JOHN ABBOTT CEGEP/COLLEGE

Applied Statistics in Social Science

SOCIAL SCIENCE
COURSE OUTLINE
WINTER 2025

General Information.

Discipline: Mathematics *Course code*: 201-SH5-AB
Ponderation: 2-1-3 *Credits*: 2 *Prerequisite*: 360-223-AB
Objective:

- 0PU5: Analyze problems studied in the social sciences by using statistical tools based on probability theory.

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. Applied Statistics is an optional mathematics course in the Social Science program and is required for the Psychology profile. It is usually taken in the fourth semester. Applied Statistics introduces the student to probability and advanced statistical tools in the field of Social Science.

The primary purpose of the course is the attainment of Objective 0PU5 ("Analyze problems studied in the social sciences by using statistical tools based on probability theory."). 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.

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 assigned by the teacher 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.

A scientific (non-graphing, non-programmable) calculator is required for the lectures and for all the assessments. A suitable model (SHARP EL-531) is available at the bookstore for around $24.

Evaluation Plan. A student's Final Grade will be calculated by the following distribution:

-	Class Tests:	40%	(2-4 written in-class tests)
-	Minor Assessments:	20%	(see outline addendum)
-	Final Exam:	40%	

The Final Evaluation Task in this course consists of the Final Exam, which covers all elements of the competency.

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

Academic Success Centre. The Academic Success Centre, located in H-139, offers study skills workshops and individual tutoring.

College Policies.

Policy No. 7 - IPESA, Institutional Policy on the Evaluation of Student Achievement: https://www.johnabbott.qc.ca/wp-content/uploads/2021/05/Policy-No.-7-IPESA-FINAL.pdf.

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. The chapter and section numbers below refer to the reference textbook *Understanding Basic Statistics, 8th Edition*, by Brase and Brase – (Houghton Mifflin). 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 μ when is σ known
- 8.2 Estimating μ when is σ unknown
- 8.3 Estimating p in the binomial distribution

Chapter 9: Hypothesis Testing.

- 9.1 Introduction to statistical tests
- 9.2 Testing the mean μ
- 9.3 Testing a 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)

OBJECTIVES	STANDARDS
Statement of the competency Analyze problems studied in the social sciences by using statistical tools based on probability theory. (0PU5).	**General Performance Criteria for the Competency as a Whole** • Accurate recognition of the context in which situations involving the use of statistics and probability emerged • Appropriate mathematical modelling of real-world situations studied in the social sciences • Correct use of mathematical syntax • Demonstration of rigorous mathematical reasoning • Accurate and coherent interpretation of the results
Elements of the Competency	**General Performance Criteria**
1. Use probability theory in a decision-making process specific to a current human reality.	• Accurate characterization of current human realities involving chance • Application of the basics of set theory to a current human reality • Accurate evaluation of the probability of an event using combinatorial analysis • Appropriate representation of a probabilistic situation associated with a current human reality • Rigorous use of Bayesian inference in a decision-making process specific to a current human reality
2. Apply probability models to current human realities.	• Accurate recognition of the characteristics of the main probability distributions (uniform, binomial, normal distribution) • Appropriate construction of the probability distribution of a discrete random variable specific to a current human reality • Correct calculation of the expectation and standard deviation of a discrete random variable specific to a current human reality • Establishment of relevant relationships between probability models and current human realities
3. Use statistical inference in a decision-making process specific to a current human reality.	• Accurate recognition of the characteristics of the statistical inference and of the conditions for applying the central limit theorem • Accurate determination of the confidence intervals (small samples included) • Rigorous performance of relevant hypothesis testing depending on the situations encountered (hypothesis testing pertaining to a mean, a proportion, two paired or independent samples) • Correct interpretation of Type I and Type II errors as well as the P value • Correct determination of the adjustment of a current human reality to a probability distribution (uniform, binomial, normal distribution) • Establishment of relevant relationships between the statistical inference results and the decision-making process specific to a current human reality
4. Detect different types of biases in a decision-making process specific to a current human reality.	• Appropriate recognition of the main statistical biases • Appropriate recognition of statistical and probability paradoxes • Accurate interpretation of the biases associated with statistical and probability paradoxes as they pertain to a current human reality (Simpson's paradox, Will Rogers phenomenon, Birthday paradox, Monty Hall problem)

Specific Performance Criteria	**Intermediate Learning Objectives**
	[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 . . . ".]
1. ***Concepts of Probability***	
1.1 Definition of basic terminology	1.1.1. State the definition of probability. 1.1.2. Differentiate between classical, relative frequency and subjective probabilities. 1.1.3. Define outcomes, sample space and events.
1.2 Use of counting methods	1.2.1. State and apply the multiplication counting principle. 1.2.2. State and apply the Permutation and Combination rules. 1.2.3. Calculate probabilities in situations similar to the Birthday Problem.
1.3 Probability theories	1.3.1. State and apply the conditional probability rule. 1.3.2. State and apply the multiplication rule. 1.3.3. State and apply the addition rule. 1.3.4. State and apply Bayes' Rule. 1.3.5. Recognize and explain counter-intuitive results in probability, including Simpson's paradox and the Monty Hall problem.
2. ***Probability Distributions***	
2.1 Description of a random variable	2.1.1. State the definition of a discrete random variable (r.v.) 2.1.2. State the definition of a continuous random variable.
2.2 Computation and interpretation of the mean, variance and std. deviation of a discrete random variable (r.v.)	2.2.1. Define and calculate the mean of a discrete random variable. 2.2.2. Define and calculate the expected value of a discrete random variable. 2.2.3. Define and calculate the variance and std. deviation of a discrete r.v.
2.3 Calculation of probabilities, mean and variance of a binomial r.v.	2.3.1. Define a binomial r.v. 2.3.2. Define a binomial probability mass function (p.m.f.). 2.3.3. Calculate probabilities using the binomial p.m.f. 2.3.4. Compute the mean and variance of the binomial r.v.
2.4 Determination of probabilities, mean and variance of a continuous r.v.	2.4.1. Calculate the probability of an event described in terms of a continuous r.v. as an area (including the uniform distribution) 2.4.2. Explain when a uniform distribution or a normal distribution would apply in practice. 2.4.3. Explain the graphical interpretation of the mean and variance of a continuous r.v..
3. ***Standardize Data***	
3.1 Calculation and application of probabilities for a normal distribution	3.1.1. State the probability density function (p.d.f.) of a normal r.v. 3.1.2. State the mean, std. deviation and resulting p.d.f. 3.1.3. Use the std. normal tables to compute probabilities for a normal r.v. 3.1.4. Use the normal distribution to solve social science related problems. 3.1.5. State the conditions under which the normal distribution can be used as an approximation of the binomial distribution. 3.1.6. Calculate probabilities using the normal approximation.
3.2 Determination of probabilities for a sampling distribution	3.2.1. State the Central Limit Theorem (C.L.T.) 3.2.2. Determine intuitively the results of the C.L.T. 3.2.3. Use the C.L.T. to calculate probabilities of an event described in terms of the distribution of the sample means. 3.2.4. State the distribution of sample proportions. 3.2.5. Calculate the probability of an event described in terms of the distribution of sample proportions.
4. ***Interval Estimation***	
4.1 Determination of confidence interval estimates (one population)	4.1.1. State the definition of the level of confidence $(1-\alpha)$. 4.1.2. Determine a confidence interval estimate for the population mean (using a z-value) 4.1.3. Determine a confidence interval estimate for the population mean (using a t-value) 4.1.4. Determine a confidence interval estimate for the population proportion. 4.1.5. Write an appropriate interpretation of the confidence interval in the context of a real application.
5. ***Test of Hypothesis***	
5.1 Definition of basic terms	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 ; $P-$value ; Discussion and conclusion 5.1.2. Correctly calculate or estimate the P-value using the normal or t distribution tables. 5.1.3. Write an appropriate interpretation of the P-value. 5.1.4. Write an appropriate interpretation of the conclusion of a test of hypothesis in the context of a real application.
5.2 Test of hypothesis about the population mean	5.2.1. Perform a hypothesis test about the population mean (z-test). 5.2.2. Perform a hypothesis test about the population mean (t-test). 5.2.3. Correctly determine when a z-test or t-test is appropriate given the situation.
5.3 Test of hypothesis about the proportion of successes in a binomial population	5.3.1. Perform a test of hypothesis about the population proportion.
5.4 Test of hypothesis about the difference of two population means	5.4.1. Perform a hypothesis test about the difference of two population means using two dependent samples (paired data). 5.4.2. Perform a hypothesis test about the difference of two population means using two independent random samples. 5.4.3. Recognize and explain the Will Rogers phenomenon.