DALHOUSIE UNIVERSITY

# Faculty of Science Course Syllabus
## Department of *Mathematics and Statistics*
### *Stat 3360*
### *Probability*
### *Fall 2019*

**Instructor:** Dr. Ammar Sarhan *ammar.sarhan@dal.ca* Chase 105

**Lectures**: TR 11:35 -12:55 LSC C240

**Laboratories**: *None* **Tutorials**: *None*

**Office hours:** TWF 10:30-11:25

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**Course Description**

The concepts and application of probability. Topics include the classical discrete and continuous distributions, including the binomial, hypergeometric, multinomial, Poisson, uniform, exponential and normal; definitions and properties of random variables; independence; sums of independent random variables, including the law of large numbers and central limit theorem; conditional probability; and the bivariate normal distribution. Examples will be taken from the natural and physical sciences.

**Course Prerequisites**

STAT/MATH 2060 and MATH 2001

**Course Objectives/Learning Outcomes**

- Calculate the expected value and variance of a continuous random variable.
- Compute probabilities for Uniform random variables.
- Calculate probabilities given a Normal density.
- Calculate the shortest intervals given a Normal density and the probability of the interval.
- Calculate parameter values for a normal density given probabilities over some intervals.
- Use Normal approximation to approximate Binomial probabilities.
- Calculate probabilities for exponential distribution.
- Interpret the memoryless property of an exponential random variable.
- Apply the memoryless property of an exponential random variable to derive the hazard rate function.
- Derive the distribution of a function of a random variable given probability density function or probability mass function of the random variable.
- Calculate probabilities for multiple random variables based on joint probability functions.
- Calculate marginal distributions from joint distributions.
- Calculate joint density functions from Joint cumulative distribution functions or Vice verse.
- Solve problems using the properties of independent random variables.
- Calculate the joint probability distribution of functions of random variables.
- Calculate the probability density functions or cumulative distribution functions for sums of independent random variables.
- Calculate the conditional probability mass function and conditional probability distribution function for discrete random variables.
- Calculate the conditional probability density function and conditional probability distribution function for continuous random variables.

- Using the property of expectation of sums of random variables to solve expected value problems or calculate probabilities.
- Calculate expectation and variance by calculating the moments of the number of events that occur.
- Calculate covariance of random variables.
- Calculate expectation by conditional expectation.
- Calculate conditional variance.
- Calculate variance through calculating the expectation of conditional variance and variance of conditional expectation.
- Calculate moment generating functions for either a discrete random variable or a continuous random variable.
- Compute moments of a random variable by differentiating the moment generating function of the random variable.
- Use Markov's inequality to obtain bounds on the probabilities of some events.
- Use Chebyshev's Inequality to obtain bounds on the probabilities of some events.
- Use Chernoff bounds to obtain bounds on the probabilities of some events.
- Solve probability problems for large samples by applying Central limit theorem.
- Apply the weak law of large numbers or the strong law of large numbers to derive behaviour of a random variable which can be expressed as mean of n iid random variables when n is large.

## Course Materials

- **Textbook:** "A First Course in Probability" (10th Edition) by Sheldon Ross; Pearson, 2018
- ***Course website:*** *Brightspace*

## Course Assessment

| Component | Weight (% of final grade) | Date |
|---|---|---|
| ***Midterm Exam*** | *30* | ***October 24*** |
| ***Final exam*** | *55* | *(Scheduled by Registrar)* |
| ***Assignments*** | ***15*** | ***8 (approximately weekly) assignments*** |

## Other course requirements

**Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A+ | (90-100) | B+ | (77-79) | C+ | (65-69) | D | (50-54) |
| A | (85-89) | B | (73-76) | C | (60-64) | F | (<50) |
| A- | (80-84) | B- | (70-72) | C- | (55-59) | | |

## Course Policies

- Late assignments will not be accepted.
- I do not use the **Student Declaration of Absence form** for missed academic requirement.
- Students should work independently on the assignments.
- Students can work together on the assignments, but they cannot copy the same answers.
- Copying the same answer from another student or somewhere else (for example: from the internet or the manual solution, or previous years assignments, etc.) will be considered as an academic offense.
- Plagiarism software may be used in course

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**Course Content**

- We expect to cover most of the material in Chapters 1-8 in the textbook.
- The following table shows the sections of the textbook that will be covered each week. This list may be updated from time to time, depending on the progress made in earlier lectures.

| Week beginning | Tuesday | Thursday |
|---|---|---|
| Sept 2 | 1.2 Basic Principle of Counting (Multiplication Principle, Rule of product), 1.3 Permutations, 1.4 Combinations | 1.5 Multinomial Coefficients, 2.2 Sample Spaces & events, 2.3 Axioms of Probability, 2.4 Simple Propositions |
| Sep 9 | 2.5 Sample Spaces of Equally Likely Events, 2.6 Probability as a Continuous Set Function, 2.7 Probability as a Measure of Belief | 3.2 Conditional Probability, 3.3 Bayes Formula |
| Sept 16 | 3.4 Independent Events, 3.5 P(.\|F) is a probability | 4.1 Random Variables (RVs), 4.2 Discrete RVs, 4.3 Expected Value |
| Sept 23 | 4.4 Expectation of a Function of a RV, 4.5 Variance, 4.6 Bernoulli & Binomial RVs, 4.7 Poisson RVs | 4.9 Expectation of Sums of RVs, 4.10 Cumulative Distribution Functions |
| Sept 30 | 5.1 Continuous RVs, 5.2 Expectation and Variance of Continuous RVs, 5.3 Uniform Vs | 5.4 Normal Random Variables |
| Oct 7 | 5.5 Exponential RVs, 5.7 Distribution of a Function of a RV | Revision Chapters 1-5 |
| Oct 14 | 6.1 Joint Distribution Functions, 6.2 Independent RVs | 6.3 Sums of Independent RVs, 6.7 Joint Probability Distribution of Functions of RVs |
| Oct 21 | Revision Chapters 1-6 | MIDTERM EXAMINATION |
| Oct 28 | 6.4 Conditional Distributions (Discrete), 6.5 Conditional Distributions (Continuous) | 7.2 Expectation of Sums of RVs, 7.3 Moments of the Number of Events that Occur |
| Nov 4 | 7.4 Covariance, Variance of Sums and Correlation, 7.5 Conditional Expectation, 7.6 Conditional Expectation and Prediction | 7.7 Moment Generating Functions, 7.8 Additional Properties of Normal Random Variables |
| Nov 11 | Study break | |
| Nov 18 | 8.2 Markov's Inequality, Chebyshev's Inequality and the Weak Law of Large Numbers, 8.3 The Central Limit Theorem | 8.4 The Strong Law of Large Numbers, 8.5 Other Inequalities (One-sided Chebyshev Inequality, Chernoff Bounds) |
| Nov 25 | Revision | Revision |
| Dec 2 | CLASSES END | |

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## University Policies and Statements

### This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

**Academic Integrity**

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

**Information**: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

**Accessibility**

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

**Information**: https://www.dal.ca/campus_life/academic-support/accessibility.html

**Student Code of Conduct**

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

**Code**: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

**Diversity and Inclusion – Culture of Respect**

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

**Statement**: http://www.dal.ca/cultureofrespect.html

**Recognition of Mi'kmaq Territory**

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca).

**Information**: https://www.dal.ca/campus_life/communities/indigenous.html

**Important Dates** in the Academic Year (including add/drop dates)
https://www.dal.ca/academics/important_dates.html

**University Grading Practices**
https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

**Missed or Late Academic Requirements due to Student Absence (policy)**
**https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html**

## Student Resources and Support

### Advising

**General Advising** https://www.dal.ca/campus_life/academic-support/advising.html

**Science Program Advisors**: https://www.dal.ca/faculty/science/current-students/academic-advising.html

**Indigenous Student Centre:** https://www.dal.ca/campus_life/communities/indigenous.html

**Black Students Advising Centre**: https://www.dal.ca/campus_life/communities/black-student-advising.html

**International Centre**: https://www.dal.ca/campus_life/international-centre/current-students.html

## Academic supports

**Library:** https://libraries.dal.ca/

**Writing Centre**: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

**Studying for Success:** https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

**Copyright Office**: https://libraries.dal.ca/services/copyright-office.html

**Fair Dealing Guidelines** https://libraries.dal.ca/services/copyright-office/fair-dealing.html

## Other supports and services

**Student Health & Wellness Centre**: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html

**Student Advocacy**: https://dsu.ca/dsas

**Ombudsperson**: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

### Safety

**Biosafety**: https://www.dal.ca/dept/safety/programs-services/biosafety.html

**Chemical Safety**: https://www.dal.ca/dept/safety/programs-services/chemical-safety.html

**Radiation Safety**: https://www.dal.ca/dept/safety/programs-services/radiation-safety.html

**Scent-Free Program:** https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html