NIAGARA ACADEMY
COURSE OUTLINE

COURSE:	Calculus and Vectors, Grade 12, University Preparation, (MCV4U)
SCHOOL:	Niagara Academy
DEVELOPED BY:	R. Cooper, September, 2007
REVISED BY:	R. Cooper 2009, M. Wilson 2013, T. Bozza 2014, S. Davis 2015, J. Zelic, 2017
COURSE TITLE:	Calculus and Vectors
COURSE TYPE:	University Preparation
COURSE GRADE:	Twelve
COURSE CODE:	MCV4U
DEVELOPED FROM:	The Ontario Curriculum Grades 11 and 12, Mathematics, 2007, http://www.edu.gov.on.ca/eng/curriculum/secondary/math1112currb.pdf
PREREQUISITE:	Grade 12 Advanced Functions, University Preparation must be taken prior to, or concurrently with, Calculus and Vectors
COURSE DURATION:	110 hours
COURSE VALUE:	1.0 credits
COURSE TEXT:	Calculus and Vectors 12, Erdman, Wayne et al, McGraw-Hill Ryerson, 2008

COURSE DESCRIPTION AND RATIONALE

This course builds on students' previous experience with functions and their developing understanding of rates of change. Students will solve problems involving geometric and algebraic representations of vectors and representations of lines and planes in three dimensional space; broaden their understanding of rates of change to include the derivatives of polynomial, sinusoidal, exponential, rational, and radical functions; and apply these concepts and skills to the modelling of real-world relationships. Students will also refine their use of the mathematical processes necessary for success in senior mathematics. This course is intended for students who choose to pursue careers in fields such as science, engineering, economics, and some areas of business, including those students who will be required to take a university-level calculus, linear algebra, or physics course.

OVERALL CURRICULUM EXPECTATIONS

A. Rate of Change: By the end of this course, students will:	
1.	demonstrate an understanding of rate of change by making connections between average rate of change over an interval and instantaneous rate of change at a point, using the slopes of secants and tangents and the concept of the limit;
2.	graph the derivatives of polynomial, sinusoidal, and exponential functions, and make connections between the numeric, graphical, and algebraic representations of a function and its derivative;
3.	verify graphically and algebraically the rules for determining derivatives; apply these rules to determine the derivatives of polynomial, sinusoidal, exponential, rational, and radical functions, and simple combinations of functions; and solve related problems.

B. Derivatives and their Applications: By the end of this course, students will:	
1.	make connections, graphically and algebraically, between the key features of a function and its first and second derivatives, and use the connections in curve sketching;
2.	solve problems, including optimization problems, that require the use of the concepts and procedures associated with the derivative, including problems arising from real-world applications and involving the development of mathematical models.

C. Geometry and Algebra of Vectors: By the end of this course, students will:	
1.	demonstrate an understanding of vectors in two-space and three-space by representing them algebraically and geometrically and by recognizing their applications;
2.	perform operations on vectors in two-space and three-space, and use the properties of these operations to solve problems, including those arising from real-world applications;
3.	distinguish between the geometric representations of a single linear equation or a system of two linear equations in two-space and three-space, and determine different geometric configurations of lines and planes in three-space;
4.	represent lines and planes using scalar, vector, and parametric equations, and solve problems involving distances and intersections.

ASSESSMENT AND EVALUATION

Evaluation and Reporting of Student Achievement

Student achievement is communicated formally to students and parents twice per semester by means of the Provincial Report Card, Grades 9–12. The report card provides a record of the student's achievement of the curriculum expectations in every course, at particular points in the school year or semester, in the form of a percentage grade. The percentage grade represents the quality of the student's overall achievement of the expectations for the course which are described in the achievement chart on pages 28-29 of The Ontario Curriculum Grades 11 and 12, Mathematics, 2007, http://www.edu.gov.on.ca/eng/curriculum/secondary/math1112currb.pdf.

Learning Skills will also be assessed and reported on the Provincial Report Card, Grades 9-12. The quality of the learning skills demonstrated by a student are recorded in six categories – Responsibility, Organization, Independent Work, Collaboration, Initiative, Self-Regulation – and are assessed throughout the semester using a four-point scale (E-Excellent, G-Good, S-Satisfactory, N-Needs Improvement), and using the document Growing Success: Assessment, Evaluation and Reporting in Ontario Schools, 2010 (page 11), as a guide (http://www.edu.gov.on.ca/eng/policyfunding/growSuccess.pdf).

Assessment for Learning will be used as a process for seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go, and how best to get there. Teachers will use diagnostic assessment before instruction and formative assessment will occur frequently and in an ongoing manner to monitor students' progress. Observation and conversation will be used to determine the needs of individual student learning.

Assessment as Learning will focus on the explicit fostering of student's capacity over time to be their own best assessors, but teachers need to start by presenting and modelling external, structured opportunities for students to assess themselves. Formative assessment be used by students to monitor their own and their peers' progress.

Assessment of Learning will be used as the assessment that becomes public and results in statements or symbols about how well students are learning. Summative assessment will be used by the teacher to summarize learning at a given point in time. (Ref: page 31 of Growing Success, or page 8 of this document)

The teacher will use assessment strategies that:

- are fair, transparent and equitable for all students;
- are clearly communicated to students at the beginning of the course and at other points throughout the semester
- are varied in nature, administered over a period of time and designed to provide opportunities for students to demonstrate the full range of their learning
- are appropriate for the learning activities used, the purposes of instruction and the needs and experiences of the students

- relate to the curriculum expectations and learning goals and, as much as possible, to the interests, learning styles and preferences, needs and experiences of all students
- accommodate students with special education needs, consistent with the strategies outlined in their Individual Education Plan
- accommodate the needs of students who are learning the language of instruction
- ensure that each student is given clear directions for improvement
- promote students' ability to assess their own learning and to set specific goals
- ensure that each student is given clear directions for improvement

A final grade is recorded for every course, and a credit is granted and recorded for every course in which the student's grade is 50% or higher. The final grade for each course in Grades 9–12 will be determined as follows:

• Seventy per cent of the grade will be based on evaluations conducted throughout the course. This portion of the grade should reflect the student's most consistent level of achievement throughout the course, although special consideration should be given to more recent evidence of achievement. Please see the following page for an explanation of how course work marks will be obtained.

• Thirty per cent of the grade will be based on a final evaluation in the form of an examination, performance task and/or other method of evaluation suitable to the course content and administered towards the end of the course. This final evaluation will include a Culminating Activity 10% and a Final Exam 20%.

A student's achievement of the overall curriculum expectations will be evaluated in accordance with the achievement charts in the provincial curriculum and will be reported using percentage marks. It is expected that both mathematical calculations and professional judgement will inform the determination of percentage marks.

COURSE CONTENT AND EVALUATION

Evaluation in each unit will include Knowledge/Understanding - 25%, Thinking - 25%, Communication - 25%, Application - 25%. Examples of term work to be assessed are unit tests, assignments, quizzes, class work, performance tasks. Assessments will include modeling math using both manipulatives and technology, using a variety of problem-solving strategies, making connections to real-life.

Unit	Unit Description	Evaluation	Hours
Unit One	**Rates of Change:** rates of change and the slope of a curve, limits, limits and continuity, introduction to derivatives	13%	16
Unit Two	**Derivatives:** derivatives of a polynomial function, the product rule, velocity, acceleration, and second derivatives, the chain rule, derivatives of quotients	20%	20
Unit Three	**Derivatives of Sinusoidal Functions:** instantaneous rates of change of sinusoidal functions, derivatives of sine and cosine functions, differentiation rules for sinusoidal functions, applications of sinusoidal functions and their derivatives.	20%	20
Unit Four	**Exponential and Logarithmic Functions:** rates of change, and the number e , the natural logarithm, derivatives of exponential functions, differentiation rules for exponential functions.	13%	16
Unit Five	**Geometric Vectors:** introduction to vectors, addition and subtraction of vectors, applications of vector addition, resolution of vectors into rectangular components.	13%	16
Unit Six	**Cartesian Vectors:** Cartesian vectors, dot product, vectors in three-space, applications of the dot product and cross product.	13%	16
Unit Seven	**Independent Study:** Curve Sketching (increasing and decreasing functions, maxima and minima, concavity and the second derivative test, optimization problems), and Lines and Planes (equations of planes, properties of planes, intersections of lines and planes, intersections of planes).	8%	6
	Term Work Total	**70%**	**110 hrs**
Final Evaluation	Final Examination	**30%**	
	FINAL MARK	**100%**	

TEACHING AND LEARNING STRATEGIES

Since the over-riding aim of this course is to help students use the language of mathematics skillfully, confidently and flexibly, a wide variety of instructional strategies are used to provide learning opportunities to accommodate a variety of learning styles, interests and ability levels. Seven mathematical processes will form the heart of the teaching and learning strategies used.

- *Communicating:* To improve student success there will be several opportunities for students to share their understanding both in oral as well as written form.
- *Problem solving:* Scaffolding of knowledge, detecting patterns, making and justifying conjectures, guiding students as they apply their chosen strategy, directing students to use multiple strategies to solve the same problem, when appropriate, recognizing, encouraging, and applauding perseverance, discussing the relative merits of different strategies for specific types of problems.
- *Reasoning and proving:* Asking questions that get students to hypothesize, providing students with one or more numerical examples that parallel these with the generalization and describing their thinking in more detail.
- *Reflecting:* Modeling the reflective process, asking students how they know.
- *Selecting Tools and Computational Strategies:* Modeling the use of tools and having students use technology to help solve problems.
- *Connecting:* Activating prior knowledge when introducing a new concept in order to make a smooth connection between previous learning and new concepts, and introducing skills in context to make connections between particular manipulations and problems that require them.
- *Representing:* Modeling various ways to demonstrate understanding, posing questions that require students to use different representations as they are working at each level of conceptual development - concrete, visual or symbolic, allowing individual students the time they need to solidify their understanding at each conceptual stage.

CONSIDERATIONS FOR PROGRAM PLANNING

The planning and administering of this course is based on the premise that all students can be successful language learners. The teacher will provide quality instruction that respects students' strengths and address their learning needs, using assessment information to plan instruction. Accommodation for IEP students is not applicable at Niagara Academy, but the teacher will make appropriate adaptions for English Language Learners, such as the following:

- modification of some or all of the course expectations, based on the student's level of English proficiency;
- use of a variety of instructional strategies (e.g. extensive use of visual cues, manipulatives, pictures, diagrams, graphic organizers; attention to clarity of instructions; modelling of preferred ways of working in mathematics; previewing of textbooks; pre-teaching of key specialized vocabulary; encouragement of peer tutoring and class discussion; strategic use of students' first languages);
- use of a variety of learning resources (e.g., visual material, simplified text, bilingual dictionaries, culturally diverse materials);
- use of assessment accommodations (e.g., granting of extra time; use of alternative forms of assessment, such as oral interviews, learning logs, or portfolios; simplification of language used in problems and instructions).

Information and communications technology will be used throughout the course where it is appropriate. The program will also include opportunities for students to apply their language skills to work-related situations, to explore educational and career options, and to become self-directed learners.

RESOURCES

• Calculus and Vectors 12 Study Guide and University Handbook, McGraw-Hill Ryerson, 2008, ISBN 0-07-09360-1

• Advanced Functions and Introductory Calculus, Addison-Wesley, 2003, ISBN 0-201-77104-7

• Geometry and Discrete Mathematics 12, Addison-Wesley, 2003, ISBN -201-77096-2