

# Statistics (STAT)

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## Statistics (STAT) Courses

### Mathematics & Statistics

#### Faculty of Science

Note: see regulations concerning Deferred Final Examinations in the Academic Regulations section of this Calendar.

#### **STAT 2507 [0.5 credit]**

##### **Introduction to Statistical Modeling I**

A data-driven introduction to statistics. Basic descriptive statistics, introduction to probability theory, random variables, various discrete and continuous distributions, contingency tables and goodness-of-fit, sampling distributions, distribution of sample mean, Central Limit Theorem, application to interval estimation and hypothesis testing. A statistical software package will be used.

STAT 2507 may not be counted for credit in any program, if taken after successful completion of STAT 2559.

Precludes additional credit for BIT 2000, BIT 2100, ECON 2200, ECON 2201, GEOG 2006, STAT 2606, STAT 3502.

Prerequisite(s): an Ontario Grade 12 university-preparation Mathematics or equivalent, or permission of the School of Mathematics and Statistics.

Lectures three hours a week, laboratory one hour a week.

#### **STAT 2509 [0.5 credit]**

##### **Introduction to Statistical Modeling II**

A data-driven approach to statistical modeling. Basics of experimental design, analysis of variance, simple linear regression and correlation, nonparametric procedures. A statistical software package will be used.

Precludes additional credit for STAT 2607, ECON 2202.

Prerequisite(s): i) STAT 2507 and ii) Grade 12 Mathematics (Geometry and Discrete Mathematics), or MATH 0107; or equivalents; or permission of the School.

Lectures three hours a week, laboratory one hour a week.

#### **STAT 2559 [0.5 credit]**

##### **Basics of Statistical Modeling (Honours)**

Estimation and hypothesis testing for one and two samples, analysis of categorical data, basics of experimental design, analysis of variance, simple linear regression and correlation. Nonparametric procedures. A statistical software package will be used.

Prerequisite(s): STAT 2655 or permission of the School.

Lectures three hours a week, tutorial/laboratory one hour a week.

#### **STAT 2605 [0.5 credit]**

##### **Probability Models**

Basic probability; discrete random variables with focus on binomial and Poisson random variables; continuous random variables, transformation theorem, simulating continuous random variables; exponential random variable, normal random variable, sums of random variables, central limit theorem. Elements of Markov chains, and introduction to Poisson processes.

Restricted to students in Bachelor of Computer Science, Bachelor of Mathematics in Computer Mathematics, and Bachelor of Engineering in Communications Engineering. Precludes additional credit for STAT 2655 and STAT 3502. Prerequisite(s): MATH 1007 or MATH 1004 or MATH 1002, and MATH 1104 or MATH 1107 (or MATH 1102).

Lectures three hours a week, tutorial one hour a week.

#### **STAT 2606 [0.5 credit]**

##### **Business Statistics I**

Introduction to statistical computing; probability concepts; descriptive statistics; estimation and testing of hypotheses. Emphasis on the development of an ability to interpret results of statistical analyses with applications from business.

Restricted to students in the School of Business.

Precludes additional credit for BIT 2000, BIT 2100, ECON 2200, ECON 2201, GEOG 2006, STAT 2507, STAT 3502.

Prerequisite(s): either: item (iii); or both of items (i) and (ii): (i) MATH 1009 with a grade of C- or better; (ii) MATH 0107; (iii) BUSI 1703 with a grade of C- or better, or BUSI 1704 and BUSI 1705 with an average grade of C- or better; or equivalents.

Lectures three hours a week and one hour laboratory.

#### **STAT 2607 [0.5 credit]**

##### **Business Statistics II**

Topics include: experimental design, multiple regression and correlation analysis, covariance analysis, and introductory time series. Use of computer packages.

Restricted to students in the School of Business.

Precludes additional credit for STAT 2509, ECON 2202.

Prerequisite(s): STAT 2606.

Lectures three hours a week and one hour laboratory.

#### **STAT 2655 [0.5 credit]**

##### **Introduction to Probability with Applications (Honours)**

Axioms of probability, basic combinatorial analysis, conditional probability and independence, discrete and continuous random variables, joint and conditional distributions, expectation, central limit theorem, sampling distributions, simulation and applications to descriptive statistics. A statistical software package will be used.

Precludes additional credit for STAT 2605.

Prerequisite(s): one of MATH 1002 or MATH 2007 or MATH 1005 with a grade of C+ or better; and one of MATH 1102 or MATH 1107 or MATH 1104 with a grade of C+ or better.

Lectures three hours a week, tutorial one hour a week.

**STAT 3502 [0.5 credit]****Probability and Statistics**

Axioms of probability; conditional probability and independence; random variables; distributions: binomial, Poisson, hypergeometric, normal, gamma; central limit theorem; sampling distributions; point estimation: maximum likelihood, and method of moments; confidence intervals; testing of hypotheses: one and two populations; engineering applications: acceptance sampling, control charts, reliability.

This course may not be used to meet the 3000-level course requirements in any General or Honours program in Mathematics and Statistics.

Precludes additional credit for STAT 2507, STAT 2605, STAT 2606, ECON 2200, ECON 2201.

Prerequisite(s): MATH 2004 and enrolment in the Faculty of Engineering or B.Sc. programs of the Department of Physics [except Double Honours Mathematics and Physics].

Lectures three hours a week and one hour laboratory.

**STAT 3503 [0.5 credit]****Regression Analysis**

Review of simple and multiple regression with matrices, Gauss-Markov theorem, polynomial regression, indicator variables, residual analysis, weighted least squares, variable selection techniques, nonlinear regression, correlation analysis and autocorrelation. Computer packages are used for statistical analyses.

Precludes additional credit for STAT 3553. PSYC 3000 is precluded for additional credit for students registered in a Mathematics program.

Prerequisite(s): i) STAT 2509 or STAT 2607, or ECON 2200, or ECON 2202, or equivalent; and ii) MATH 1102 or MATH 1107 or MATH 1109 or equivalent; or permission of the School.

Lectures three hours a week and one hour laboratory.

**STAT 3504 [0.5 credit]****Analysis of Variance and Experimental Design**

Single and multifactor analysis of variance, orthogonal contrasts and multiple comparisons, analysis of covariance; nested, crossed and repeated measures designs; completely randomized, randomized block, Latin squares, factorial experiments, related topics. Computer packages are used for statistical analyses.

Precludes additional credit for STAT 4504. PSYC 3000 is precluded for additional credit for students registered in a Mathematics program.

Prerequisite(s): STAT 3503 or permission of the School.

Lectures three hours a week and one hour laboratory.

**STAT 3506 [0.5 credit]****Stochastic Processes and Applications (Honours)**

Conditional probability and conditional expectation; Stochastic modeling; discrete time Markov chains including classification of states, stationary and limiting distributions; exponential distribution and the Poisson processes; queueing models; applications to computer systems, operations research and social sciences.

Prerequisite(s): STAT 2655; or a CGPA of 6.00 or better over the three courses MATH 2007, MATH 2107 (or MATH 1102), and STAT 2605; or permission of the School.

Lectures three hours a week, tutorial one hour a week.

**STAT 3507 [0.5 credit]****Sampling Methodology**

The sample survey as a vehicle for information collection in government, business, scientific and social agencies. Topics include: planning a survey, questionnaire design, simple random, stratified, systematic and cluster sampling designs, estimation methods, problem of non-response, related topics.

Prerequisite(s): one of STAT 2507, or STAT 2509, STAT 2606, STAT 2607, ECON 2200, ECON 2201 or ECON 2202 or equivalent; or permission of the School.

Lectures three hours a week and one hour laboratory.

**STAT 3508 [0.5 credit]****Elements of Probability Theory**

Discrete and continuous distributions, moment-generating functions, marginal and conditional distributions, transformation theory, limiting distributions.

Precludes additional credit for STAT 3558 and STAT 3608.

Prerequisite(s): i) MATH 2008 (or MATH 2004 or MATH 2009); and ii) one of STAT 2507, STAT 2606, ECON 2200, or ECON 2201 or permission of the School.

Lectures three hours a week, tutorial one hour a week.

**STAT 3509 [0.5 credit]****Mathematical Statistics**

Point and interval estimation, sufficient statistics, hypothesis testing, chi-square tests with enumeration data. Precludes additional credit for STAT 3559.

Prerequisite(s): STAT 3508 or permission of the School.

Lectures three hours a week, tutorial one hour a week.

**STAT 3553 [0.5 credit]****Regression Modeling (Honours)**

Linear regression - theory, methods and application(s). Normal distribution theory. Hypothesis tests and confidence intervals. Model selection. Model diagnostics. Introduction to weighted least squares and generalized linear models.

Precludes additional credit for STAT 3503. PSYC 3000 is precluded for additional credit for students registered in a Mathematics program.

Prerequisite(s): i) STAT 2559 or STAT 2509; and ii) MATH 1102 or MATH 2107; or permission of the School.

Lectures three hours a week, laboratory one hour a week.

**STAT 3558 [0.5 credit]****Elements of Probability Theory (Honours)**

Random variables and moment-generating functions, concepts of conditioning and correlation; laws of large numbers, central limit theorem; multivariate normal distribution; distributions of functions of random variables, sampling distributions, order statistics.

Precludes additional credit for STAT 3508 and STAT 3608.

Prerequisite(s): i) STAT 2655 (or STAT 2605); and ii) MATH 2000 (or a grade of C+ or better in MATH 2008); or permission of the School.

Lectures three hours a week, tutorial one hour a week.

**STAT 3559 [0.5 credit]****Mathematical Statistics (Honours)**

Empirical distribution functions, Monte Carlo methods, elements of decision theory, point estimation, interval estimation, tests of hypotheses, robustness, nonparametric methods.

Precludes additional credit for STAT 3509.

Prerequisite(s): STAT 3558 or permission of the School.

Lectures three hours a week, tutorial one hour a week.

**STAT 3608 [0.5 credit]****Probability in Communications and Electrical Engineering**

Probability models and basic concepts; independence and conditional probabilities; discrete, continuous and multiple random variables; distribution and density functions; expectations and moments; sums of random variables; elementary statistics; introduction to random processes; applications to areas such as communication systems and networks.

Restricted to students in the Faculty of Engineering.

Precludes additional credit for STAT 3508 and STAT 3558.

Prerequisite(s): MATH 2004, or equivalent.

Lectures three hours a week, tutorial one hour a week.

**STAT 4500 [0.5 credit]****Parametric Estimation (Honours)**

Preliminaries on probability theory; exact and asymptotic sampling distributions; unbiasedness, consistency, efficiency, sufficiency and completeness; properties of maximum likelihood estimators; least squares estimation of location and scale parameters based on order statistics and sample quantiles; Best Asymptotically Normal (BAN) estimators.

Prerequisite(s): STAT 3559 or permission of the School.

Also offered at the graduate level, with different requirements, as STAT 5600, for which additional credit is precluded.

Lectures three hours a week.

**STAT 4501 [0.5 credit]****Probability Theory (Honours)**

Introduction to probability, characteristic functions, probability distributions, limit theorems.

Prerequisite(s): STAT 3506 and STAT 3558 or permission of the School.

Lectures three hours a week.

**STAT 4502 [0.5 credit]****Survey Sampling (Honours)**

Basic concepts in sampling from finite populations; simple random sampling; stratified sampling; choice of sampling unit; cluster and systematic sampling; introduction to multistage sampling; ratio estimation; sampling with unequal probabilities and with replacement; replicated sampling; related topics.

Prerequisite(s): i) STAT 2559 or STAT 2509; and ii) either STAT 3559, or a grade of C+ or better in STAT 3509; or permission of the School.

Lectures three hours a week.

**STAT 4503 [0.5 credit]****Applied Multivariate Analysis (Honours)**

Selected topics in regression and correlation non-linear models. Multivariate statistical methods, principal components, factor analysis, multivariate analysis of variance, discriminant analysis, canonical correlation, analysis of categorical data.

Prerequisite(s): STAT 3553 or (STAT 3509 and STAT 3503) or permission of the School.

Also offered at the graduate level, with different requirements, as STAT 5509, for which additional credit is precluded.

Lectures three hours a week.

**STAT 4504 [0.5 credit]****Statistical Design and Analysis of Experiments (Honours)**

An extension of the designs discussed in STAT 2559 to include analysis of the completely randomized design, designs with more than one blocking variable, incomplete block designs, fractional factorial designs, multiple comparisons; and response surface methods.

Precludes additional credit for STAT 3504 and ECON 4706. PSYC 3000 is precluded for additional credit for students registered in a Mathematics program.

Prerequisite(s): STAT 3553 or STAT 3503; or permission of the School of Mathematics and Statistics.

Lectures three hours a week, laboratory one hour a week.

**STAT 4506 [0.5 credit]****Nonparametric Methods (Honours)**

Order statistics; projections; U-statistics; L-estimators; rank, sign, and permutation test statistics; relative efficiency of tests; nonparametric tests of goodness-of-fit, homogeneity, symmetry, and independence and their efficiency; nonparametric density estimation.

Prerequisite(s): STAT 3559 or permission of the School.

Also offered at the graduate level, with different requirements, as STAT 5516, for which additional credit is precluded.

Lectures three hours a week.

**STAT 4507 [0.5 credit]****Statistical Inference (Honours)**

Sufficient statistics, simple and composite hypotheses, most powerful and similar region test, distribution-free tests, confidence intervals, goodness-of-fit and likelihood ratio tests, large sample theory, Bayesian and likelihood methods, sequential tests.

Prerequisite(s): STAT 4500 or permission of the School.

Also offered at the graduate level, with different requirements, as STAT 5501, for which additional credit is precluded.

Lectures three hours a week.

**STAT 4508 [0.5 credit]****Stochastic Models (Honours)**

Review of discrete Markov chains and Poisson processes; continuous time Markov chains; pure jump Markov processes, and birth and death processes including the Q-matrix approach; the Kolmogorov equations; renewal theory; introduction to Brownian motion; queueing theory.

Prerequisite(s): STAT 3506 or permission of the School.

Also offered at the graduate level, with different requirements, as STAT 5701, for which additional credit is precluded.

Lectures three hours a week.

**STAT 4509 [0.5 credit]****Advanced Mathematical Modeling (Honours)**

Real-life situations in the physical, social, and life sciences are often modeled using mathematical tools. This course will examine various models and techniques used in their analysis, e.g., matrix procedures in connection with population models. Students will use a computer package to obtain numerical results.

Prerequisite(s): i) MATH 2454 and STAT 2655 (or MATH 2404 and STAT 2605) and ii) STAT 3506; or permission of the School.

Also offered at the graduate level, with different requirements, as STAT 5601, for which additional credit is precluded.

Lectures three hours a week.

**STAT 4555 [0.5 credit]****Monte Carlo Simulation (Honours)**

Basic ideas and algorithms of Monte Carlo; simulation of basic stochastic processes. Brownian motion and the Poisson process, applications to financial modelling, queueing theory. Output analysis; variance reduction. Markov chain Monte Carlo methods; Gibbs sampling, simulated annealing and Metropolis-Hastings samplers with applications.

Precludes additional credit for STAT 3555 (no longer offered).

Prerequisite(s): STAT 3558, or a grade of B or higher in STAT 3508, or permission of the School.

Lectures three hours a week, tutorial/laboratory one hour a week.

**STAT 4601 [0.5 credit]****Data Mining I (Honours)**

Data visualization; knowledge discovery in datasets; unsupervised learning: clustering algorithms; dimension reduction; supervised learning: pattern recognition, smoothing techniques, classification. Computer software will be used.

Prerequisite(s): STAT 3553 or STAT 3503 or MATH 3806, or permission of the School.

Lectures three hours a week, laboratory one hour a week.

**STAT 4603 [0.5 credit]****Time Series and Forecasting (Honours)**

Time series regression. Nonstationary and stationary time series models. Nonseasonal and seasonal time series models. ARIMA (Box-Jenkins) models. Smoothing methods. Parameter estimation, model identification, diagnostic checking. Forecasting techniques.

A statistical software package will be used.

Prerequisite(s): STAT 3553 or STAT 3503, or permission of the School.

Lectures three hours a week, laboratory one hour a week.

**STAT 4604 [0.5 credit]****Statistical Computing (Honours)**

Statistical computing techniques, pseudo-random number generation, tests for randomness, numerical algorithms in statistics; optimization techniques; environments for data analysis, efficient programming techniques; statistics with mainstream software.

Prerequisite(s): STAT 3553 or STAT 3503 or permission of the School.

Lectures three hours a week, laboratory one hour a week.

**STAT 4605 [0.5 credit]****Statistical Methods in Biostatistics (Honours)**

Review of distributions, moments, sampling distributions, and large sample approximations; parametric inferences; Bayesian methods; nonparametric methods. Illustrations are based on real data sets from biomedical experiments or investigations.

Prerequisite(s): i) STAT 3508 or STAT 3558, and ii) STAT 3509 or STAT 3559, or permission of the School.

Lectures three hours a week, laboratory one hour a week

**STAT 4606 [0.5 credit]****Practices in Biostatistics (Honours)**

Correlation and regression analysis, multiple sample analysis; analysis of covariance; analysis of frequency data; multiple logistic regression; longitudinal study; Kaplan-Meier estimator; proportional hazard model. Use of statistical computer packages will be emphasized.

Prerequisite(s): STAT 4605 or the permission of the School.

Lectures three hours a week, laboratory one hour a week.

**Summer session:** some of the courses listed in this Calendar are offered during the summer. Hours and scheduling for summer session courses will differ significantly from those reported in the fall/winter Calendar. To determine the scheduling and hours for

summer session classes, consult the class schedule at [central.carleton.ca](http://central.carleton.ca)

Not all courses listed are offered in a given year. For an up-to-date statement of course offerings for the current session and to determine the term of offering, consult the class schedule at [central.carleton.ca](http://central.carleton.ca)