

## General Information.

**Discipline:** Mathematics

**Course code:** 201-AS2-AB

**Ponderation:** 2-2-2

**Credits:** 2

**Prerequisite:** 201-AS1-AB (Differential Calculus)

**Objective:** To solve problems using integral calculus (01Y2)

*Students are strongly advised to seek help promptly from their teacher if they encounter difficulties in the course.*

**Introduction.** Integral Calculus is the sequel to Differential Calculus, and so is the second mathematics course in the Arts and Sciences program; it is generally taken in the second semester. The student will already be familiar with the notions of definite and indefinite integration from Differential Calculus. In Integral Calculus, these notions are studied in greater depth and their use in other areas of science, such as physics and to a lesser extent chemistry, is explored. In addition, the course introduces the student to the concept of infinite series and to the representation of functions by power series.

The primary purpose of the course is the attainment of objective 01Y2 ("To solve problems using integral calculus"). To achieve this goal, the course must help the student understand the following basic concepts: indefinite and definite integrals, improper integrals, sequences, infinite series, and power series involving real-valued functions of one variable (including algebraic, trigonometric, inverse 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 use the techniques of integration in several contexts, and to interpret the integral both as an antiderivative and as a limit of a sum of products. 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.

Calculators are not permitted during tests and final examinations. Students will have access to the Math Lab 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.** None apart from the text listed above.

**Evaluation Plan.** The Final Evaluation in this course consists of the Final Exam, which covers all elements of the competency. The Final Grade is a combination of the Class Mark and the mark on the Final Exam. The Class Mark will include four tests (worth 80% of the Class Mark), and quizzes and assignments (worth 20% of the Class Mark).

The Final Grade will be the better of:

50% Class Mark and 50% Final Exam Mark

or

25% 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.**

**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.

**Course Outline Change.** Please note that course outlines may be modified if health authorities change the access allowed on-site. This includes the possibility of changing between an in-person and online format.

**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.

**Course Content** (with selected exercises). The exercises listed on the next page should help you practice and learn the material taught in this course; they form a good basis for homework but they don't set a limit on the type of question that may be asked. Your teacher may supplement this list or assign equivalent exercises during the semester. Regular work done as the course progresses should make it easier for you to master the course.

An item beginning with a decimal number (e. g., 3.5) refers to a section in *Single Variable Calculus: Early Transcendentals*, 8th edition. Answers to odd-numbered exercises can be found in the back of the text. Solutions to *all* the exercises are posted in the Calculus 2 Community on the JAC Portal; also, the complete solutions manual can be consulted in the Math Lab (see below). Additional resources for the textbook may be found at

[http://stewartcalculus.com/media/17\\_home.php](http://stewartcalculus.com/media/17_home.php)

*Inverse trigonometric functions.*

- 1.6 Inverse Functions and Logarithms (63–72)
- 2.6 Limits at Infinity; Horizontal Asymptotes (35, 40)
- 3.5 Implicit Differentiation (49–57)
- 4.9 Antiderivatives (18, 22, 24, 33)
- 5.3 The Fundamental Theorem of Calculus (39, 42)
- 5.4 Indefinite Integrals and the Net Change Theorem (12, 41, 43)

*Techniques of Integration.*

- 5.5 The Substitution Rule (7–28, 30–35, 38–48, 53–71, 79, 87–91)
- 7.1 Integration by Parts (3–13, 15, 17–24, 26–42)
- 7.2 Trigonometric Integrals (1–31, 33–49)
- 7.3 Trigonometric Substitution (5–20, 22–30)
- 7.4 Integration of Rational Functions and Partial Fractions (1–36, 46–51, 53, 54)
- 7.5 Strategy for Integration (1–80; skip 53, 74)

### *Improper Integrals.*

#### 4.4 Indeterminate Forms and l'Hospital's Rule

(13–67; skip 24, 28, 29, 38, 42, 58)

#### 7.8 Improper Integrals (1, 2, 5–41, 58)

### *Applications of Integration.*

#### 6.1 Areas Between Curves (1–14, 17, 22, 23, 25, 27)

#### 6.2 Volumes (1–12, 15–18)

#### 6.3 Volumes by Cylindrical Shells

(1–20, 21–25 part (a) only, 37, 38, 41–43)

#### 8.1 Arc Length (9, 11, 14, 15, 17–20, 33)

#### 9.3 Separable Equations (1–14, 16–20, 39, 42, 45–48)

#### 9.4 Models for Population Growth (9, 11)

### *Infinite Sequences and Series.*

#### 11.1 Sequences (1–3, 13–18, 23–51)

#### 11.2 Series (1–4, 17–47, 60–62; skip 45)

#### 11.3 The Integral Test and Estimates of Sums (3–5, 21, 22, 29)

#### 11.4 The Comparison Tests (1–31, 41, 44–46)

#### 11.5 Alternating Series (2–7, 12–15)

#### 11.6 Absolute Convergence and the Ratio and Root Tests (1–38)

#### 11.7 Strategy for Testing Series (1–28, 30–34)

#### 11.8 Power Series (3–21, 23–26, 29–31)

#### 11.10 Taylor and Maclaurin Series (3–9, 11–14, 21–26)

**Teaching Methods.** This course will be 60 hours, meeting three times per week for a total of four hours per week. It relies mainly on the lecture method, although some of the following techniques may also be used: question-and-answer sessions, 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 exercises 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. This allows the student the maximum benefit from any discussion of the homework (which usually occurs in the following class). Supplementary notes and problems may be provided as appropriate.

### **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 8:30 until 15:30 to give math help on a drop-in basis.

**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.: intercession, 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.



Specific Performance Criteria	Intermediate Learning Objectives
<p>1. <i>Indefinite integrals</i></p> <p>1.1 Use of basic substitutions to determine simple indefinite integrals.</p> <p>1.2 Use of more advanced techniques to determine more complex indefinite integrals.</p> <p>2. <i>Limits of indeterminate forms</i></p> <p>2.1 Use of l'Hôpital's rule to determine limits of indeterminate forms.</p> <p>3. <i>Definite and improper integrals</i></p> <p>3.1 Use of the Fundamental Theorem of Calculus to evaluate a definite integral.</p> <p>3.2 Use of limits to calculate improper integrals.</p> <p>4. <i>Differential equations</i></p> <p>4.1 Use the language of differential equations to express physical problems.</p> <p>4.2 Use of antidifferentiation to obtain general solutions to simple differential equations.</p> <p>4.3 Use of antidifferentiation to obtain particular solutions to simple initial value problems.</p> <p>5. <i>Areas, volumes, and lengths</i></p> <p>5.1 Use of differentials to set up definite integrals.</p> <p>5.2 Calculation of areas of planar regions.</p> <p>5.3 Calculation of volumes of revolution</p> <p>5.4 Calculation of lengths of curves.</p> <p>6. <i>Infinite series</i></p> <p>6.1 Determination of the convergence or divergence of a sequence.</p> <p>6.2 Determination of the convergence or divergence of an infinite series of positive terms.</p> <p>6.3 Determination of the convergence, conditional or absolute, or divergence of an infinite series.</p> <p>6.4 Expression of functions as power series</p>	<p>1.1.1. Express Calculus I differentiation rules as antidifferentiation rules.</p> <p>1.1.2. Use these antidifferentiation rules and appropriate substitutions to calculate indefinite integrals.</p> <p>1.2.1. Use identities to prepare indefinite integrals for solution by substitution.</p> <p>1.2.2. Evaluate an indefinite integral using integration by parts.</p> <p>1.2.3. Evaluate an indefinite integral using trigonometric identities.</p> <p>1.2.4. Evaluate an indefinite integral by partial fractions.</p> <p>1.2.5. Evaluate an indefinite integral by selecting an appropriate technique.</p> <p>1.2.6. Evaluate an indefinite integral by using a combination of techniques.</p> <p>2.1.1. State l'Hôpital's rule and the conditions under which it is valid.</p> <p>2.1.2. Calculate limits of the indeterminate forms <math>\frac{0}{0}</math> and <math>\frac{\infty}{\infty}</math> using l'Hôpital's rule.</p> <p>2.1.3. For the indeterminate forms <math>0 \cdot \infty</math>, <math>\infty - \infty</math>, <math>1^\infty</math>, <math>0^0</math>, <math>\infty^0</math>, use the appropriate transformation to determine the limit using l'Hôpital's rule.</p> <p>3.1.1. Use the Fundamental Theorem of Calculus to calculate definite integrals.</p> <p>3.2.1. Calculate an improper integral where at least one of the bounds is not a real number.</p> <p>3.2.2. Calculate an improper integral where the integrand is discontinuous at one or more points in the interval of integration.</p> <p>4.1.1. Translate a physical problem into the language of differential equations.</p> <p>4.2.1. Express a simple differential equation in the language of integration, and obtain the general solution.</p> <p>4.3.1. Express a simple initial value problem in the language of integration, and obtain the particular solution.</p> <p>5.1.1. Analyze a quantity <math>A</math> as a sum <math>\sum \Delta A</math> over an interval <math>[a, b]</math>; approximate <math>\Delta A</math> by a product <math>f(x) dx</math>; conclude that <math>A</math> is the definite integral <math>\int_a^b f(x) dx</math>.</p> <p>5.2.1. Use 5.1.1 to set up a definite integral to calculate an area.</p> <p>5.2.2. Sketch the area between two functions (<math>y = f(x)</math>, <math>y = g(x)</math>) and use 5.2.1 to calculate the area.</p> <p>5.2.3. Sketch the area between two functions (<math>x = f(y)</math>, <math>x = g(y)</math>) and use 5.2.1 to calculate the area.</p> <p>5.2.4. Sketch the area between two curves and determine the most efficient way (5.2.2 or 5.2.3) to calculate the area.</p> <p>5.3.1. Sketch the three dimensional solid obtained by revolving a region (of type 5.2.2 or 5.2.3) around an axis.</p> <p>5.3.2. Use 5.1.1 to set up a definite integral to calculate the volume of the solid (5.3.1) by cross-sections.</p> <p>5.3.3. Use 5.1.1 to set up a definite integral to calculate the volume of the solid (5.3.1) by shells.</p> <p>5.3.4. Determine the most efficient way (cross-sections or shells) to calculate the volume of the solid (5.3.1), and calculate the volume by that method.</p> <p>5.4.1. Use 5.1.1 to set up a definite integral to calculate the length of a curve.</p> <p>5.4.2. Use 5.1.1 and 1.2 to calculate the length of a curve.</p> <p>6.1.1. State the definition of the limit of a sequence.</p> <p>6.1.2. Determine whether a sequence converges, and calculate its limit if it does, using: properties of the limit of a sequence; l'Hôpital's Rule; the Squeeze Theorem; the convergence of bounded monotonic sequences.</p> <p>6.2.1. State the definition of convergence for an infinite series.</p> <p>6.2.2. State the test for divergence of an infinite series.</p> <p>6.2.3. Use 6.2.1 to determine if a telescoping series converges, and if so, calculate the sum.</p> <p>6.2.4. State the criterion for the convergence of an infinite geometric series.</p> <p>6.2.5. Calculate the sum of a convergent geometric series (6.2.4); use this to solve appropriate problems (e.g., the distance travelled by a bouncing ball).</p> <p>6.2.6. State the integral, <math>p</math>-series, (direct) comparison, limit comparison, ratio and <math>(n^{\text{th}})</math> root tests for convergence of an infinite series.</p> <p>6.2.7. Determine whether an infinite series converges or diverges by choosing (and using) correct methods among (6.2.1–6.2.6)</p> <p>6.3.1. State the definitions of absolute and conditional convergence of an infinite series.</p> <p>6.3.2. State the definition of an alternating series.</p> <p>6.3.3. State the criterion for the (conditional) convergence of an alternating series.</p> <p>6.3.4. Determine if an infinite series is absolutely convergent, conditionally convergent, or divergent, using the methods of (6.2.1–6.2.7, 6.3.1–6.3.3).</p> <p>6.4.1. Use the methods of (6.2, 6.3) to find the radius and interval of convergence for a power series.</p> <p>6.4.2. State the definitions of the Taylor and Maclaurin polynomials of degree <math>n</math> for a function <math>f</math> centred at <math>a</math>.</p> <p>6.4.3. State the definitions of the Taylor and Maclaurin series for a function <math>f</math> centred at <math>a</math>.</p> <p>6.4.4. Use 6.4.3 to approximate a function <math>f</math> at a given point.</p>