Statistics and Actuarial Science (C22)

The statistics and actuarial science programs train students for a variety of careers. Statisticians deal with organization, analysis, and presentation of data. Actuaries establish the procedures used by the insurance industry. Statisticians in business are involved in management information systems, analysis of consumer behavior, investment analysis, inventory control, and many other tasks. The pharmaceutical industry is one of the largest employers of statisticians, and here the statisticians are instrumental in designing and evaluating drug testing protocols. Actuaries apply mathematics, probability, and statistics to the fields of insurance and pension management. Most actuaries are employed by the insurance industry, but many are now finding careers in pension management, health care industries, government, and private consulting.

Programs of Study

CAREER PREPARATION
The programs offer students the theory and techniques for the use of mathematics in solving business problems. Each course places special emphasis on methods that solve actual problems. Students work extensively with computers and statistical software.

Statistics is a recommended comajor of all the functional areas of the Stern School, particularly because of the Internet and the ubiquity of large databases.

Qualification as an actuary requires passing a series of professional examinations given by either the Society of Actuaries (for life insurance and pensions) or by the Casualty Actuarial Society (property and casualty insurance). The department offers courses that prepare students for the content of the first three of these examinations, plus courses that satisfy the requirements for the three VEE (Validation by Educational Experience) examinations in economics, finance, and statistics. Stern is one of only a few schools with a program ideally matched to the needs of the actuarial profession.

STATISTICS COMAJOR REQUIREMENTS
(12 CREDITS)
Each course carries 3 credits.
C22.0017/B90.2301 Regression and Multivariate Data Analysis
Plus 9 credits from the following:
C22.0008/B90.2308 Applied Stochastic Processes for Financial Models
C22.0014/B90.3301 Introduction to the Theory of Probability
C22.0015/B90.3302 Statistical Inference and Regression Analysis
C22.0018/B90.2302 Forecasting Time Series Data
C22.0027/B90.2309 Mathematics of Investment
Suggested corerequisite is C15.0007.

Students in the statistics comajor should consult with their adviser in the Office of Academic Advising by the end of their sophomore year to ensure that course distribution requirements are being met and to formally declare the statistics comajor. The statistics and actuarial science undergraduate faculty adviser is always available to advise on the statistics comajor course selection or other matters statistics comajor students may wish to discuss.

STATISTICS MAJOR REQUIREMENTS
(28 CREDITS)
Each course carries 3 credits, except as noted.
V63.0121 Calculus I, 4 credits
V63.0122 Calculus II, 4 credits
V63.0123 Calculus III, 4 credits
V63.0124 Linear Algebra, 4 credits
C22.0014/B90.3301 Introduction to the Theory of Probability
Plus one of the following two courses:
C22.0015/B90.3302 Statistical Inference and Regression Analysis
or
C22.0017/B90.2301 Regression and Multivariate Data Analysis

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Courses

Statistics for Business Control and Regression and Forecasting Models
C22.0103 6 credits. Fall, spring, and summer. Prerequisite: V63.0121. This course combines C22.0001 and C22.0003. Modern statistical methods as a basis for decision making in the face of uncertainty are examined. Topics include probability theory, discrete and continuous distributions, hypothesis testing, estimation, and statistical quality control. With the aid of the computer, these statistical methods are used to analyze data. Also presented is an introduction to statistical models and their application to decision making. Topics include the simple linear regression model, inference in regression analysis, sensitivity analysis, and multiple regression analysis.

Statistics for Business Control
C22.0001 4 credits. Fall and spring. This course is not to be taken by students who have taken C22.0103. Prerequisite: V63.0121. Modern statistical methods as a basis for decision making in the face of uncertainty are examined. Topics include probability theory, discrete and continuous distributions, hypothesis testing, estimation, and statistical quality control. With the aid of the computer, these statistical methods are used to analyze data.

II. Courses in Finance
C15.0007 Financial Management
Note: The course C15.0007 from the Department of Finance covers topics that appear on the actuarial examinations.

III. Actuarial Science and Statistics Courses
C22.0014/B90.3301 Introduction to the Theory of Probability
C22.0027/B90.2309 Mathematics of Investment
C22.0015/B90.3302 Statistical Inference and Regression Analysis
C22.0018/B90.2302 Forecasting of Time Series Data
C22.0037/B90.3335 Life Contingencies
C22.0021/B90.3321 Introduction to Stochastic Processes
C22.0010/B90.3301 Categorical Data
C22.0017/B90.2301 Applied Stochastic Processes for Financial Models
C22.0015/B90.3302 Statistical Inference and Regression Analysis
C22.0018/B90.2302 Forecasting of Time Series Data
C22.0037/B90.3335 Life Contingencies
C22.0021/B90.3321 Introduction to Stochastic Processes

Plus two of the following four courses:

C22.0003 2 credits. Fall and spring. This course is not to be taken by students who have taken C22.0103. Prerequisite: C22.0001 or equivalent. Presents an introduction to statistical models and their application to decision making. Topics include the simple linear regression model, inference in regression analysis, sensitivity analysis, and multiple regression analysis.

Applied Stochastic Processes for Financial Models
C22.0008 3 credits. Fall and spring. Cross-listed with B90.2308. Prerequisite: C22.0103 or C22.0003. Presents a mathematical background for the stochastic processes that are widely employed as modeling tools in finance. The emphasis is on an intuitive approach and examples rather than on proofs and mathematical rigor. Topics include random walks, martingales, Markov chains, Poisson process and other continuous time Markov chains, Brownian motion, geometric Brownian motion, and other diffusion processes. The relevance of the considered processes to financial modeling is stressed throughout. In particular, applications to pricing of derivative securities and to modeling of the term structure of interest rates are discussed.

Categorical Data
C22.0010 3 credits. Fall. Cross-listed with B90.3307. Prerequisite: C22.0015. Introduces discrete random variables, with most of the emphasis going to the bivariate and multivariate situations. Major topics are the chi-squared statistic, Fisher's exact test, odds ratio estimates and intervals, sets of tables, the log-linear model, model fitting, and logit analysis. Minor topics that may be covered are the Mantel-Haenszel statistic, rate standardizing, and detailed modeling of interaction in the two-dimensional table.
Sampling Techniques
C22.0011 3 credits. Spring. Cross-listed with B90.3308. Prerequisite: C22.0013.
Considers commonly used sampling schemes such as simple, random, stratified, multistage, and double sampling and examines their efficiency. Studies methods of estimation, including ratio and regression. Other topics include poststratification, multivariate surveys, analytic studies, problems of nonresponse, nonsampling errors, and randomized response technique. Theory is illustrated with examples from diverse fields.

Introduction to the Theory of Probability
C22.0014 3 credits. Fall and spring. Cross-listed with B90.3301. Prerequisites: V63.0121 and V63.0122.
Covers the basic concepts of probability. Topics include the axiomatic definition of probability; combinatorial theorems; conditional probability and independent events; random variables and probability distributions; expectation of functions of random variables; special discrete and continuous distributions, including the chi-square, t, F, and bivariate normal distributions; law of large numbers; central limit theorem; and moment generating functions. The theory of statistical estimation is introduced with a discussion on maximum likelihood estimation.

Statistical Inference and Regression Analysis
C22.0015 3 credits. Fall and spring. Cross-listed with B90.3302. Prerequisites: V63.0121, V63.0122, and C22.0014.
Consists of two distinct components: statistical inference and regression analysis. Statistical inference topics include the principles of statistical estimation and inference, Neyman Pearson Lemma, testing of means, variances, tests of independence, and nonparametric methods. Regression analysis discusses the general linear regression model, least squares estimation, departures from standard assumptions, autocorrelation, multicollinearity, analysis of residuals, choice of variables, and nonlinear models.

Regression and Multivariate Data Analysis
C22.0017 3 credits. Fall and spring. Cross-listed with B90.2301 and B90.3312. Can be substituted for C22.0015 (B90.3302). Prerequisite: C22.0103 or C22.0003.
A data-driven, applied statistics course focusing on the twin subjects of regression and multivariate data analysis. Emphasizes applications to the analysis of business data and makes extensive use of computer statistical packages. Topics include data analysis and management, multiple linear and nonlinear regression, selection of variables, residual analysis, model building, autoregression, and multicollinearity. Topics in multivariate data analysis include principal components, analysis of variance, categorical data analysis, factor analysis, cluster analysis, discriminant analysis, and logistic regression.

Forecasting Time Series Data
C22.0018 3 credits. Fall and spring. Cross-listed with B90.2302 and B90.3312. Prerequisite: C22.0103 or C22.0003.
The course is an exposition of time series and forecasting techniques with emphasis on ideas, methods, and interpretations. Discusses the determination of the best analytical model for a given problem and the application of this model in the decision-making process for purposes that include description, explanation, and control of time-dependent data. Illustrates all techniques with case studies and uses computer program packages as an aid for obtaining solutions. The major focus is the Box-Jenkins approach to modeling and forecasting time series. Topics include model building, model selection, descriptions of timing and correlation relationships among data sets and forecasting models, estimation, and diagnostic checking. Other topics are seasonal adjustment, exponential smoothing models, state space models, and nonlinear models.

Introduction to Stochastic Processes
C22.0021 3 credits. Fall. Cross-listed with B90.3321.
This is an introductory course in stochastic processes. Presents classes of stochastic processes, which are widely used as modeling tools in many fields of application, including finance, economics, accounting, and actuarial science. Covers basic theory of discrete and continuous time Markov chains, Brownian motion and its generalization, and martingales. Also discusses statistical aspects of these processes. In the final part of the course, introduces the idea of stochastic integration and develops the rules of stochastic calculus. If time permits, also considers some stochastic differential equations.

Mathematics of Investment
C22.0027 3 credits. Fall. Cross-listed with B90.2309. Prerequisites: V63.0121 and V63.0122; also suggested C15.0002.
Discusses the mathematical and technical aspects of investments. Topics include measurement of interest and discount rates, accumulated value and present value, annuities, sinking funds, amortization of debt, and determination of yield rates on securities. Applications include bond evaluation, mortgages, capital budgeting, and depreciation methods.

Life Contingencies
C22.0037 3 credits. Spring. Cross-listed with B90.3335. Prerequisites: C22.0014 and C22.0027.
Applies probability and mathematics of investment to problems of premiums and reserves on annuities and insurance policies. Topics include probabilities of mortality, laws of mortality, joint life probabilities and annuities, and multiple decrement theory. Applications to pension plans are discussed.

Independent Study in Statistics, Operations Research, or Actuarial Science
Prerequisite: permission of the undergraduate faculty adviser.
For selected students whose academic records indicate ability to conduct independent research. Each student makes an intensive study of some topic of his or her own choosing, subject to the approval of the instructor. Included are seminar sessions for group discussions of the various projects.