

## General Information.

*Discipline:* Mathematics

*Course code:* 201-301-RE

*Ponderation:* 2-1-3

*Credits:* 2

*Prerequisite:* 360-300-RE

### Objectives:

- 022W: To analyze, to apply advanced statistical tools, based on the probability theory, to decision making in contexts of study in the field of Social Science
- 022R: To thoroughly analyze a human phenomenon
- 022S: To apply concepts related to Social Science disciplines to the understanding of the human phenomena in concrete situations

*Students are strongly advised to seek help from their instructor as soon as they encounter difficulties in the course.*

**Introduction.** Advanced Quantitative Methods is an optional mathematics course in the Social Science Program especially for the Psychology exit profile. It is usually taken in the third or fourth semester. Advanced Q.M. introduces the student to advanced statistical tools in the field of Social Science.

The primary purpose of the course is the attainment of Objectives 022W, 022R, 022S (“To analyze, to apply advanced statistical tools, based on the probability theory, to decision making in contexts of study in the field of Social Science. To thoroughly analyze a human phenomenon. To apply concepts related to Social Science disciplines to the understanding of the human phenomena in concrete situations”). To achieve this goal, this course must help the student understand the techniques of probability and inferential statistics to analyze data.

Emphasis will be placed on clarity, accuracy and rigor in reasoning and in the application of methods. The student will learn to interpret statistical data using public or private data in the field of Social Science such as grouped and ungrouped frequency distributions, probability distributions and sampling distributions. This will lead to the two main areas of inference: Estimation and Tests of hypothesis.

Students will be encouraged to use a scientific (non-graphing) calculator at the discretion of the instructor. Students will also have access to computers where appropriate data processing software programs used for statistical purposes are available for student use.

This course can contribute to the Environmental Studies certificate. For more information, talk to the teacher or contact the [certificate coordinator](#).

**Teaching Methods.** This course will be 45 hours, meeting twice a week for a total of 3 hours a week. The main techniques used will be the lecture and laboratory approaches. Other methods that may be used are: problem-solving sessions, class discussions and assigned reading for independent study. Regular homework involving a minimum of three hours per week should be expected. Students are responsible for all problems and exercises in the text relevant to material covered in class.

**Textbook.** There is no required textbook for this course. A set of exercises will be provided by your teacher. A good reference for the course material is *Understanding Basic Statistics, 8th Edition*, by Brase and Brase – (Houghton Mifflin). Note that this book may not be available for purchase at the bookstore, but reference copies are available in the Math Study Area and at the Library.

## Course Costs.

Your instructor might recommend you acquire a scientific (non-graphing) calculator (available at Bureau en Gros for approximately \$15 to \$20).

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

**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 will be calculated by the following distribution:

- Classmark: 60%
- Final Exam: 40%

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

## 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.

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

**Course Content.** Your teacher may supplement this list during the semester. Regular work done as the course progresses should make it easier for you to master the course.

### Chapter 5: Elementary Probability Theory.

- 5.1 What is probability?
- 5.2 Some probability rules - Compound events  
Bayes’ theorem - Teacher’s notes
- 5.3 Trees and counting techniques

### Chapter 6: The Binomial Probability Distribution and Related Topics.

- 6.1 Introduction to random variables and probability distributions
- 6.2 Binomial probabilities
- 6.3 Additional properties of the binomial distribution

### Chapter 7: Normal Distribution and Sampling Distributions.

- 7.1 Graphs of normal probability distributions
- 7.2 Standard units and areas under the curve
- 7.3 Areas under any normal curve
- 7.4 Sampling distributions
- 7.5 The central limit theorem
- 7.6 Normal approximation to the binomial distribution

### Chapter 8: Estimation.

- 8.1 Estimating  $\mu$  when  $\sigma$  is known
- 8.2 Estimating  $\mu$  when  $\sigma$  is unknown
- 8.3 Estimating  $p$  in the binomial distribution

### Chapter 9: Hypothesis Testing.

- 9.1 Introduction to statistical tests
- 9.2 Testing the mean  $\mu$
- 9.3 Testing the proportion  $p$

### Chapter 10: Inferences About Differences.

- 10.1 Tests involving paired differences (dependent samples)
- 10.2 Inferences about the differences of two means  $\mu_1 - \mu_2$
- 10.3 Inferences about the differences of two proportions  $p_1 - p_2$  (optional)

### Chapter 11: Chi square.

**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.

**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.

OBJECTIVES	STANDARDS
<p><b>Statement of the competency</b></p> <p>To analyze, to apply advanced statistical tools, based on the probability theory, to decision making in contexts of study in the field of Social Science (022W). To thoroughly analyze a human phenomenon (022R). To apply concepts related to Social Science disciplines to the understanding of the human phenomena in concrete situations (022S)</p> <p><b>Elements of the Competency</b></p> <ol style="list-style-type: none"> <li>1. To correctly use concepts of probability in the decision-making process.</li> <li>2. To correctly use the various probability distributions in the decision-making process.</li> <li>3. To standardize data</li> <li>4. To estimate an average in a given population by confidence interval, using small samples and taking the confidence level into account.</li> <li>5. To perform the most relevant test of hypothesis.</li> </ol>	<p><b>General Performance Criteria</b></p> <ul style="list-style-type: none"> <li>• Accurate use of appropriate concepts and vocabulary.</li> <li>• Accurate evaluation of the probability of events using combinatory analysis, binomial distribution or normal distribution.</li> <li>• Appropriate calculation of the probability distribution of a discrete random variable and of its expectation and standard deviation.</li> <li>• Correct use of probability distributions in a decision-making process.</li> <li>• Satisfactory transformation of data into standardized data based on a rating scale commonly used in psychology and education.</li> <li>• Interval estimation of an average in a given population, using small samples and taking the confidence level into account.</li> <li>• Rigorous performance of tests of hypothesis on an average, a proportion and a population, and the test of goodness of fit on a distribution, taking into account the significance level.</li> <li>• Formal verification of the effect of the treatment on a group by comparing two averages using paired or independent samples.</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>1. <i>Concepts of Probability</i></p> <p>1.1 Definition of basic terminology</p>	<p>1.1.1. State the definition of probability.</p> <p>1.1.2. Differentiate between classical, relative frequency and subjective probabilities.</p> <p>1.1.3. Define outcomes, sample space and events.</p>
<p>1.2 Use of counting methods</p>	<p>1.2.1. State and apply the fundamental counting principle.</p> <p>1.2.2. State and apply the Permutation and Combination rules.</p>
<p>1.3 Probability theories</p>	<p>1.3.1. State and apply the conditional probability rule.</p> <p>1.3.2. State and apply the multiplication rule.</p> <p>1.3.3. State and apply the addition rule.</p> <p>1.3.4. State and apply Bayes' Rule.</p>
<p>2. <i>Probability Distributions</i></p>	
<p>2.1 Description of a random variable</p>	<p>2.1.1. State the definition of a discrete random variable (r.v.)</p> <p>2.1.2. State the definition of a continuous random variable.</p>
<p>2.2 Computation and interpretation of the mean, variance and std. deviation of a discrete random variable (r.v.)</p>	<p>2.2.1. Define and calculate the mean of a discrete random variable.</p> <p>2.2.2. Define and calculate the expected value of a discrete random variable.</p> <p>2.2.3. Define and calculate the variance and std. deviation of a discrete r.v.</p>
<p>2.3 Determination of a mean, variance and std. deviation of a linear function of a discrete r.v.</p>	<p>2.3.1. Define a linear function of a discrete r.v.</p> <p>2.3.2. Calculate and interpret the mean and variance of a linear function of a discrete r.v.</p>
<p>2.4 Calculation of probabilities, mean and variance of a binomial r.v.</p>	<p>2.4.1. Define a binomial r.v.</p> <p>2.4.2. Define a binomial probability mass function (p.m.f.).</p> <p>2.4.3. Calculate probabilities using the binomial p.m.f.</p> <p>2.4.4. Compute the mean and variance of the binomial r.v.</p>
<p>2.5 Determination of probabilities, mean and variance of a continuous r.v.</p>	<p>2.5.1. Define and compute the mean of a continuous r.v.</p> <p>2.5.2. Define and compute the variance of a continuous r.v.</p> <p>2.5.3. Calculate the probability of an event described in terms of a continuous r.v.</p>
<p>3. <i>Standardize Data</i></p>	
<p>3.1 Calculation and application of probabilities for a normal distribution</p>	<p>3.1.1. State the probability density function (p.d.f.) of a normal r.v.</p> <p>3.1.2. State the mean, std. deviation and resulting p.d.f.</p> <p>3.1.3. Use the std. normal tables to compute probabilities for a normal r.v.</p> <p>3.1.4. Use the normal distribution to solve social science related problems.</p> <p>3.1.5. State the conditions under which the normal distribution can be used as an approximation of the binomial distribution.</p> <p>3.1.6. Calculate probabilities using the normal approximation.</p>
<p>3.2 Determination of probabilities for a sampling distribution</p>	<p>3.2.1. State the Central Limit Theorem (C.L.T.)</p> <p>3.2.2. Determine intuitively the results of the C.L.T.</p> <p>3.2.3. Use the C.L.T. to calculate probabilities of an event described in terms of the distribution of the sample means.</p> <p>3.2.4. State the distribution of sample proportions.</p> <p>3.2.5. Calculate the probability of an event described in terms of the distribution of sample proportions.</p>
<p>4. <i>Estimation of an average</i></p>	
<p>4.1 Determination of confidence interval estimates (one population, small sample)</p>	<p>4.1.1. State the definition of the level of confidence <math>(1 - \alpha)</math>.</p> <p>4.1.2. Determine a confidence interval estimate for the population mean.</p> <p>4.1.3. Determine a confidence interval estimate for the population proportion.</p>
<p>5. <i>Test of Hypothesis</i></p>	
<p>5.1 Definition of basic terms</p>	<p>5.1.1. Define the following terms used in a test of hypothesis: Null hypothesis ; Alternative hypothesis ; Type I and Type II errors ; Test criteria ; Test statistic ; Level of significance ; <math>P</math>-value ; Discussion and conclusion</p>
<p>5.2 Test of hypothesis about the population mean (small sample)</p>	<p>5.2.1. Perform a hypothesis test about the population mean.</p>
<p>5.3 Test of hypothesis about the proportion of successes in a binomial population (small sample)</p>	<p>5.3.1. Perform a test of hypothesis about the population proportion (small sample).</p>
<p>5.4 Test of hypothesis about the difference of two population means</p>	<p>5.4.1. Perform a hypothesis test about the difference of two population means using two dependent samples (paired data).</p> <p>5.4.2. Perform a hypothesis test about the difference of two population means using two independent random samples.</p>
<p>5.5 Test of goodness of fit on a distribution (non-parametric statistics)</p>	<p>5.5.1. Application of the Chi-Squared distribution.</p>