



## STAT-206 – Calculus Based Statistics

University Arts and Science

**Effective Term & Year:** Fall 2022

**Course Outline Review Date:** 2024-09-01

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**Program Area:** Math and Sciences

### **Description:**

This course is intended for students who are pursuing Engineering or a Bachelor of Science degree. Topics include probability theory, random variables, expected values, variance, moments, probability distributions (binomial, hypergeometric, Poisson, normal, geometric, negative binomial and gamma), estimation (properties of estimators, method of maximum likelihood and method of moments), hypothesis testing (type I and II errors, and generalized likelihood ratio tests), distributions ( $\chi^2$ , t and F) and their tests, goodness of fit and contingency tables, regression and ANOVA. Statistics are used to analyze data throughout the sciences, including Biology, Chemistry, Commerce, Computer Science, Engineering, Geology, Mathematics, Medicine and Physics.

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### **Program Information:**

This course can be used to satisfy the requirements of an Associate of Science degree at College of the Rockies.

**Delivery Methods:** On-campus (Face-to-Face)

**Credit Type:** College of the Rockies Credits

**Credits:** 3

**Course type/s:** Sciences

### **Instructional Activity and Hours:**

Activity	Hours
Classroom, Directed Studies or Online Instruction	45
Seminar/Tutorials	
Laboratory/Studio	
Practicum/Field Experience	
Co-op/Work Experience	
Other	
<b>Total</b>	<b>45</b>

### Course Requisites:

- Completed or concurrently enrolled in:
  - [MATH104](#) – Integral Calculus (3)

### Flexible Assessment: Yes

In some cases students may be able to apply for recognition of prior learning outside the classroom. This flexible assessment process provides equivalent course credit. It is a rigorous process that may include external evaluation, worksite assessment, demonstration, standardized test, self-assessment, interview, products/portfolio, and challenge exam, or other measures as appropriate. Tuition fees apply. Contact an education advisor for more information.

### Course Transfer Credit:

For information about receiving transfer credit for courses taken at either British Columbia or Alberta institutions, please see <https://www.bctransferguide.ca/> or <https://transferalberta.alberta.ca> . For more transfer credit information, please visit <https://www.cotr.bc.ca/Transfer>

All requests for course transfer credit from institutions in British Columbia or elsewhere should go to the College of the Rockies Enrolment Services office.

### Textbook Resources:

Textbook selection varies by instructor and may change from year to year. At the Course Outline Effective Date the following textbooks were in use:

Larsen, Richard J., and Morris, L. Marx, *An Introduction to Mathematical Statistics and its' Applications* 5th edition

Please see the instructor's syllabus or check COTR's online text calculator <https://textbook.cotr.bc.ca/> for a complete list of the currently required textbooks.

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## Learning Outcomes:

Because statistics are used in any field where data must be analyzed, this course is appropriate for many careers, including Biology, Chemistry, Commerce, Computer Science, Engineering, Geology, Mathematics, Medicine and Physics.

Upon the successful completion of this course, students will be able to:

- understand the fundamentals of probability including the axioms, discrete and continuous probability distributions, and conditional and combinatorial probability;
- work with random variables including their expected values, variance, higher moments and moment generation functions;
- work with special probability distributions including the binomial, hypergeometric, poisson, normal, geometric, negative binomial and gamma distributions, and recognize when they are appropriate;
- understand desirable properties for estimators, including unbiasedness, efficiency, consistency and sufficiency;
- use the methods of maximum likelihood and moments to find estimators and determine if they have the desired properties;
- understand the concept of an hypothesis test and type I and type II errors;
- understand how to generate hypothesis tests using generalized likelihood ratio tests;
- understand the normal distribution including estimators for the mean and variance, central limit theorem and the  $\chi^2$ ,  $t$ -, and  $F$ - distributions;
- perform relevant two sample tests;
- perform goodness of fit tests;
- use linear regression including least squares fits, covariance and correlation, and the appropriate hypothesis tests; and
- do ANOVA.

This course should help students

- use written and oral communication skills effectively, employing methods appropriate to message and context;
- think clearly and critically, fusing experience, knowledge and reasoning into considered judgment;
- identify, interpret and solve problems, effectively implementing and evaluating proposed strategies;
- develop organizational, problem solving, and critical thinking skills;
- learn to work both independently and in groups;
- learn to transfer knowledge to new contexts;
- practice comprehending and interpreting abstract materials from text; and
- develop an appreciation of the importance of persistence, a positive attitude and energy.

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**Course Topics:**

## 1. Probability

- a) Axioms
- b) Discrete probability functions
- c) Continuous probability functions
- d) Conditional probability; independence
- e) Combinatorial probability

## 2. Random variables

- a) Densities; joint densities
- b) Combining and transforming random variables
- c) Conditional densities
- d) Expected values: properties
- e) Variance
- f) Moments and moment generating functions
- g) Chebyshev's inequality

## 3. Probability distributions

- a) Binomial distribution
- b) Hypergeometric distribution
- c) Poisson distribution
- d) Normal distribution
- e) Geometric distribution
- f) Negative binomial distribution
- g) Gamma distribution

#### 4. Estimation

##### a) Properties

i) Unbiasedness

ii) Efficiency; minimum variance estimator

iii) Consistency

iv) Sufficiency

##### b) Methods of finding estimators

i) Method of Maximum Likelihood

ii) Method of Moments

##### c) Interval estimation

#### 5. Hypothesis testing

a) Errors: type I and type II errors

b) Generalized likelihood ratio tests

#### 6. The normal distribution

a) Point estimates for  $\mu$  and  $\sigma^2$ .

b) Central limit theorem

c) The  $\chi^2$ ,  $t$  and  $F$ -distributions

d) One sample  $t$  test

#### 7. Two sample tests

a) Testing (two sample  $t$ -test)

b) Testing ( $F$  test)

c) Testing (binomial data)

d) Confidence intervals

#### 8. Goodness of fit

- a) Multinomial distribution
- b) goodness-of-fit tests
  - i) Parameters known
  - ii) Parameters unknown
- c) contingency tables

## 9. Regression

- a) Covariance and correlation
- b) Least squares
- c) Linear model
- d) Bivariate normal

## 10. ANOVA

- a) The  $F$ -test
- b) Computational formulae
- c) Orthogonal contrasts
- d) Tukey's method

*See instructor's syllabus for the detailed outline of weekly readings, activities and assignments.*

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## Evaluation and Assessments

### Assessment Type: On-Campus (face-to-face)

Assessment Type	% of Total Grade
Assignments	15%
Project	15%
Midterm Tests	30%
Final Exam	40%
Total	100%

### Grade Scheme

A+	A	A-	B+	B	B-	C+	C	C-	D	F
>=90	89-85	84-80	79-76	75-72	71-68	67-64	63-60	59-55	54-50	<50

**Evaluation Notes:** A grade of “D” grants credit, but may not be sufficient as a prerequisite for sequential courses.

### Evaluation Notes Comments:

*Please see the instructor' syllabus for specific classroom policies related to this course, such as details of evaluation, penalties for late assignments and use of electronic aids.*

### Exam Attendance:

Students must attend all scheduled exams at the appointed time and place. Instructors may approve an alternate exam to accommodate an illness or personal crisis. Department heads will consider other written requests. Any student who misses a scheduled exam without prior approval will receive a “0” on the exam.

### Academic Policies:

College of the Rockies policies related to courses can be found at <https://cotr.bc.ca/about-us/college-policies/> and include the following:

- Policy 2.4.3 Students with Documented Disabilities
- Policy 2.4.4 Student Conduct (plagiarism, other cheating, behavioral misconduct)
- Policy 2.5.8 Academic Performance
- Policy 2.5.3 Grade Appeal
- Policy 2.4.9 Student Concerns Re Faculty

### Course Changes:

The College of the Rockies updates course outlines regularly to meet changing educational, employment and marketing needs. The instructor will notify students in writing of any updates to this outline during the semester. The instructor reserves the right to revise, add or delete material while meeting the learning outcomes of this course outline.