders and knowledge keepers.

**make connections:**

- Bishop’s cultural practices: counting, measuring, locating, designing, playing, explaining ([http://www.csus.edu/indiv/o/oreyd/ACP.htm\\_files/abishop.htm](http://www.csus.edu/indiv/o/oreyd/ACP.htm_files/abishop.htm))
- [www.aboriginaleducation.ca](http://www.aboriginaleducation.ca)
- *Teaching Mathematics in a First Nations Context*, FNEC (<http://www.fnesc.ca/resources/math-first-peoples/>)

Content – Elaborations

**derivative:**

- rate of change (slope), average versus instantaneous (secant versus tangent lines)

**limits:**

- table of values, graphically, algebraically; one-sided versus two-sided; continuity

**derivatives:**

- history, definition; notation; differentiability; powers, logarithmic, exponential, trigonometric; implicit differentiation; higher-order derivatives; product; quotient and chain rules

**applications:**

- relating graph of  $f(x)$  to  $f'(x)$  and  $f''(x)$  (increasing/decreasing, concavity), Newton’s method; contextual problems, including related rates and optimization problems

**integral:**

- infinite sum, Riemann sum (rectangle approximation method, trapezoidal rule)

**integrals:**

- fundamental theorem of calculus; integrals of functions (indefinite and definite), substitution, parts

**integration:**

- area under a curve; volume of solids; differential equations (initial value problems)