GRADE 12 APPLIED MATHEMATICS (40S)

Grade 12 Applied Mathematics (40S) is intended for students considering post-secondary studies that do not require a study of theoretical calculus. It is context-driven and promotes the learning of numerical and geometrical problem-solving techniques as they relate to the world around us.

The primary goals of Applied Mathematics are to have students develop critical-thinking skills through problem solving and through modelling real-world situations mathematically to make predictions.

These goals may be attained in a number of ways. Students may collect data in experiments and activities to develop mathematical concepts by analyzing that data. They are encouraged to learn and demonstrate effective communication skills through a variety of media. Students are expected to become proficient in both oral and written communication skills.

Applied Mathematics is designed to promote student flexibility and responsibility. Flexibility is encouraged by having students work on non-routine problems and projects. Responsibility is encouraged as students work individually and in cooperative groups to explore connections with other mathematical areas, school subjects, and real-life applications.

Technology is an integral part of both learning and assessment in Applied Mathematics. Graphing calculators, spreadsheets, or other computer software will be used by students for mathematical explorations, modelling, and problem solving.

Assessment of Grade 12 Applied Mathematics should be a balance of assessment *for* learning, assessment *as* learning, and assessment *of* learning. Assessment tools used in Grade 12 Applied Mathematics should be varied and may include observation, homework, learning conversations or interviews, summative unit essays, demonstrations, presentations, performance tasks, learning logs, projects, investigations, reflective journals, portfolios, quizzes, tests, and examinations. An appropriately prepared portfolio requires a consistent effort throughout the school term and a commitment to completing quality work on a daily basis.

The Grade 12 Applied Mathematics course includes the following topics: Financial Mathematics, Logical Reasoning, Probability, Relations and Functions, and Design and Measurement. Additionally, students will complete a Mathematics Research Project.

Learning outcomes from various topic areas may be combined in any order when considering learning activities. The suggested time includes instructional and assessment time. Two possible teaching sequences and suggested hours are presented in the following tables:

Possibility 1			Possibility 2		
Unit	Learning Outcomes	Suggested Hours	Unit	Learning Outcomes	Suggested Hours
Sinusoidal Functions	L1, R3	12	Analysis of Games and Numbers	L1	5 (integrated throughout course)
Compound Interest	L1, FM1, FM2	12	Probability	P1, P2, P3	15
Probability	L1, L2, L3, P1, P2, P3	20	Personal Finance	FM1, FM2, FM3	23
Polynomial Functions	L1, R1	12	Functions	R1, R2	20
Permutations and Combinations	L1, P4, P5, P6	12	Logic	L2, L3	7
Investments	L1, FM3	12	Permutations and Combinations	P4, P5, P6	10
Design and Measurement	L1, D1	10	Sinusoidal Functions	R3	10
Research Project	L1, RP1	10	Design and Measurement	D1	10
Exponential and Logarithmic Functions	L1, R2	10	Research Project	RP1	10
	Total	**110**		**Total**	**110**

General and Specific Learning Outcomes with Achievement Indicators by Course

Grade 12 Applied Mathematics

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Strand: Financial Mathematics	General Learning Outcome: Develop number sense in financial applications.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*
12A.FM.1. Solve problems that involve compound interest in financial decision making. [C, CN, PS, T, V]	■ Explain the advantages and disadvantages of compound interest and simple interest. ■ Identify situations involving compound interest. ■ Graph and compare the total interest paid or earned for different compounding periods. ■ Determine, given the principal, interest rate, and number of compounding periods, the total interest of a loan. ■ Graph and describe the effects of changing the value of one of the variables in a situation involving compound interest. ■ Determine, using technology, the total cost of a loan under a variety of conditions, such as different amortization periods, interest rates, and compounding periods or terms. ■ Compare and explain, using technology, different credit options involving compound interest, including bank or store credit cards or special promotions. ■ Solve a contextual problem involving compound interest.

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Strand: Financial Mathematics *(continued)*	General Learning Outcome: Develop number sense in financial applications.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*
12A.FM.2. Analyze costs and benefits of renting, leasing, and buying. [CN, PS, R, T]	■ Identify and describe examples of assets that appreciate or depreciate. ■ Compare, using examples, renting, leasing, and buying. ■ Justify, for a specific set of circumstances, whether renting, buying, or leasing would be advantageous. ■ Solve, using technology, a contextual problem involving renting, leasing, or buying . ■ Solve, using technology, a contextual problem involving cost-and-benefit analysis.
12A.FM.3. Analyze an investment portfolio in terms of ■ interest rate ■ rate of return ■ total return [ME, PS, R, T] Students should be able to solve an investment problem using tools such as debt-to-equity ratio, gross debt service ratio, or net worth.	■ Determine, using technology, the total value of an investment when there are regular contributions to the principal. ■ Graph and compare the total value of an investment with or without regular contributions. ■ Apply the Rule of 72 to solve investment problems, and explain the limitations of the rule. ■ Determine, using technology, possible investment strategies to achieve a financial goal. ■ Explain the advantages and disadvantages of long-term or short-term investment options. ■ Explain, using examples, why smaller investments over a longer term may be better than larger investments over a shorter term. ■ Determine and compare the strengths and weaknesses of two or more portfolios. ■ Solve an investment problem.

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Strand: Logical Reasoning	**General Learning Outcome:** Develop logical reasoning.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*

12A.L.1.   Analyze puzzles and games that involve numerical and logical reasoning, using problem-solving strategies.
[CN, ME, PS, R, T]

> It is intended that this learning outcome be integrated throughout the course by using games and puzzles such as chess, Sudoku, Nim, logic puzzles, magic squares, Kakuro, and cribbage.

- Determine, explain, and verify a strategy to solve a puzzle or to win a game such as
  - guess and check
  - look for a pattern
  - make a systematic list
  - draw or model
  - eliminate possibilities
  - simplify the original problem
  - work backward
  - develop alternative approaches
- Identify and correct errors in a solution to a puzzle or in a strategy for winning a game.
- Create a variation on a puzzle or a game, and describe a strategy for solving the puzzle or winning the game.

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Strand: Logical Reasoning *(continued)*	General Learning Outcome: Develop logical reasoning.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*

12A.L.2. Solve problems that involve the application of set theory. [CN, PS, R, T, V]	■ Explain how set theory is used in applications such as Internet searches, database queries, data analysis, games, and puzzles. ■ Provide examples of the empty set, disjoint sets, subsets, and universal sets in context, and explain the reasoning. ■ Organize information such as collected data and number properties, using graphic organizers, and explain the reasoning. ■ Explain what a specified region in a Venn diagram represents. ■ Determine the elements in the complement, the intersection, or the union of two sets. ■ Identify and correct errors in a solution to a problem that involves sets. ■ Solve a contextual problem that involves sets, and record the solution.
12A.L.3. Solve problems that involve conditional statements. [C, CN, PS, R, T]	■ Analyze an "if-then" statement, make a conclusion, and explain the reasoning. ■ Make and justify a decision, using "what if?" questions, in contexts such as probability, finance, sports, games, or puzzles, with or without technology. ■ Determine the converse, inverse, and contrapositive of an "if-then" statement, determine its truth, and, if it is false, provide a counter-example. ■ Demonstrate, using examples, that the truth of any statement does not imply the truth of its converse or inverse. ■ Demonstrate, using examples, that the truth of any statement does imply the truth of its contrapositive. ■ Identify and describe contexts in which a biconditional statement can be justified. ■ Analyze and summarize, using a graphic organizer such as a truth table or Venn diagram, the possible results of given logical arguments that involve biconditional, converse, inverse, or contrapositive statements.

[C] Communication	**[PS]** Problem Solving
[CN] Connections	**[R]** Reasoning
[ME] Mental Mathematics and Estimation	**[T]** Technology
	[V] Visualization

Strand: Probability	General Learning Outcome: Develop critical thinking skills related to uncertainty.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*
12A.P.1.　Interpret and assess the validity of odds and probability statements. [C, CN, ME, T]	▪ Provide examples of statements of probability and odds found in fields such as media, biology, sports, medicine, weather, sociology, or psychology. ▪ Explain, using examples, the relationship between odds (part-part) and probability (part-whole). ▪ Express odds as a probability and vice versa. ▪ Determine the probability of, or the odds for and against, an outcome in a situation. ▪ Explain, using examples, how decisions may be based on probability or odds and on subjective judgments. ▪ Solve a contextual problem that involves odds or probability.
12A.P.2.　Solve problems that involve the probability of mutually exclusive and non-mutually exclusive events. [CN, PS, R, T, V]	▪ Classify events as mutually exclusive or non-mutually exclusive, and explain the reasoning. ▪ Determine whether two events are complementary, and explain the reasoning. ▪ Represent, using set notation or graphic organizers, mutually exclusive (including complementary) and non-mutually exclusive events. ▪ Solve a contextual problem that involves the probability of mutually exclusive or non-mutually exclusive events. ▪ Solve a contextual problem that involves the probability of complementary events. ▪ Create and solve a problem that involves mutually exclusive or non-mutually exclusive events.

[C] Communication	**[PS]** Problem Solving
[CN] Connections	**[R]** Reasoning
[ME] Mental Mathematics and Estimation	**[T]** Technology
	[V] Visualization

Strand: Probability *(continued)*	**General Learning Outcome:** Develop critical thinking skills related to uncertainty.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*
12A.P.3. Solve problems that involve the probability of independent and dependent events. [CN, PS, R, T]	■ Compare, using examples, dependent and independent events. ■ Determine the probability of an event, given the occurrence of a previous event. ■ Determine the probability of two dependent or two independent events. ■ Create and solve a contextual problem that involves determining the probability of dependent or independent events.
12A.P.4. Solve problems that involve the fundamental counting principle. [PS, R, T, V]	■ Represent and solve counting problems, using a graphic organizer. ■ Generalize, from examples, the fundamental counting principle. ■ Identify and explain assumptions made in solving a counting problem. ■ Solve a contextual counting problem, using the fundamental counting principle, and explain the reasoning.
12A.P.5. Solve problems that involve permutations. [ME, PS, R, T, V] Students should be able to use strategies such as cases or grouping objects together to solve a contextual problem. Also, it is intended that circular permutations not be included.	■ Represent the number of arrangements of n elements taken n at a time, using factorial notation. ■ Determine the value of a factorial. ■ Simplify a numeric fraction containing factorials in both the numerator and denominator. ■ Determine the number of permutations of n elements taken r at a time. ■ Determine the number of permutations of n elements taken n at a time where some elements are not distinct. ■ Explain, using examples, the effect on the total number of permutations of n elements when two or more elements are identical. ■ Generalize strategies for determining the number of permutations of n elements taken r at a time. ■ Solve a contextual problem that involves probability and permutations.

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Strand: Probability *(continued)*	**General Learning Outcome:** Develop critical thinking skills related to uncertainty.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*
12A.P.6. Solve problems that involve combinations. [ME, PS, R, T, V]	■ Explain, using examples, why order is or is not important when solving problems that involve permutations or combinations. ■ Determine the number of combinations of *n* elements taken *r* at a time. ■ Generalize strategies for determining the number of combinations of *n* elements taken *r* at a time. ■ Solve a contextual problem that involves probability and combinations.

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[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Strand: Relations and Functions	General Learning Outcome: Develop algebraic and graphical reasoning through the study of relations.

Specific Learning Outcomes *It is expected that students will:*	Achievement Indicators *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*
12A.R.1. Represent data, using polynomial functions (of degree ≤ 3), to solve problems. [C, CN, PS, T, V]	■ Describe, orally and in written form, the characteristics of polynomial functions by analyzing their graphs or their equations. ■ Match equations in a set to their corresponding graphs. ■ Graph data and determine the polynomial function that best approximates the data. ■ Interpret the graph of a polynomial function that models a situation, and explain the reasoning. ■ Solve, using technology, a contextual problem that involves data that is best represented by graphs of polynomial functions, and explain the reasoning.
12A.R.2. Represent data, using exponential and logarithmic functions, to solve problems. [C, CN, PS, T, V]	■ Describe, orally and in written form, the characteristics of exponential or logarithmic functions by analyzing their graphs or their equations. ■ Match equations in a set to their corresponding graphs. ■ Graph data and determine the exponential or logarithmic function that best approximates the data. ■ Interpret the graph of an exponential or logarithmic function that models a situation, and explain the reasoning. ■ Solve, using technology, a contextual problem that involves data that is best represented by graphs of exponential or logarithmic functions, and explain the reasoning.

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[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Strand: Relations and Functions *(continued)*	General Learning Outcome: Develop algebraic and graphical reasoning through the study or relations.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*
12A.R.3. Represent data, using sinusoidal functions, to solve problems. [C, CN, PS, T, V]	■ Describe, orally and in written form, the characteristics of sinusoidal functions by analyzing their graphs or their equations. ■ Match equations in a set to their corresponding graphs. ■ Graph data and determine the sinusoidal function that best approximates the data. ■ Interpret the graph of a sinusoidal function that models a situation, and explain the reasoning. ■ Solve, using technology, a contextual problem that involves data that is best represented by graphs of sinusoidal functions, and explain the reasoning.

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[C] Communication	**[PS]** Problem Solving
[CN] Connections	**[R]** Reasoning
[ME] Mental Mathematics and Estimation	**[T]** Technology
	[V] Visualization

Strand: Mathematics Research Project	**General Learning Outcome:** Develop an appreciation of the role of mathematics in society.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether* *students have met the corresponding specific learning outcome.*

12A.RP.1. Research and give a presentation on a current event or an area of interest that involves mathematics.
[C, CN, ME, PS, R, T, V]

- Collect primary or secondary data (statistical or informational) related to the topic.
- Assess the accuracy, reliability, and relevance of the primary or secondary data collected by
  - identifying examples of bias and points of view
  - identifying and describing the data collection methods
  - determining whether the data is relevant
  - determining whether the data is consistent with information obtained from other sources on the same topic
- Interpret data, using statistical methods if applicable.
- Identify controversial issues, if any, and present multiple sides of the issues with supporting data.
- Organize and present the research project, with or without technology.

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		[V]	Visualization

Strand: Design and Measurement	**General Learning Outcome:** Develop critical thinking skills related to measurement design.
Specific Learning Outcomes *It is expected that students will:*	**Achievement Indicators** *The following set of indicators **may** be used to determine whether students have met the corresponding specific learning outcome.*

12A.D. 1	Analyze objects, shapes, and processes to solve cost and design problems. [C, CN, ME, PS, R, T, V]	■ Solve a problem involving perimeter, area, and volume using dimensions and unit prices. ■ Solve a problem involving estimation and costing for objects, shapes, or processes when a design is given. ■ Identify and correct errors in a solution to a problem that involves costing for objects, shapes, or processes. ■ Estimate the solutions to complex measurement problems using simplified models. ■ Design an object, shape, layout, or process within a specified budget.