Pacing Guide - Calculus 12

Every September, teachers work hard to create a space that is safe and welcoming for all learners. The first weeks are a time to establish a sense of community, engage learners in rich interactive experiences to promote critical thinking and create opportunities for collaboration and discussion. This is an opportune time to develop a culture and a climate for mathematics learning, conducive to collaboration, risk taking and inquiry.

The following is a pacing guide for Mathematics at Work 10, which provides an overview of the units. It is a reference tool to support teachers with the timing of yearlong learning. Teachers are encouraged to use their professional judgment and consider the needs of their students when planning for instruction. **For the purposes of planning your mathematics lessons, refer to the Calculus 12 curriculum document and the Calculus 12 Outcomes (2022) that provide essential background information and describe learning opportunities and assessment tasks for each of the outcomes in the unit.**

Limits and Continuity (15-20 hours)
Derivatives (30-35 hours)
Applications of Derivatives (15-20 hours)
The Definite Integral and Its Applications (25-30 hours)

Note: The student text referred to is: Calculus: Graphical, Numerical, Algebraic, 2nd Ed., Finney (1999).
MMBk4 refers to Mathematical Modeling, Book 4 from Nelson Education (2002).

Unit 1: Limits and Continuity

Timeline	GCO/SCO	Topic	Resources
February	**Limits and Continuity –** **B1** Calculate and interpret average and instantaneous rate of change. **B2** Calculate limits for function values and apply limit properties with and without technology **C1** identify the intervals upon which a given function is continuous and understanding the meaning of a continuous function **B3** Remove removable discontinuities by extending or modifying a function **B4** Apply the properties of algebraic combinations and composites of continuous functions **A1** apply, understand and explain average and instantaneous rates of change an extend these concepts to secant lines and tangent line slopes **C2** Understand the development of the slope of a tangent line from the slope of a secant line **C3** Find the equations of the tangent and normal lines at a given point	– Introduction to calculus – Course outline/formalizing norms etc.	– Develop classroom norms – An overview of the big concepts from Calculus (Limits, Derivatives and Integrals). Review prerequisites for Calculus from student text Chap 1
		Introduction to limits	**MMBk4:** Investigation #4 “Closer and Closer” p.28
		Rates of change and limits	**Curriculum Document**: pp.2-9 **Student Text:** Section 2.1
		Continuity and piecewise functions	**Curriculum Document**: pp.10-15 **Student Text:** Section 2.3
		Rates of change, secant and tangent lines	**Curriculum Document**: pp.16-23 **Student Text:** Section 2.4
		Reinforcement, consolidation and assessment	**Student Text:** Chap 2 pp.91-93
		Approx. 19 hours	

Unit 2: Derivatives

**Note: B10 and B12 (approximately 2 hours removed)
B10: Apply the rules for differentiating the six inverse trigonometry functions (optional)
B12: Apply Newton's method to approximate zeros of a function (optional)

Timeline	GCO/SCO	Topic	Resources
March -April	**Derivatives -** **A2** demonstrate an understanding of the definition of the derivative. **C4** demonstrate an understanding of the connection between the graphs of *f* and *f'*. **B5** Find where a function is not differentiable and distinguish between corners, cusps, discontinuities, and vertical tangents. **B6** Derive, apply, and explain power, sum, difference, product and quotient rules. **B7** Apply the chain rule to composite functions **B8** Use derivatives to analysis and solve problems involving rates of change. **B9** Apply the rules for differentiating the six trigonometric functions **A3** Demonstrate understanding of implicit differentiation and identify situations that require implicit differentiation **B11** Calculate and apply derivatives of exponential and logarithmic functions **B13** Estimate the change in a function using differentials and apply them to real world situations **B14** Solve and interpret related rate problems	Building a conceptual understanding of the derivative including the definition of the derivative.	**Curriculum Document**: pp.26-31 **Student Text:** Section 3.1 **MMBk4:** Investigation #7 "Instantaneous Velocity" p89 and Investigation #8 "The Derivative" p95
		Differentiability	**Curriculum Document**: pp.32-35 **Student Text:** Section 3.2
		Rules for differentiation (power, sum, difference, product and quotient)	**Curriculum Document**: pp.36-41 **Student Text:** Section 3.3
		The chain rule	**Curriculum Document**: pp.42-43 **Student Text:** Section 3.6 *Postpone chain rule exercises dealing with trig until later. (select from questions: p.146 9, 12, 15, 16, 33, 34, 35, 37, 38)*
		Implicit differentiation	**Curriculum Document**: pp.48-51 **Student Text:** Section 3.7
		Graphs of trig functions and reciprocal trig functions	**MMBk4:** Investigation #5 "Other Trigonometric Functions" p.233
		Derivatives of trig functions	**Curriculum Document**: pp.46-47 **Student Text:** Section 3.5 *Revisit chain rule questions including trig from pp.146-147*
		Determine, describe, and apply the value for "e"	**MMBk4:** Investigation #8 "Continuous Interest" p.183, Investigation #9 "Properties of $y=e^x$" p.186, Investigation #10 "The Derivative of $y=e^x$" p.187

		Derivatives of exponential and logarithmic functions	**Curriculum Document**: pp.54-55 **Student Text:** Section 3.9
		Velocity and other rates of change	**Curriculum Document**: pp.44-45 **Student Text:** Section 3.4
		Reinforcement, consolidation and assessment	**Student Text:** Chap 3 pp.172-175 **Student Text:** Chap 4 pp.242-245
		Approx. 37 hours	

Unit 3: Applications of Derivatives

Timeline	GCO/SCO	Topic	Resources
April	**Applications of Derivatives -** **B15** Demonstrate an understanding of critical points and absolute extreme values of a function **B16** Find the intervals on which a function is increasing or decreasing **C5** Apply the First and Second Derivative Tests to determine the local extreme values of a function **C6** Determine the concavity of a function and locate the points of inflection by analyzing the second derivative **B17** Solve application problems involving maximum or minimum values of a function	Critical points and absolute extreme values of functions	**Curriculum Document**: pp.66-67 **Student Text:** Section 4.1 **MMBk4:** Focus C End Behaviour and Oblique Asymptotes, Focus F Analysis of Rational Functions p.151
		Mean value theorem	**Curriculum Document**: pp.68-69 **Student Text:** Section 4.2
		Curve sketching. connecting f’ and f’’ with the graph of f	**Curriculum Document**: pp.70-73 **Student Text:** Section 4.3
		Modeling and optimization	**Curriculum Document**: pp.74-75 **Student Text:** Section 4.4 *Consider deriving the vertex formula using calculus as an introduction.*
		Related rates	**Curriculum Document**: pp.60-63 **Student Text:** Section 4.6
		Reinforcement, consolidation and assessment	**Student Text:** Chap 4 pp.242-245
		Approx. 19 hours	

Unit 4: The Definite Integral & Its Application

Timeline	GCO/SCO	Topic	Resources
May -June	**The Definite Integral & Its Applications** **D1** Apply and understand how Riemann's sum can be used to determine the area under a polynomial curve **D2** Demonstrate an understanding of the meaning of area under the curve **D3** Express the area under the curve as a definite integral **D4** Compute the area under a curve using a numerical integration procedure **C7** Solve initial value problems of the form $dy/dx = f(x)$, $y_0 = f(x_0)$ **B18** Apply rules for definite integrals **B19** Apply the Fundamental Theorem of Calculus **C8** Understand the relationship between the derivative and the definite integral as expressed in both parts of the Fundamental Theorem of Calculus **C9** Construct antiderivatives using the Fundamental Theorem of Calculus **C10** Find antiderivatives of polynomials, e^{kx}, and selected trigonometric functions of *kx* **B20** Compute indefinite and definite integrals by the method of substitution **B21** Apply integration by parts to evaluate indefinite and definite integrals **(optional)** **B22** Solve problems in which a rate is integrated to find the net change over time **D5** Apply integration to calculate areas of regions in a plane	Sigma notation	**MMBk4:** Focus B More and More Minutes p.8
		Estimating a the area under a curve with finite sums (RAM)	**Curriculum Document**: pp.78-79 **Student Text:** Section 5.1 http://www.intmath.com/integration/riemann-sums.php
		Definite integrals and Riemann sums	**Curriculum Document**: pp.80-81 **Student Text:** Section 5.2
		Definite integrals and antiderivatives	**Curriculum Document**: pp.84-85 **Student Text:** Section 5.3
		Fundamental theorem of calculus	**Curriculum Document**: pp.86-87 **Student Text:** Section 5.4
		Antiderivatives	**Curriculum Document**: pp.88-89 **Student Text:** Section 6.1 *(Omit slope fields, start on p.306)* **Student Text:** Table 6.2 p.307
		Antidifferentiation by substitution	**Curriculum Document**: pp.90-91 **Student Text:** Section 6.2
		Antidifferentiation by parts (optional)	**Curriculum Document**: pp.92-93 **Student Text:** Section 6.3
		Initial value problems	**Curriculum Document**: pp.82-83 **Student Text:** Section 6.1
		Integral as net change	**Curriculum Document**: pp.94-95 **Student Text:** Section 7.1
		Areas in the plane	**Curriculum Document**: pp.96-99 **Student Text:** Section 7.2
		Reinforcement, consolidation and assessment	**Student Text:** Chap 5 pp.298-301 **Student Text:** Chap 6 pp.358-361 **Student Text:** Chap 7 pp.413-415
		Approx. 30 hours	

Outcome D6 (below) is optional and should be addressed if additional time is available at the end of the course. Refer to the curriculum document for additional information. Additionally, topics of Complex Numbers or Polar Coordinates/Functions could be added as optional topics.

D6 *Apply integration (by slices or shells) to calculate volumes of solids* ***(optional)***