

## General Information.

*Discipline:* Mathematics

*Course code:* 201-NYA-05

*Ponderation:* 3-2-3

*Credits:* 2 $\frac{2}{3}$

*Prerequisite:* Secondary V Math TS5 or SN5 (or equivalent)

*Objectives:* 00UN, 00UU

Your teacher will give you his/her schedule and availability.  
 Students are strongly advised to seek help promptly from their teacher if they encounter difficulties in the course.

**Introduction.** Calculus I is the first of the required mathematics courses in the Science program. It is usually taken in the first semester and it introduces the student to the limit processes that are so vital to the development of calculus. Since differential calculus is a basic tool in physics, some of the applications will be related to problems in physics. To a lesser extent, differential calculus can also be applied to problems in chemistry and biology.

The primary purpose of the course is the attainment of objective 00UN (“To apply the methods of differential calculus to the study of functions and problem solving”). To achieve this goal, the course will help the student understand the following basic concepts: limits, continuity and derivatives involving real-valued functions of one variable (including algebraic, trigonometric, exponential, and logarithmic functions).

Emphasis will be placed on clarity and rigour in reasoning and in the application of methods. The student will learn to interpret the derivative both as a mathematical tool and as a rate of change. The derivative will be used in various contexts including velocity, acceleration, curve sketching, optimization and related rates. The basic concepts are illustrated by applying them to various problems where their application helps arrive at a solution. In this way, the course encourages the student to apply learning acquired in one context to problems arising in another. Towards the end of the course, the student will be introduced to antiderivatives in order to help with the transition from Calculus I to Calculus II.

Students may be permitted to use a scientific or graphing calculator in class; however, calculators (of any kind) will not be permitted on tests and the final exam. Students will also have access to computers where suitable mathematical software, including MAPLE, is available for student use. The course uses a standard college level calculus textbook, chosen by the Calculus I and Calculus II course committees.

**Textbook.** Your teacher may require *Single Variable Calculus: Early Transcendentals, 9th edition*, by James Stewart (Brooks/Cole). It is available from the college bookstore for about \$132. Note that the 7th or 8th edition of this book are also suitable.

**Course Costs.** In addition to the cost of the textbook (see above), your instructor might recommend you acquire an inexpensive scientific calculator (\$15-\$25). *No calculators are allowed during tests or the final exam.*

**Teaching Methods.** This course will be 75 hours, meeting three times a week for a total of five hours a week. It relies mainly on the lecture method, although some of the following techniques are also used: question-and-answer sessions, labs, problem solving periods, class discussions, and assigned reading for independent study. In general, each class begins with a question period on previous topics, then new material is introduced, followed by worked examples. No marks are deducted for absenteeism (however, see below). Failure to keep pace with the lectures results in a cumulative inability to cope with the material and a failure in the course. A student will generally succeed or fail depending on how many problems have been attempted and solved successfully. It is entirely the student’s responsibility to complete suggested homework assignments as soon as possible following the lecture, as the material will be fresher in his/her mind. This also allows the student the maximum benefit from any discussion of the homework (which usually occurs in the following class). Answers to a selected

number of problems can be found in the back of the text. Individual teachers may provide supplementary notes and problems as they see fit.

**Evaluation Plan.** The Final Evaluation in this course consists of the Final Exam, which covers all elements of the competency. A student’s Final Grade is a combination of the Class Mark and the mark on the Final Exam. The Class Mark will be 75% (three to five tests) and 25% at your teacher’s discretion (more tests, quizzes or assignments). The specifics of the Class Mark are included in an appendix that is distributed to students along with this course outline. The Final Exam is set by the NYA course committee (which consists of all instructors currently teaching this course), and is marked by each individual instructor. Every effort is made to ensure equivalence between the various sections of the course.

The Final Grade will be the better of:

1% Diagnostic Test, 49% Class Mark and 50% Final Exam Mark

or

1% Diagnostic Test, 24% Class Mark and 75% Final Exam Mark

A student *choosing not to write* the Final Exam will receive a failing grade of 50% or their Class Mark, whichever is less.

**Students must be available until the end of the final examination period to write exams.**

**Course Outline Change.** Please note that course outlines may be modified if health authorities change the access allowed on-site.

**Departmental Attendance Policy.** Due to the COVID-19 health crisis, attendance policies may need to be adjusted by your teacher. Regular attendance is expected, and your teacher will inform you of any details or modifications as needed. Please note that attendance continues to be extremely important for your learning, but your teacher may need to define it in different terms based on the way your course is delivered during the semester.

**Additional Software.** In addition to LEA, Teams and Moodle, additional software may be used for the submission of essays or projects or for testing. Further details will be provided if applicable.

**Class Recordings.** Classes on Teams or other platforms may be recorded by your teacher and subsequently posted on Teams and/or LEA to help for study purposes only. If you do not wish to be part of the recording, please let your teacher know that you wish to not make use of your camera, microphone or chat during recorded segments. Any material produced as part of this course, including, but not limited to, any pre-recorded or live video is protected by copyright, intellectual property rights and image rights, regardless of the medium used. It is strictly forbidden to copy, redistribute, reproduce, republish, store in any way, retransmit or modify this material. Any contravention of these conditions of use may be subject to sanction(s) by John Abbott College.

## Other Resources.

*Math Website.*

<http://departments.johnabbott.qc.ca/departments/mathematics>

*Math Study Area.* Located in H-200A and H-200B; the common area is usually open from 8:30 to 17:30 on weekdays as a quiet study space. Computers and printers are available for math-related assignments. It is also possible to borrow course materials when the attendant is present.

*Math Help Centre.* Located in H-216; teachers are on duty from 9:00 until 16:00 to give math help on a drop-in basis.

*Peer Tutoring.* Starting on the fifth week of each semester, first year students can be paired with a fellow finishing student for a weekly appointment of tutoring. Ask your teacher for details.

*Academic Success Centre.* The Academic Success Centre, located in H-117, offers study skills workshops and individual tutoring.

## College Policies.

*Policy No. 7 - IPESA, Institutional Policy on the Evaluation of Student Achievement:* <http://johnabbott.qc.ca/ipesa>.

*Religious Holidays (Article 3.2.13 and 4.1.6).* Students who wish to miss classes in order to observe religious holidays must inform their teacher of their intent in writing within the first two weeks of the semester.

*Student Rights and Responsibilities: (Article 3.2.18).* It is the responsibility of students to keep all assessed material returned to them and/or all digital work submitted to the teacher in the event of a grade review. (The deadline for a Grade Review is 4 weeks after the start of the next regular semester.)

*Student Rights and Responsibilities: (Article 3.3.6).* Students have the right to receive graded evaluations, for regular day division courses, within two weeks after the due date or exam/test date, except in extenuating circumstances. A maximum of three (3) weeks may apply in certain circumstances (ex. major essays) if approved by the department and stated on the course outline. For evaluations at the end of the semester/course, the results must be given to the student by the grade submission deadline (see current Academic Calendar). For intensive courses (i.e.: intersession, abridged courses) and AEC courses, timely feedback must be adjusted accordingly.

*Academic Procedure: Academic Integrity, Cheating and Plagiarism (Article 9.1 and 9.2).* Cheating and plagiarism are unacceptable at John Abbott College. They represent infractions against academic integrity. Students are expected to conduct themselves accordingly and must be responsible for all of their actions.

*College definition of Cheating:* Cheating means any dishonest or deceptive practice relative to examinations, tests, quizzes, lab assignments, research papers or other forms of evaluation tasks. Cheating includes, but is not restricted to, making use of or being in possession of unauthorized material or devices and/or obtaining or providing unauthorized assistance in writing examinations, papers or any other evaluation task and submitting the same work in more than one course without the teacher's permission. It is incumbent upon the department through the teacher to ensure students are forewarned about unauthorized material, devices or practices that are not permitted.

*College definition of Plagiarism:* Plagiarism is a form of cheating. It includes copying or paraphrasing (expressing the ideas of someone else in one's own words), of another person's work or the use of another person's work or ideas without acknowledgement of its source. Plagiarism can be from any source including books, magazines, electronic or photographic media or another student's paper or work.

**Course Content** (with selected exercises). This is a *minimal* list of exercises which you should attempt, assuming you are also doing regular homework (e.g., WEBWORK) assigned by your instructor. **These problems can be found in the 8th edition of the textbook - a PDF file will be provided.**

1.1: 1, 2, 7, 9, 14, 49, 55, 63, 72, 73

1.2: 1, 3, 8, 10, 11, 17

1.3: 3, 6, 12, 24, 30, 31, 37, 41, 45, 53, 61, 63, 65

1.4: 12, 14, 21, 23, 30, 37

1.5: 18, 21, 37, 41, 50, 53, 56, 61

Chap. 1 Review (p. 69): 2, 10, 17, 18, 23, 24, 25a, 25b

2.1: [instructor's discretion]

2.2: 6, 9, 11, 17, 31, 35, 40

2.3: 2, 9, 15, 19, 23, 29, 37, 40, 43, 45, 59, 64, 65

2.4: [instructor's discretion]

2.5: 4, 7, 21, 33, 35, 41, 46, 47, 52, 69, 71

2.6: 4, 9, 21, 24, 29, 32, 33, 39, 45, 49, 52, 54, 59, 63, 67

2.7: 3, 8, 10, 11, 17, 22, 23, 28, 35, 37, 39, 59, 60

2.8: 3, 25, 28, 30, 43, 51, 57, 63, 67

Chap. 2 Review (p. 166): 1, 2, 8, 12, 15, 17, 20, 22, 23, 29, 33, 36, 43, 47, 54

3.1: 3, 9, 23, 24, 27, 31, 37, 55, 60, 62, 66, 69, 81, 83, 86

3.2: 9, 15, 20, 23, 25, 26, 27, 32, 41, 44, 48, 49, 52, 53, 62

3.3: 5, 8, 13, 16, 20, 22, 32, 34, 37, 43, 45, 50, 52, 54, 58

3.4: 19, 25, 38, 40, 41, 44, 45, 48, 53, 59, 65, 74, 76, 78, 84

3.5: 7, 16, 19, 20, 21, 23, 29, 38, 39, 43, 46, 75, 77, 79, 80

3.6: 9, 12, 13, 21, 22, 29, 34, 40, 42, 45, 49, 50, 52, 56

3.7: 1, 5, 10

3.8: [instructor's discretion]

3.9: 12, 18, 23, 27, 29, 30, 33, 42, 44, 47, 50

Chap. 3 Review (p. 267): 28, 37, 41, 50, 53, 59, 60, 66, 81, 85, 89, 95, 98, 109, 112

4.1: 5, 7, 10, 13, 27, 39, 43, 44, 51, 56, 57, 63, 67, 72, 77

4.2: 9, 12, 18, 19, 22, 24, 25, 37, 38

4.3: 8, 11, 12, 16, 18, 19, 27, 30, 35, 45, 47, 55, 60, 75, 79, 82

4.5: 7, 13, 15, 24, 27, 30, 34, 39, 40, 43, 46, 50

4.7: 13, 16, 22, 33, 34, 36, 39, 50, 58, 68, 71, 73, 74

4.9: 5, 12, 15, 16, 29, 37, 38, 47, 50, 53, 55, 61, 63, 69, 77

Chap. 4 Review (p. 359): 5, 6, 17, 24, 29, 32, 47, 54, 72, 74, 78, 79, 84, 85

5.1: 5, 7, 17, 21, 25, 27

5.2: 4, 7, 17, 25, 30, 33, 37, 49, 53

5.3: 3, 7, 18, 26, 29, 33, 37, 41, 43, 63, 65, 73, 75, 83

5.4: 1, 4, 9, 14, 15, 16, 18, 29, 31, 37, 38, 46, 49, 61, 71

Chap. 5 Review (p. 422): 2, 5, 7, 12, 25, 40, 49, 58, 62, 67, 72

To strengthen your skills with more practice, attempt any of the exercises in the sections above which not omitted explicitly below. While doing so, it is a good idea to focus on types of problems with which you struggle.

### *Practice exercises: Omissions*

1.5: Omit 63–76

Chap. 1 Review: omit 25c, 25d, 26d

2.5: omit 29, 32, 60

2.6: omit 35, 40

Chap. 2 Review: omit 19

3.5: omit 17, 49–64

Chap. 3 Review: omit 6, 12, 17, 31, 38, 43, 45, 47, 48

4.1: omit 42, 62

4.2: omit 34, 35

4.3: omit 56, 64

4.5: omit 41, 42, 45, 48, 51–54, 71

4.9: omit 18, 19, 22, 24, 33, 44

Chap. 4 Review: omit 7–14, 31, 33, 34, 61–64, 66, 68, 73, 81–83

5.3: omit 38, 39, 42, 62

5.4: omit 12, 13, 30, 40, 41, 43, 48

Chap. 5 Review: omit 8, 14, 17–24, 26–38, 41, 42, 44, 56, 63, 65, 66, 71

OBJECTIVES	STANDARDS
<p><b>Statement of the Competency</b></p> <p>To apply the methods of differential calculus to the study of functions and problem solving (00UN).</p> <p><b>Elements of the Competency</b></p> <ol style="list-style-type: none"> <li>1. To recognize and describe the characteristics of a function expressed in symbolic or graphic form.</li> <li>2. To determine whether a function has a limit. To determine whether a function is continuous at a point or on an interval. To determine whether a function is differentiable at a point or on an interval.</li> <li>3. To apply the rules and techniques of differentiation.</li> <li>4. To use the derivative and related concepts to analyze the variations of a function and to be able to graph it.</li> <li>5. To solve optimization and rate-of-change problems.</li> <li>6. To apply basic rules and techniques of integration.</li> </ol>	<p><b>General Performance Criteria</b></p> <ul style="list-style-type: none"> <li>• Appropriate use of concepts</li> <li>• Appropriate use of terminology</li> <li>• Representation of a situation as a function</li> <li>• Accurate graphical representation of a function</li> <li>• Correct choice and application of differential techniques</li> <li>• Use of algebraic operations in conformity with rules</li> <li>• Accuracy of calculations</li> <li>• Correct interpretation of results</li> <li>• Explanation of steps in problem-resolution procedure</li> </ul> <p><b>Specific Performance Criteria</b></p> <p><i>[Specific performance criteria for each of these elements of the competency are shown below with the corresponding intermediate learning objectives. For the items in the list of learning objectives, it is understood that each is preceded by: "The student is expected to ...".]</i></p>



Specific Performance Criteria	Intermediate Learning Objectives
<p>2.3 Use of the limit definition of the derivative</p> <p>2.4 Use of the graph of a function to determine whether a function is differentiable at a point or on an interval</p>	<p>2.3.1. Define the derivative of a function as (i) the limit of a difference quotient, (ii) the slope of a tangent line, and (iii) the rate of change (in particular the velocity function associated with a position function).</p> <p>2.3.2. Use the limit definition of the derivative to determine the derivative of a polynomial of degree 1, 2 or 3, square root and simple rational functions.</p> <p>2.3.3. Use the limit definition of the derivative to determine the numerical value of the derivative at a given point.</p> <p>2.3.4. Use the limit definition of the derivative to determine the slope of the tangent line to a curve at a specific point.</p> <p>2.3.5. Use the limit definition of the derivative to determine the equation of the tangent line to a curve at a specific point.</p> <p>2.4.1. Determine if the derivative of a function exists at a point or on an interval by examining the graph of the function.</p>
<p>3. <i>Rules and Techniques of Differentiation</i></p>	
<p>3.1 Recognition of the equivalence of various derivative notations</p>	<p>3.1.1. Recognize different notations for the derivative of <math>y</math> with respect to <math>x</math>:</p> $y', f'(x), \frac{dy}{dx}, \frac{d}{dx}f(x), D_x y$
<p>3.2 Use of basic differentiation formulas and rules and proof of simple propositions</p>	<p>3.2.1. Recognize when and how to use the basic differentiation formulas:</p> $\begin{array}{ll} \frac{d}{dx}[c] = 0 & \frac{d}{dx}[\sin x] = \cos x \\ \frac{d}{dx}[x^n] = nx^{n-1} & \frac{d}{dx}[\cos x] = -\sin x \\ \frac{d}{dx}[e^x] = e^x & \frac{d}{dx}[\tan x] = \sec^2 x \\ \frac{d}{dx}[\ln x] = \frac{1}{x} & \frac{d}{dx}[\sec x] = \sec x \tan x \\ \frac{d}{dx}[a^x] = a^x \ln a & \frac{d}{dx}[\csc x] = -\csc x \cot x \\ \frac{d}{dx}[\log_a x] = \frac{1}{x \ln a} & \frac{d}{dx}[\cot x] = -\csc^2 x \end{array}$ <p>3.2.2. Recognize when and how to use the following differentiation formulas derived from the chain rule:</p> $\begin{array}{ll} \frac{d}{dx}[u^n] = nu^{n-1}u' & \frac{d}{dx}[\sin u] = \cos u u' \\ \frac{d}{dx}[e^u] = e^u u' & \frac{d}{dx}[\cos u] = -\sin u u' \\ \frac{d}{dx}[\ln u] = \frac{u'}{u} & \frac{d}{dx}[\tan u] = \sec^2 u u' \\ \frac{d}{dx}[a^u] = a^u (\ln a) u' & \frac{d}{dx}[\sec u] = \sec u \tan u u' \\ \frac{d}{dx}[\log_a u] = \frac{u'}{u \ln a} & \frac{d}{dx}[\csc u] = -\csc u \cot u u' \\ & \frac{d}{dx}[\cot u] = -\csc^2 u u' \end{array}$ <p>3.2.3. Recognize when and how to use the following rules: constant rule, power rule, constant multiple rule, sum and difference rule.</p> <p>3.2.4. Recognize when and how to use the product, quotient and chain rules.</p> <p>3.2.5. Prove a selection of the rules in 3.2.1 using the limit definition of the derivative.</p>
<p>3.3 Determination of whether a function is differentiable at a point or on an interval</p>	<p>3.3.1. Determine whether a function is differentiable at a specified point or on an interval using graphical, numerical, or analytical methods.</p>
<p>3.4 Use of differentiation rules to perform implicit and logarithmic differentiation</p>	<p>3.4.1. Recognize when and how to use implicit differentiation.</p> <p>3.4.2. Recognize when and how to use logarithmic differentiation.</p>
<p>3.5 Evaluation and application of higher order derivatives</p>	<p>3.5.1. Find higher order derivatives.</p> <p>3.5.2. Use higher-order derivatives to solve position, velocity and acceleration problems.</p>
<p>3.6 Use of derivatives to find the slope of a tangent (normal) line to a curve at a point</p>	<p>3.6.1. Use the differentiation rules listed in 3.2.1 and 3.2.2 to find the slope of the tangent line to a curve at a point.</p> <p>3.6.2. Use the differentiation rules listed in 3.2.1 and 3.2.2 to find the equation of the tangent line to a curve at a point.</p> <p>3.6.3. Use the differentiation rules listed in 3.2.1 and 3.2.2 to find the equation of the normal line to a curve at a point.</p>

Specific Performance Criteria	Intermediate Learning Objectives
<p>4. <i>Graphing of Functions</i></p> <p>4.1 Use of the derivative and related concepts to analyze the variations of a function and to sketch a graph of the function</p> <p>4.2 Demonstration of the ability to understand abstract properties of continuous and differentiable functions, as illustrated by two simple standard theorems.</p> <p>5. <i>Optimization and Rate-of-Change Problems</i></p> <p>5.1 Solution of optimization problems</p> <p>5.2 Solution of problems involving related rates</p> <p>6. <i>Integration</i></p> <p>6.1 Evaluation of the indefinite integral</p> <p>6.2 Evaluation of the definite integral</p> <p>6.3 Solution of simple differential equations</p>	<p>4.1.1. Find critical numbers.</p> <p>4.1.2. Find intervals on which a function is increasing and decreasing using the sign of the first derivative.</p> <p>4.1.3. Find relative and absolute extrema.</p> <p>4.1.4. Use the first or second derivative test to decide whether the critical points represent relative maxima or relative minima.</p> <p>4.1.5. Find inflection points.</p> <p>4.1.6. Find intervals on which a function is concave up or concave down using the sign of the second derivative.</p> <p>4.1.7. Use limits to find all vertical and horizontal asymptotes.</p> <p>4.1.8. Use 4.1.1–4.1.7 to graph polynomial, rational, trigonometric, logarithmic and exponential functions.</p> <p>4.2.1. State the conditions necessary for Rolle’s Theorem.</p> <p>4.2.2. State the conclusion of Rolle’s Theorem.</p> <p>4.2.3. State the conditions necessary for the Mean Value Theorem.</p> <p>4.2.4. State the conclusion of the Mean Value Theorem.</p> <p>5.1.1. Represent an optimization word problem in functional form.</p> <p>5.1.2. Determine the quantity, <math>P</math>, to be maximized or minimized and identify the variables which are involved.</p> <p>5.1.3. Draw a diagram, if possible, to illustrate the problem and list any other relationship(s) between the variables.</p> <p>5.1.4. Express <math>P</math> as a function of one variable.</p> <p>5.1.5. Find the derivative of the function for <math>P</math> obtained in 5.1.4.</p> <p>5.1.6. Find all the possible critical values by solving the equation <math>P' = 0</math>.</p> <p>5.1.7. Test the critical value(s) and interval endpoints for absolute maximum or minimum.</p> <p>5.1.8. Interpret (explain) the results found in the optimization problem.</p> <p>5.2.1. Represent a word problem involving related rates in functional form.</p> <p>5.2.2. Identify the variables and rates in the problem.</p> <p>5.2.3. Draw a diagram, if possible, to illustrate the problem.</p> <p>5.2.4. Determine the equation relating the variables.</p> <p>5.2.5. Differentiate the equation in 5.2.4 with respect to time, <math>t</math>.</p> <p>5.2.6. Solve the equation in 5.2.5 for the required rate.</p> <p>5.2.7. Interpret (explain) the results found in the problem involving related rates.</p> <p>6.1.1. Give the definition of the indefinite integral as an antiderivative.</p> <p>6.1.2. Express the basic differentiation formulas listed in 3.2.1 as antidifferentiation formulas.</p> <p>6.1.3. Recognize when and how to use the constant multiple rule and the sum and difference rule in the evaluation of integrals.</p> <p>6.1.4. Use the antidifferentiation formulas from 6.1.2 and the rules in 6.1.3 to evaluate indefinite integrals.</p> <p>6.2.1. State the definition of the definite integral.</p> <p>6.2.2. State the Fundamental Theorem of Calculus.</p> <p>6.2.3. Find the definite integral of functions described in 6.1.</p> <p>6.2.4. Use the Fundamental Theorem of Calculus to find the area of a region under a curve on a closed interval.</p> <p>6.3.1. Find the general solution to a differential equation of the form <math>y' = f(x)</math>.</p> <p>6.3.2. Find the particular solution to a differential equation of the form <math>y' = f(x)</math> given an initial condition <math>y(a) = b</math>.</p>