JOHN ABBOTT CEGEP/COLLEGE

Advanced Quantitative Methods

SOCIAL SCIENCE
COURSE OUTLINE
WINTER 2017

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 the Mathematics Lab and the Penfield Computer Centre where appropriate data processing software programs used for statistical purposes are available for student use. The course uses a standard college level Statistics textbook, chosen by the course committee.

OBJECTIVES	STANDARDS
Statement of the competency 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)	**General Performance Criteria** • Accurate use of appropriate concepts and vocabulary. • Accurate evaluation of the probability of events using combinatory analysis, binomial distribution or normal distribution. • Appropriate calculation of the probability distribution of a discrete random variable and of its expectation and standard deviation. • Correct use of probability distributions in a decision-making process. • Satisfactory transformation of data into standardized data based on a rating scale commonly used in psychology and education. • Interval estimation of an average in a given population, using small samples and taking the confidence level into account. • 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. • Formal verification of the effect of the treatment on a group by comparing two averages using paired or independent samples.
Elements of the Competency 1. To correctly use concepts of probability in the decision-making process. 2. To correctly use the various probability distributions in the decision-making process. 3. To standardize data 4. To estimate an average in a given population by confidence interval, using small samples and taking the confidence level into account. 5. To perform the most relevant test of hypothesis.	**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 . . . ".]*

Specific Performance Criteria	**Intermediate Learning Objectives**
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 fundamental counting principle. 1.2.2. State and apply the Permutation and Combination rules.
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.
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 Determination of a mean, variance and std. deviation of a linear function of a discrete r.v.	2.3.1. Define a linear function of a discrete r.v. 2.3.2. Calculate and interpret the mean and variance of a linear function of a discrete r.v.
2.4 Calculation of probabilities, mean and variance of a binomial r.v.	2.4.1. Define a binomial r.v. 2.4.2. Define a binomial probability mass function (p.m.f.). 2.4.3. Calculate probabilities using the binomial p.m.f. 2.4.4. Compute the mean and variance of the binomial r.v.
2.5 Determination of probabilities, mean and variance of a continuous r.v.	2.5.1. Define and compute the mean of a continuous r.v. 2.5.2. Define and compute the variance of a continuous r.v. 2.5.3. Calculate the probability of an event described in terms 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. *Estimation of an average*	
4.1 Determination of confidence interval estimates (one population, small sample)	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. 4.1.3. Determine a confidence interval estimate for the population proportion.
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
5.2 Test of hypothesis about the population mean (small sample)	5.2.1. Perform a hypothesis test about the population mean.
5.3 Test of hypothesis about the proportion of successes in a binomial population (small sample)	5.3.1. Perform a test of hypothesis about the population proportion (small sample).
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.
5.5 Test of goodness of fit on a distribution (non–parametric statistics)	5.5.1. Application of the Chi-Squared distribution.

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 four hours per week should be expected. Students are responsible for all problems and exercises in the text relevant to material covered in class.

Other Resources.

Math Website.
http://departments.johnabbott.qc.ca/departments/mathematics

Math Lab. Located in H-022; open from 9:00 to 16:00 (weekdays) as a study area, and from 11:30 to 16:00 for borrowing course materials or using the computers and printers for math assignments.

Math Help Centre. Located in H-022; 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.

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.

Textbook. The textbook for this course is
Understanding Basic Statistics, 7th Edition, by Brase and Brase – (Houghton Mifflin). Reference copies are available in the Math Lab.

Course Costs.
In addition to the cost of the text listed above, your instructor might recommend you acquire a scientific (non-graphing) calculator (available at Bureau en Gros for approximately $5 to $20).

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 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 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.

Evaluation Plan. 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.

College Policies. Article numbers refer to the IPESA (Institutional Policy on the Evaluation of Student Achievement, available at http://johnabbott.qc.ca/ipesa). Students are encouraged to consult the IPESA to learn more about their rights and responsibilities.

Changes to Evaluation Plan in Course Outline (Article 4.3). Changes to the evaluation plan, during the semester, require unanimous consent.

Mid-Semester Assessment MSA (Article 3.3). Students will receive an MSA in accordance with College procedures.

Religious Holidays (Article 3.2). Students who wish to observe religious holidays must inform their teacher in writing within the first two weeks of the semester of their intent.

Grade Reviews (Article 3.2, item 19). It is the responsibility of students to keep all assessed material returned to them in the event of a grade review. (The deadline for a Grade Review is 4 weeks after the start of the next regular semester.)

Results of Evaluations (Article 3.3, item 7). Students have the right to receive the results of evaluation, for regular day division courses, within two weeks. For evaluations at the end of the semester/course, the results must be given to the student by the grade submission deadline.

Cheating and Plagiarism (Articles 8.1 & 8.2). Cheating and plagiarism are serious infractions against academic integrity, which is highly valued at the College; they are unacceptable at John Abbott College. Students are expected to conduct themselves accordingly and must be responsible for all of their actions.