

# Statistics (STAT)

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## Statistics (STAT) Courses

### 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, discrete and continuous distributions, contingency tables, sampling distributions, distribution of sample mean, Central Limit Theorem, interval estimation and hypothesis testing. A statistical software package will be used.

Includes: Experiential Learning Activity

Precludes additional credit for BIT 2000, BIT 2100 (no longer offered), BIT 2300 (no longer offered), ECON 2201 (no longer offered), ECON 2210, ENST 2006, GEOG 2006, STAT 2606, and STAT 3502. May not be counted for credit in any program if taken after successful completion of STAT 2559.

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.

Includes: Experiential Learning Activity

Precludes additional credit for STAT 2607, ECON 2202, ECON 2220.

Prerequisite(s): STAT 2507 or STAT 2606 or STAT 3502; 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.

Includes: Experiential Learning Activity

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.

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).

Restricted to students in Bachelor of Computer Science, Bachelor of Mathematics in Computer Mathematics, and Bachelor of Engineering in Communications Engineering.

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.

Includes: Experiential Learning Activity

Precludes additional credit for BIT 2000, BIT 2100 (no longer offered), BIT 2300 (no longer offered), ECON 2201 (no longer offered), ECON 2210, ENST 2006, GEOG 2006, STAT 2507, and STAT 3502.

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

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

### 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.

Includes: Experiential Learning Activity

Precludes additional credit for STAT 2509, ECON 2202, ECON 2220.

Prerequisite(s): STAT 2606.

Lectures three hours a week and one hour laboratory.

**STAT 2655 [0.5 credit]****Introduction to Probability with Applications (Honours)**

Probability axioms, basic combinatorial analysis, conditional probability and independence, discrete and continuous random variables, joint and conditional distributions, expectation and moments, probability and moment generating functions, Chebyshev's inequality and weak law of large numbers, central limit theorem, sampling distributions, simulation and applications to descriptive statistics.

Precludes additional credit for STAT 2605.

Prerequisite(s): MATH 1002 with a grade of C+ or higher or MATH 2007 or MATH 1005 with a grade of B+ or higher; and MATH 1102 with a grade of C+ or higher or MATH 2107 with a grade of B+ or higher; or permission of the School.

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

**STAT 2660 [0.5 credit]****Mathematics for Finance (Honours)**

Interest rates, growth of money, discount functions, yield rates, time value of money, annuities, cash flows and portfolios, loans, mortgages, bonds, immunization, swaps, hedging and investment strategies, stocks and financial markets, arbitrage.

Prerequisite(s): i) one of MATH 1002 or MATH 2007 or MATH 1005, grade of C+ or higher; and ii) one of MATH 1102 or MATH 1107 or MATH 1104, grade of C+ or higher; or permission of the School.

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, method of moments; confidence intervals; testing of hypotheses: one and two populations; engineering applications: acceptance sampling, control charts, reliability.

Includes: Experiential Learning Activity

Precludes additional credit for BIT 2000, BIT 2100 (no longer offered), BIT 2300 (no longer offered), ECON 2201 (no longer offered), ECON 2210, STAT 2507, STAT 2605, and STAT 2606.

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.

Includes: Experiential Learning Activity

Precludes additional credit for STAT 3553.

Prerequisite(s): i) STAT 2509 or STAT 2607 or ECON 2202 or ECON 2220 or equivalent; and ii) MATH 1102 or MATH 1107 or MATH 1119 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.

Includes: Experiential Learning Activity

Precludes additional credit for STAT 4504.

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 with a grade of C- or higher; 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.

Includes: Experiential Learning Activity

Prerequisite(s): one of: STAT 2507, STAT 2509, STAT 2606, STAT 2607, ECON 2201, ECON 2202, ECON 2210, ECON 2220, 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.

Includes: Experiential Learning Activity

Precludes additional credit for STAT 3503.

Prerequisite(s): i) STAT 2559 with a grade of C- or higher, or STAT 2509 with a grade of B or higher; and ii) a grade of C- or higher in MATH 1102 or MATH 1107 or MATH 1104; 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 with a grade of C- or higher; and ii) MATH 2000 with a grade of C- or higher, or (a grade of C+ or higher in MATH 2008 or MATH 2004, and permission of the instructor); 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 with a grade of C- or higher; or (STAT 3508 with a grade of B or higher, and permission of the instructor); or permission of the School.

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

**STAT 3660 [0.5 credit]****Actuarial Mathematics I**

Severity, frequency models, loss models, risk measures, value at risk, stochastic processes, Poisson process, characteristics of actuarial models, creating new univariate distributions, heavy-tailed distributions, mixed distributions, coverage modifications.

Prerequisite(s): STAT 2655, or permission from the school.

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

**STAT 3661 [0.5 credit]****Life Contingent Risk Modelling I**

Mixed distributions; conditional expectations; introduction to life insurance; traditional and modern insurance contracts; underwriting; premiums; pension plans and retirement benefits; survival models; reserves; present value random variable; force of mortality; life tables; insurance benefits; annuities; premium calculation.

Prerequisite(s): STAT 2660 and STAT 3506 with grades of C+ or higher; or permission of the School.

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

**STAT 3662 [0.5 credit]****Life Contingent Risk Modelling II**

Policy values; multiple state models; formulae for probability; Markov multiple state models; pension mathematics; yield curves; interest rate risk; emerging costs for life insurance; equity linked insurance; deterministic and stochastic pricing; reserving, participating, and universal life insurance.

Prerequisite(s): STAT 3661 with a grade of C+ or higher; or permission of the School.

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.

Includes: Experiential Learning Activity

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 Statistics (Honours)**

Order statistics; projections; U-statistics; L-estimators; rank, sign, and permutation test statistics; nonparametric tests of goodness-of-fit, homogeneity, symmetry, and independence; nonparametric density estimation; nonparametric regression analysis: kernel estimators, orthogonal series estimators, smoothing splines; high-dimensional inference and false discovery.

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.

Includes: Experiential Learning Activity

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.

Includes: Experiential Learning Activity

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.

Includes: Experiential Learning Activity

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.

Includes: Experiential Learning Activity

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

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

**STAT 4607 [0.5 credit]****Bayesian Statistical Analysis (Honours)**

Probability basics for Bayesian statistics. Bayesian inference for simple exponential families. Markov Chain Monte Carlo for posterior inference. Empirical Bayes. Hierarchical Bayes. Bayesian inference for the multivariate normal model. Bayesian linear regression. More advanced topics may be included. Computer software will be used.

Includes: Experiential Learning Activity

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

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

**STAT 4660 [0.5 credit]****Actuarial Mathematics II**

Empirical models, complete data, grouped data, credibility theory, failure time, accuracy, kernel estimation, goodness of fit tests, Bayesian analysis, inference for loss models, frequentist estimation, model selection.

Prerequisite(s): STAT 3660 with C+ or higher, or permission of the school.

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

**STAT 4661 [0.5 credit]****Life Contingent Risk Modelling II**

Policy values; multiple state models; formulae for probability; Markov multiple state models; pension mathematics; yield curves; interest rate risk; emerging costs for life insurance; equity linked insurance; deterministic and stochastic pricing; reserving, participating, and universal life insurance.

Prerequisite(s): STAT 3661 with a grade of C+ or higher; or permission of the School.