**General Information.**

**Discipline:** Mathematics  
**Course code:** 201-AS2-AB  
**Ponderation:** 2-2-2  
**Prerequisite:** 201-AS1-AB (Differential Calculus)  
**Credits:** 2  
**Objective:** To solve problems using integral calculus (01Y2)

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**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.

**Departmental Attendance Policy.** Regular attendance is expected. Missing six classes is grounds for automatic failure in this course. Many of the failures in this course are due to students missing classes.

**Evaluation Plan.** 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 20% of the Class Mark), and quizzes and assignments (worth 25% of the Class Mark).

The Final Grade will be the better of:

- 50% Class Mark and 50% Final Exam Mark
- 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.**


**Course Costs.** None apart from the text listed above.

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**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)
1.7 Inverse Trigonometric Functions (73–78)
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.**

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 near H-211; teachers are on duty from 9:00 until 16:00 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.

Changes to Evaluation Plan in Course Outline (Article 5.3). Changes to require documented unanimous consent from regularly attending students and approval by the department and the program dean.

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. Supplementary notes and problems may be provided as appropriate.

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OBJECTIVES

Statement of the Competency

To solve problems using integral calculus (01Y2).

Elements of the Competency

1. Represent the problem as a real-valued function of one variable.
2. Apply integral calculus to solve the problem.
3. Evaluate the results in terms of the problem to be solved.
4. Explain the problem-solving process.

STANDARDS

General Performance Criteria

• Representation of a situation as a function: clear description of the relevant variables and precise formulation of the function
• Adequate representation of surfaces and solids of revolution
• Appropriate use of concepts
• Appropriate use of terminology
• Correct choice and application of integration techniques
• Correct algebraic operations
• Accurate calculations
• Correct interpretation of results
• Proper justification of steps in a solution

Specific Performance Criteria

[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 ...”.]
<table>
<thead>
<tr>
<th>Specific Performance Criteria</th>
<th>Intermediate Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Indefinite integrals</strong></td>
<td><strong>1.1.1.</strong> Express Calculus I differentiation rules as antidifferentiation rules.</td>
</tr>
<tr>
<td>1.1 Use of basic substitutions to determine simple indefinite integrals.</td>
<td><strong>1.1.2.</strong> Use these antidifferentiation rules and appropriate substitutions to calculate indefinite integrals.</td>
</tr>
<tr>
<td>1.2 Use of more advanced techniques to determine more complex indefinite integrals.</td>
<td><strong>1.2.1.</strong> Use identities to prepare indefinite integrals for solution by substitution.</td>
</tr>
<tr>
<td><strong>2. Limits of indeterminate forms</strong></td>
<td><strong>1.2.2.</strong> Evaluate an indefinite integral using integration by parts.</td>
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<tr>
<td>2.1 Use of l’Hôpital’s rule to determine limits of indeterminate forms.</td>
<td><strong>1.2.3.</strong> Evaluate an indefinite integral using trigonometric identities.</td>
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<tr>
<td><strong>3. Definite and improper integrals</strong></td>
<td><strong>1.2.4.</strong> Evaluate an indefinite integral by partial fractions.</td>
</tr>
<tr>
<td>3.1 Use of the Fundamental Theorem of Calculus to evaluate a definite integral.</td>
<td><strong>1.2.5.</strong> Evaluate an indefinite integral by selecting an appropriate technique.</td>
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<tr>
<td>3.2 Use of limits to calculate improper integrals.</td>
<td><strong>1.2.6.</strong> Evaluate an indefinite integral by using a combination of techniques.</td>
</tr>
<tr>
<td><strong>4. Differential equations</strong></td>
<td><strong>2.1.1.</strong> State l’Hôpital’s rule and the conditions under which it is valid.</td>
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<tr>
<td>4.1 Use the language of differential equations to express physical problems.</td>
<td><strong>2.1.2.</strong> Calculate limits of the indeterminate forms ( \frac{0}{0} ) and ( \frac{\infty}{\infty} ) using l’Hôpital’s rule.</td>
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<tr>
<td>4.2 Use of antidifferentiation to obtain general solutions to simple differential equations.</td>
<td><strong>2.1.3.</strong> For the indeterminate forms ( 0 \cdot \infty, \infty - \infty, \frac{\infty}{0}, 0^0, \infty^0 ), use the appropriate transformation to determine the limit using l’Hôpital’s rule.</td>
</tr>
<tr>
<td>4.3 Use of antidifferentiation to obtain particular solutions to simple initial value problems.</td>
<td><strong>2.1.4.</strong> State ( \frac{f(x)}{g(x)} ) around a point.</td>
</tr>
<tr>
<td><strong>5. Areas, volumes, and lengths</strong></td>
<td><strong>2.1.5.</strong> Use ( \int f(x) , dx ) to evaluate improper integrals.</td>
</tr>
<tr>
<td>5.1 Use of differentials to set up definite integrals.</td>
<td><strong>2.1.6.</strong> Use ( \int f(x) , dx ) to determine limits of the indeterminate forms ( \frac{0}{0} ) and ( \frac{\infty}{\infty} ) using l’Hôpital’s rule.</td>
</tr>
<tr>
<td>5.2 Calculation of areas of planar regions.</td>
<td><strong>2.1.7.</strong> Use ( \int f(x) , dx ) to determine limits of the indeterminate forms ( 0 \cdot \infty, \infty - \infty, \frac{\infty}{0}, 0^0, \infty^0 ), use the appropriate transformation to determine the limit using l’Hôpital’s rule.</td>
</tr>
<tr>
<td><strong>5.3 Calculation of volumes of revolution</strong></td>
<td><strong>2.1.8.</strong> Use ( \int f(x) , dx ) to evaluate improper integrals.</td>
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<tr>
<td>5.3.1 Use of ( \int f(x) , dx ) to set up a definite integral to calculate the volume of the solid (5.3.1) by shells.</td>
<td><strong>2.1.9.</strong> Use ( \int f(x) , dx ) to determine limits of the indeterminate forms ( 0 \cdot \infty, \infty - \infty, \frac{\infty}{0}, 0^0, \infty^0 ), use the appropriate transformation to determine the limit using l’Hôpital’s rule.</td>
</tr>
<tr>
<td>5.3.2 Use ( \int f(x) , dx ) to set up an indefinite integral to calculate the volume of the solid (5.3.1) by cross-sections.</td>
<td><strong>2.1.10.</strong> Use ( \int f(x) , dx ) to evaluate improper integrals.</td>
</tr>
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<td>5.4 Calculation of lengths of curves.</td>
<td><strong>2.1.11.</strong> Use ( \int f(x) , dx ) to determine limits of the indeterminate forms ( 0 \cdot \infty, \infty - \infty, \frac{\infty}{0}, 0^0, \infty^0 ), use the appropriate transformation to determine the limit using l’Hôpital’s rule.</td>
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<td><strong>6. Infinite series</strong></td>
<td><strong>2.1.12.</strong> Use ( \int f(x) , dx ) to evaluate improper integrals.</td>
</tr>
<tr>
<td>6.1 Determination of the convergence or divergence of a sequence.</td>
<td><strong>2.1.13.</strong> Use ( \int f(x) , dx ) to determine limits of the indeterminate forms ( 0 \cdot \infty, \infty - \infty, \frac{\infty}{0}, 0^0, \infty^0 ), use the appropriate transformation to determine the limit using l’Hôpital’s rule.</td>
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<tr>
<td>6.2 Determination of the convergence or divergence of an infinite series of positive terms.</td>
<td><strong>2.1.14.</strong> Use ( \int f(x) , dx ) to evaluate improper integrals.</td>
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<tr>
<td>6.3 Determination of the convergence, conditional or absolute, or divergence of an infinite series.</td>
<td><strong>2.1.15.</strong> Use ( \int f(x) , dx ) to determine limits of the indeterminate forms ( 0 \cdot \infty, \infty - \infty, \frac{\infty}{0}, 0^0, \infty^0 ), use the appropriate transformation to determine the limit using l’Hôpital’s rule.</td>
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<tr>
<td>6.4 Expression of functions as power series</td>
<td><strong>2.1.16.</strong> Use ( \int f(x) , dx ) to evaluate improper integrals.</td>
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<tr>
<td>6.4.1 Use ( \int f(x) , dx ) to approximate a function ( f ) at a given point.</td>
<td><strong>2.1.17.</strong> Use ( \int f(x) , dx ) to determine limits of the indeterminate forms ( 0 \cdot \infty, \infty - \infty, \frac{\infty}{0}, 0^0, \infty^0 ), use the appropriate transformation to determine the limit using l’Hôpital’s rule.</td>
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