Statistics and Actuarial Science

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Undergraduate majors: actuarial science (B.S.); statistics (B.S.)
Undergraduate minor: statistics
Graduate degrees: M.S. in actuarial science; M.S. in statistics; Ph.D. in statistics
Faculty: https://stat.uiowa.edu/people
Website: https://stat.uiowa.edu/

Courses

- Statistics Courses [p. 1]
- Actuarial Science Courses [p. 4]
- Data Science Courses [p. 5]

Undergraduate Duplication and Regression Policy

Statistics majors may not earn a major in data science; likewise, data science majors may not earn a major in statistics.

Undergraduate students should be aware of the duplication and regression policies concerning the following courses.

Students may earn credit for only two of these: STAT:1010 Statistics and Society, STAT:1015 Introduction to Data Science, STAT:1020/PSQF:1020 Elementary Statistics and Inference, STAT:1030 Statistics for Business, and STAT:2010 Statistical Methods and Computing.

Credit for STAT:1010 Statistics and Society may be earned only if the course is taken before any of these: STAT:1015 Introduction to Data Science, STAT:1020/PSQF:1020 Elementary Statistics and Inference, STAT:1030 Statistics for Business, and STAT:2010 Statistical Methods and Computing.

Students may receive credit for only one course from each of these pairs: STAT:2010 Statistical Methods and Computing and STAT:4200/IGPI:4200 Statistical Methods and Computing, STAT:3100/IGPI:3100 Introduction to Mathematical Statistics I andSTAT:3120/IGPI:3120 Probability and Statistics, and STAT:3510/IGPI:3510 Biostatistics and STAT:4143/PSQF:4143 Introduction to Statistical Methods.

Students may not take STAT:3101/IGPI:3101 Introduction to Mathematical Statistics II and STAT:4101/IGPI:4101 Mathematical Statistics II at the same time and get credit for both (nor go back to STAT:3101/IGPI:3101 after taking STAT:4101/IGPI:4101).

Statistics Courses

STAT:1000 First-Year Seminar 1 s.h.
Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.

STAT:1010 Statistics and Society 3 s.h.
Statistical ideas and their relevance to public policy, business, humanities, and the social, health, and physical sciences; focus on critical approach to statistical evidence. Requirements: one year of high school algebra or MATH:0100. GE: Quantitative or Formal Reasoning.

STAT:1015 Introduction to Data Science 3 s.h.
Data collection, visualization, and wrangling; basics of probability and statistical inference; fundamentals of data learning including regression, classification, prediction, and cross-validation; computing, learning, and reporting in the R environment; literate programming; reproducible research. Requirements: one year of high school algebra or MATH:0100.

STAT:1020 Elementary Statistics and Inference 3 s.h.
Graphing techniques for presenting data, descriptive statistics, correlation, regression, prediction, logic of statistical inference, elementary probability models, estimation and tests of significance. Requirements: one year of high school algebra or MATH:0100. GE: Quantitative or Formal Reasoning. Same as PSQF:1020.

STAT:1030 Statistics for Business 4 s.h.
Descriptive statistics, graphical presentation, elementary probability, estimation and testing, regression, correlation; statistical computer packages. GE: Quantitative or Formal Reasoning.

STAT:2010 Statistical Methods and Computing 3 s.h.
Methods of data description and analysis using SAS; descriptive statistics, graphical presentation, estimation, hypothesis testing, sample size, power; emphasis on learning statistical methods and concepts through hands-on experience with real data. Recommendations: undergraduate standing. GE: Quantitative or Formal Reasoning.

STAT:2020 Probability and Statistics for the Engineering and Physical Sciences 3 s.h.
Probability, random variables, important discrete and continuous distributions, joint distributions, transformations of random variables, descriptive statistics, point and interval estimation, tests of hypotheses, regression. Prerequisites: MATH:1560 or MATH:1860.

STAT:3100 Introduction to Mathematical Statistics I 3 s.h.
Descriptive statistics, probability, conditional probability, discrete and continuous univariate and multivariate distributions, sampling distributions. Prerequisites: MATH:1860 or MATH:1560. Same as IGPI:3100.

STAT:3101 Introduction to Mathematical Statistics II **3 s.h.**
Point and interval estimation, testing statistical hypotheses, simple regression, nonparametric methods. Prerequisites: STAT:3100. Same as IGPI:3101.

STAT:3120 Probability and Statistics **4 s.h.**
Models, discrete and continuous random variables and their distributions, estimation of parameters, testing statistical hypotheses. Prerequisites: MATH:1560 or MATH:1860. Same as IGPI:3120.

STAT:3200 Applied Linear Regression **3 s.h.**
Regression analysis with focus on applications; model formulation, checking, selection; interpretation and presentation of analysis results; simple and multiple linear regression; logistic regression; ANOVA; hands-on data analysis with computer software. Prerequisites: STAT:2020 or STAT:2010 or STAT:3120. Same as IGPI:3200, ISE:3760.

STAT:3210 Experimental Design and Analysis **3 s.h.**
Single- and multifactor experiments; analysis of variance; multiple comparisons; contrasts; diagnostics; fixed, random, and mixed effects models; designs with blocking and/or nesting; two-level factorials and fractions thereof; use of statistical computing packages. Prerequisites: STAT:3200.

STAT:3510 Biostatistics **3 s.h.**
Statistical concepts and methods for the biological sciences; descriptive statistics, elementary probability, sampling distributions, confidence intervals, parametric and nonparametric methods, one-way ANOVA, correlation and regression, categorical data. Requirements: MATH:0100 or MATH:1005 or ALEKS score of 30 or higher. Same as IGPI:3510.

STAT:3620 Quality Control **3 s.h.**
Basic techniques of statistical quality control; application of control charts for process control variables; design of inspection plans and industrial experimentation; modern management aspects of quality assurance systems. Offered fall semesters. Prerequisites: STAT:2020 or BAIS:9100 or (STAT:3100 and STAT:3101 and STAT:3200). Same as CEE:3142, ISE:3600.

STAT:4100 Mathematical Statistics I **3 s.h.**
Probability, conditional probability, random variables, distribution and density functions, joint and conditional distributions, various families of discrete and continuous distributions, mgf technique for sums, convergence in distribution, convergence in probability, central limit theorem. Prerequisites: MATH:2850 and MATH:2700. Same as IGPI:4100.

STAT:4101 Mathematical Statistics II **3 s.h.**
Transformations, order statistics, point estimation, sufficient statistics, Rao-Blackwell Theorem, delta method, confidence intervals, likelihood ratio tests, applications. Prerequisites: STAT:4100. Same as IGPI:4101.

STAT:4143 Introduction to Statistical Methods **3 s.h.**
Analysis, interpretation of research data; descriptive statistics; introduction to probability, sampling theory, statistical inference (binomial, normal distribution, t-distribution models); linear correlation, regression. Same as PSQF:4143.

STAT:4200 Statistical Methods and Computing **3 s.h.**
Methods of data description and analysis using SAS; descriptive statistics, graphical presentation, estimation, hypothesis testing, sample size, power; emphasis on learning statistical methods and concepts through hands-on experience with real data. Recommendations: graduate standing in non-statistics or less quantitative major. Same as IGPI:4200.

STAT:4520 Bayesian Statistics **3 s.h.**
Bayesian statistical analysis, with focus on applications; Bayesian and frequentist methods compared; Bayesian model specification, choice of priors, computational methods; hands-on Bayesian data analysis using appropriate software; interpretation and presentation of analysis results. Prerequisites: STAT:3200 and (STAT:3101 or STAT:4101 or STAT:3120). Same as IGPI:4522, PSQF:4520.

STAT:4540 Statistical Learning **3 s.h.**
Introduction to supervised and unsupervised statistical learning, with a focus on regression, classification, and clustering; methods will be applied to real data using appropriate software; supervised learning topics include linear and nonlinear (e.g., logistic) regression, linear discriminant analysis, cross-validation, bootstrapping, model selection, and regularization methods (e.g., ridge and lasso); generalized additive and spline models, tree-based methods, random forests and boosting, and support-vector machines; unsupervised learning topics include principal components and clustering. Requirements: an introductory statistics course and a regression course. Recommendations: prior exposure to programming and/or software, such as R, SAS, and Matlab. Same as IGPI:4540.

STAT:4560 Statistics for Risk Modeling **3 s.h.**
Theory and applications of general linear models, generalized linear models, and regression-based time series models; emphasis on parameter estimation, variable selection, and diagnostic checking for these models, and their use for statistical inference and prediction; practical implementations of these models to analyze actuarial and financial data. Prerequisites: STAT:4101 with a minimum grade of C+ or STAT:5101 with a minimum grade of C+.

STAT:4580 Data Visualization and Data Technologies **3 s.h.**
Introduction to common techniques for visualizing univariate and multivariate data, data summaries, and modeling results; how to create and interpret these visualizations and assess effectiveness of different visualizations based on an understanding of human perception and statistical thinking; data technologies for obtaining and preparing data for visualization and further analysis; students learn how to present results in written reports and use version control to manage their work. Requirements: an introductory statistics course and a regression course. Recommendations: prior exposure to basic use of statistical programming software (e.g., R or SAS) as obtained from a regression course strongly recommended. Same as IGPI:4580.

STAT:4740 Large Data Analysis **3 s.h.**
Current areas that deal with problem of big data; techniques from computer science, mathematics, statistics; high performance and parallel computing, matrix techniques, cluster analysis, visualization; variety of applications including Google PageRank, seismology, Netflix-type problems, weather forecasting; fusion of data with simulation; projects. Prerequisites: (CS:1210 with a minimum grade of C- or ENGR:2730 with a minimum grade of C-) and (MATH:3800 or CS:3700) and (STAT:3200 or ISE:3760 or IGPI:3200). Same as CS:4740, IGPI:4740, MATH:4740.

STAT:5090 ALPHA Seminar 1 s.h.
Resources available to students, program requirements, tips for academic success, professional statistical organizations, library and career center resources, statistical computing, scientific document preparation, history of statistics. Requirements: graduate standing in statistics.

STAT:5100 Statistical Inference I 3 s.h.
Review of probability, distribution theory (multiple random variables, moment-generating functions, transformations, conditional distributions), sampling distributions, order statistics, convergence concepts, generating random samples. Prerequisites: MATH:2850 and STAT:3101.

STAT:5101 Statistical Inference II 3 s.h.
Continuation of STAT:5100; principles of data reduction, point estimation theory (MLE, Bayes, UMVU), hypothesis testing, interval estimation, decision theory, asymptotic evaluations. Prerequisites: STAT:5100.

STAT:5120 Mathematical Methods for Statistics 3 s.h.
Real numbers, point set theory, limit points, limits, metric spaces, continuity, sequences and series, Taylor series (multivariate), uniform convergence, Riemann-Stieltjes integrals. Requirements: statistics graduate standing.

STAT:5200 Applied Statistics I 4 s.h.
Descriptive statistics, basic inferential methods (confidence intervals, chi-square tests); linear models (regression and ANOVA models—specification and assumptions, fitting, diagnostics, selection, testing, interpretation); nonlinear models, logistic regression. Prerequisites: STAT:3101. Corequisites: STAT:4100 or STAT:5100. Requirements: facility with matrix algebra. Same as IGPI:5199.

STAT:5201 Applied Statistics II 3 s.h.
Design of experiments and analysis of designed experiments; models for fixed and random effects; mixed models; design and analysis of complex plans; sample-size methods. Prerequisites: STAT:5200. Recommendations: prior exposure to SAS software.

STAT:5400 Computing in Statistics 3 s.h.
R; database management; graphical techniques; importing graphics into word-processing documents (e.g., LaTeX); creating reports in LaTeX; SAS; simulation methods (Monte Carlo studies, bootstrap, etc.). Prerequisites: CS:1210 and STAT:3200 and (STAT:3120 or STAT:3101 or STAT:4101). Corequisites: STAT:5100 and STAT:5200 if not already completed. Same as IGPI:5400.

STAT:5610 Regression Modeling and ANOVA in the Health Sciences 3 s.h.
Continuation of BIOS:4120; correlation, simple and multiple linear regression, confounding, interactions, model selection, single and multiple factor ANOVA (analysis of variance) models, contrasts, multiple comparisons, nested and block designs, and an introduction to mixed models; designed for non-biostatistics majors. Offered spring semesters and summer sessions. Prerequisites: BIOS:4120. Same as BIOS:5120, IGPI:5120.

STAT:5810 Research Data Management 3 s.h.
Introduction to data management techniques and problems encountered in gathering and processing data from biomedical investigations; introduction to SAS, techniques taught in SAS; designed for non-biostatistics majors. Offered fall and spring semesters. Recommendations: prior programming experience with C, C++, Python, Java, or other. Same as BIOS:5310, IGPI:5310.

STAT:6220 Statistical Consulting 3 s.h.
Realistic supervised data analysis experiences, including statistical packages, statistical graphics, writing statistical reports, dealing with complex or messy data. Offered spring semesters. Prerequisites: (STAT:3200 and STAT:3210) or (STAT:5201 and STAT:5200). Requirements: for undergraduate majors—major g.p.a. of 3.00 or above, and grades of B or higher in STAT:3200 and STAT:3210.

STAT:6300 Probability and Stochastic Processes I 3 s.h.
Conditional expectations; Markov chains, including random walks and gambler's ruin; classification of states; stationary distributions; branching processes; Poisson processes; Brownian motion. Prerequisites: STAT:4100.

STAT:6301 Probability and Stochastic Processes II 3 s.h.
Markov chains with continuous state space, Martingales, random walks, Brownian motion and other continuous-time Markov chains, simulation methods. Prerequisites: STAT:6300.

STAT:6513 Intermediate Statistical Methods 3 s.h.
Statistical inference and uncertainty estimation using general linear models (i.e., linear regression, analysis of variance); interpreting and conveying statistical results. Requirements: for PSQF:6243—PSQF:4143; for STAT:6513—STAT:4143. Same as PSQF:6243.

STAT:6514 Correlation and Regression 4 s.h.
Correlation techniques; selected bivariate procedures, multiple, partial, curvilinear correlation; multiple linear regression; sampling theory applied to regression analysis and correlation coefficients; simple causal models. Requirements: for PSQF:6244—PSQF:6243; for STAT:6514—STAT:6513. Same as PSQF:6244.

STAT:6516 Design of Experiments 4 s.h.
Theory and methods in the planning and statistical analysis of experimental studies; testing of hypotheses about linear contrasts among means in single-factor and multifactor, completely randomized, and repeated measurement designs. Requirements: for PSQF:6246—PSQF:6243; for STAT:6516—STAT:6513. Same as PSQF:6246.

STAT:6530 Environmental and Spatial Statistics 3 s.h.
Geostatistics kriging, variogram estimation, trend estimation, sampling design, extensions to river networks and the globe, lattice data analysis, analysis of spatial point patterns. Prerequisites: STAT:4101 and STAT:3200. Same as IGPI:6530.

STAT:6547 Nonparametric Statistical Methods 3 s.h.
Selected nonparametric methods; one- and two-sample location tests and estimation methods, measures of association, analyses of variance; emphasis on relationships to classical parametric procedures. Same as PSQF:6247.

STAT:6550 Introductory Longitudinal Data Analysis 3 s.h.
Introduction to statistical models and estimation methods for outcome variables (normal and non-normal) clustered or measured repeatedly in time or space; focus on applications and computer software methods for ANOVA based methods, hierarchical linear models, linear mixed models, correlated regression models, generalized estimating equations, and generalized linear mixed models. Offered fall semesters. Prerequisites: BIOS:5120 or STAT:3200. Same as BIOS:6310, IGPI:6310.

STAT:6560 Applied Time Series Analysis 3 s.h.
General stationary, nonstationary models, autocovariance autocorrelation functions; stationary, nonstationary autoregressive integrated moving average models; identification, estimation, forecasting in linear models; use of statistical computer packages. Offered spring semesters. Prerequisites: (STAT:5200 or STAT:3200) and STAT:3101.

STAT:6970 Topics in Statistics 3 s.h.
Selected advanced topics in statistics.

STAT:6990 Readings in Statistics arr.
Supervised reading and research in statistics.

STAT:7100 Advanced Inference I 3 s.h.
Concepts of convergence, asymptotic methods including the delta method, sufficiency, asymptotic efficiency, Fisher information and information bounds for estimation, maximum likelihood estimation, the EM-algorithm, Bayes estimation, decision theory. Prerequisites: STAT:5101 and STAT:5120.

STAT:7101 Advanced Inference II 3 s.h.
Hypothesis testing, asymptotics of the likelihood ratio test, asymptotic efficiency, statistical functionals, robustness, bootstrap and jackknife, estimation with dependent data. Prerequisites: STAT:7100.

STAT:7190 Seminar: Mathematical Statistics arr.
Selected advanced topics in mathematical statistics.

STAT:7200 Linear Models 4 s.h.
Linear spaces and selected topics in matrix algebra, full rank and non-full rank linear models, estimability, least squares and best linear unbiased estimation, multivariate normal distribution and distributions of quadratic forms, interval estimation, hypothesis testing, random and mixed models, best linear unbiased prediction, variance component estimation. Prerequisites: STAT:5101 and STAT:5200 and STAT:5201.

STAT:7290 Seminar: Applied Statistics arr.
Selected advanced topics in applied statistics.

STAT:7300 Foundations of Probability I 3 s.h.
Probability theory, with emphasis on constructing rigorous proofs; measure spaces, measurable functions, random variables and induced measures, distribution functions, Lebesque integral, product measure and independence, Borel Cantelli lemma, modes of convergence. Prerequisites: STAT:5120.

STAT:7301 Foundations of Probability II 3 s.h.
Laws of large numbers, characteristic functions and properties, central limit theorem, Radon-Nikodym derivatives, conditional expected value and martingales. Prerequisites: STAT:7300.

STAT:7390 Seminar: Probability arr.
Selected advanced topics in probability.

STAT:7400 Computer Intensive Statistics 3 s.h.
Computer arithmetic, random variate generation, numerical optimization, numerical linear algebra, smoothing techniques, bootstrap methods, cross-validation, MCMC, EM and related algorithms; other topics per student/instructor interests. Prerequisites: (BIOS:5710 or STAT:5200) and STAT:3101. Requirements: proficiency in Fortran or C or C++ or Java. Same as IGPI:7400.

STAT:7500 Statistical Machine Learning 3 s.h.
Regularization methods for sparse models, computational algorithms for large scale problems, statistical inference in high-dimensional models, reproducing kernel Hilbert space, supervised learning, nonparametric density and conditional density estimation, neural networks and deep learning, optimal transport and generative learning, dimension reduction and representation learning. Prerequisites: STAT:5100 or STAT:5200.

STAT:7510 Analysis of Categorical Data 3 s.h.
Models for discrete data, distribution theory, maximum likelihood and weighted least squares estimation for categorical data, tests of fit, models selection. Offered spring semesters. Prerequisites: (BIOS:5720 or STAT:5200) and (STAT:5101 or STAT:4101). Same as BIOS:7410.

STAT:7520 Bayesian Analysis 3 s.h.
Decision theory, conjugate families, structure of Bayesian inference, hierarchical models, asymptotic approximations for posterior distributions, Markov chain Monte Carlo methods and convergence assessment, model adequacy and model choice. Prerequisites: STAT:5101 and STAT:5400 and STAT:5200.

STAT:7560 Time Series Analysis 3 s.h.
Stationary time series, ARIMA models, spectral representation, linear prediction inference for the spectrum, multivariate time series, state space models and processes, nonlinear time series. Prerequisites: STAT:4101 and (STAT:3200 or STAT:6560).

STAT:7570 Survival Data Analysis 3 s.h.
Types of censoring and truncation; survival function estimation; parametric inference using exponential, Weibull, and accelerated failure time models; nonparametric tests; sample size calculation; Cox regression with stratification and time-dependent covariates; regression diagnostics; competing risks; topics may include analysis of correlated survival data and/or recurrent events; designed for biostatistics and statistics majors. Offered fall semesters of odd years. Prerequisites: BIOS:5720 and ((STAT:4100 and STAT:4101) or (STAT:5100 and STAT:5101)). Same as BIOS:7210, IGPI:7210.

STAT:7990 Reading Research arr.
Supervised reading and research in statistics.

Actuarial Science Courses

ACTS:1000 First-Year Seminar 1 s.h.
Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.

ACTS:1001 Introductory Seminar on Actuarial Science 1 s.h.
Introduction to actuarial science; U.S. actuarial organizations and actuarial qualification process; program requirements and tips for academic success; career center, actuarial club, and internships; actuarial career; ethics; communication; introduction to actuarial computing. Requirements: actuarial science interest major and first-year standing.

ACTS:3080 Mathematics of Finance I 3 s.h.
Mathematics of compound interest, annuities certain, amortization schedules, yield rates, sinking funds, and bonds. Prerequisites: STAT:3100 with a minimum grade of B-. Requirements: meet the prerequisite or have graduate standing.

ACTS:3110 Actuarial Exam P Preparation 1 s.h.
Preparation for the Society of Actuaries exam P. Corequisites: STAT:3100 or STAT:4100 or STAT:5100.

ACTS:3210 Actuarial Exam FM Preparation 1 s.h.
Preparation for the Society of Actuaries exam FM. Corequisites: ACTS:3080, if not taken as a prerequisite.

ACTS:4010 Actuarial Exam IFM Preparation 1 s.h.
Preparation for the Society of Actuaries exam IFM. Requirements: multivariate calculus, linear algebra, and statistics. Recommendations: prior or concurrent enrollment in FIN:3300 or ACTS:4380.

ACTS:4110 Actuarial Exam LTAM Preparation 1 s.h.
Preparation for the Society of Actuaries exam LTAM. Corequisites: ACTS:4280, if not taken as a prerequisite.

ACTS:4130 Quantitative Methods for Actuaries 3 s.h.
Survival distributions, life tables, life insurance, life annuities. Prerequisites: STAT:3100 with a minimum grade of B- and ACTS:3080 with a minimum grade of C+. Corequisites: STAT:4100 or STAT:5100. Requirements: multivariate calculus and linear algebra.

ACTS:4160 Topics in Actuarial Science arr.
Selected topics in actuarial science, financial mathematics, and quantitative risk management.

ACTS:4180 Life Contingencies I 3 s.h.
Life annuities, net and gross premiums, net and gross premium reserves, modified reserve methods, and Markov chains. Offered spring semesters. Prerequisites: ACTS:3080 with a minimum grade of C+ and ACTS:4130 with a minimum grade of C+ and (STAT:4100 with a minimum grade of C+ or STAT:5100 with a minimum grade of C+).

ACTS:4280 Life Contingencies II 3 s.h.
Multilife models, multiple-decrement models, continuous-time Markov chain models, profit testing, and profit measures. Offered fall semesters. Prerequisites: ACTS:4180 with a minimum grade of C+.

ACTS:4380 Mathematics of Finance II 3 s.h.
Derivatives markets, forwards, options, pricing models, and actuarial applications. Prerequisites: ACTS:3080 with a minimum grade of C+. Requirements: mathematical statistics, multivariate calculus, and linear algebra.

ACTS:4990 Readings in Actuarial Science arr.

ACTS:6160 Topics in Actuarial Science arr.
Selected topics in actuarial science, financial mathematics, and quantitative risk management; required for all final-year M.S. students in actuarial science.

ACTS:6480 Loss Distributions 3 s.h.
Severity, frequency, and aggregate models and their modifications; risk measures; construction of empirical models. Offered spring semesters. Prerequisites: STAT:4101 or STAT:5101. Corequisites: ACTS:6580.

ACTS:6580 Credibility and Survival Analysis 3 s.h.
Construction and selection of parametric models, credibility, and simulation. Offered spring semesters. Prerequisites: STAT:4101 or STAT:5101. Corequisites: ACTS:6480.

ACTS:6990 Readings in Actuarial Science arr.
Supervised reading and research in actuarial science, financial mathematics, or quantitative risk management.

ACTS:7730 Advanced Topics in Actuarial Science/ Financial Mathematics arr.
Selected advanced topics in actuarial science, financial mathematics and quantitative risk management.

Data Science Courses

DATA:4880 Data Science Creative Component 1 s.h.
Independent project under a faculty advisor's supervision; emphasis on communication of ideas learned in student's data science coursework or internship.

DATA:4890 Data Science Practicum 2 s.h.
On- or off-campus internship or group-based consulting project that provides experience in a real-world setting and introduces ethical and confidentiality issues related to data collection, storage, and sharing.