STATISTICS
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101. Introductory Business Statistics. (C) Staff. Prerequisite(s): MATH 104 or equivalent; successful completion of STAT 101 is prerequisite to STAT 102.

Data summaries and descriptive statistics; introduction to a statistical computer package; Probability: distributions, expectation, variance, covariance, portfolios, central limit theorem; statistical inference of univariate data; Statistical inference for bivariate data: inference for intrinsically linear simple regression models. This course will have a business focus, but is not inappropriate for students in the college.

102. Introductory Business Statistics. (C) Shaman, Staff. Prerequisite(s): STAT 101.

Continuation of STAT 101. A thorough treatment of multiple regression, model selection, analysis of variance, linear logistic regression; introduction to time series. Business applications.

L/R 111. Introductory Statistics. (C) Staff. Prerequisite(s): High school algebra.

Fundamentals of Statistics. Descriptive statistics and simple linear regression. Emphasis is on the development of statistical thinking and applications are directed towards the behavioral sciences, especially psychology, and medicine. Topics include probability, statistical inference, hypothesis testing and confidence intervals.

112. Introductory Statistics. (C) Staff. Prerequisite(s): STAT 111.

Basic ideas of probability and statistics. Statistical methods especially suited for the social, behavioral and biological sciences. Continuation of STAT 111. Focus on multiple regression, analysis of variance, analysis of covariance, and regression diagnostics. Selected topics in the generalized linear modeling including binomial and Poisson regression. Conceptual foundations are addressed as well as hands-on use for data analysis.

430. (STAT510) Probability. (C) Staff. Prerequisite(s): MATH 114 or equivalent.

Discrete and continuous sample spaces and probability; random variables, distributions, independence; expectation and generating functions; Markov chains and recurrence theory.

431. Statistical Inference. (C) Staff. Prerequisite(s): STAT 430.

Graphical displays; one- and two-sample confidence intervals; one- and two-sample hypothesis tests; one- and two-way ANOVA; simple and multiple linear least-squares regression; nonlinear regression; variable selection; logistic regression; categorical data analysis; goodness-of-fit tests. A methodology course. This course does not have business applications but has significant overlap with STAT 101 and 102.

432. (STAT512) Mathematical Statistics. (B) Staff. Prerequisite(s): STAT 430 or 510 or equivalent.

An introduction to the mathematical theory of statistics. Estimation, with a focus on properties of sufficient statistics and maximum likelihood estimators. Hypothesis testing, with a focus on likelihood ratio tests and the consequent development of "t" tests and hypothesis tests in regression and ANOVA. Nonparametric procedures.

433. Stochastic Processes. (C) Foster. Prerequisite(s): STAT 430, or permission of instructor.

An introduction to Stochastic Processes. The primary focus is on Markov Chains, Martingales and Gaussian Processes. We will discuss many interesting applications from physics to economics. Topics may include: simulations of path functions, game theory and linear programming, stochastic optimization, Brownian Motion and Black-Scholes.

434. Financial and Economic Time Series. (A) Steele. Prerequisite(s): STAT 101 - 102 or 431. Familiarity with linear algebra.

This course will introduce students to the time series methods and practices which are most relevant to the analysis of financial and economic data. After an introduction to the statistical programming language S-Plus the course develops an autoregressive models, moving average models, and their generalizations. The course then develops models that are closely focused on particular features of financial series such as the challenges of time dependent volatility.

435. (STAT711) Forecasting Methods for Management. (B) Shaman. Prerequisite(s): STAT 102 or 112 or 431.

This course provides an introduction to the wide range of techniques available for statistical forecasting. Qualitative techniques, smoothing and decomposition of time series, regression, adaptive methods, autoregressive-moving average modeling, and ARCH and GARCH formulations will be surveyed. The emphasis will be on applications, rather than technical foundations and derivations. The techniques will be studied critically, with examination of their usefulness and limitations.

436. Stochastic Modeling. (A) Shepp. Prerequisite(s): STAT 430 or equivalent or permission of instructor.

This course will allow the student to solve stochastic control problems, arising in economics and finance, as well as in engineering and biology. We will study probability, Markov processes, martingales, and Ito calculus mainly at an intuitive, non-rigorous, level. The student will be expected to put in a lot of effort, but the return will be proportional.

451. (INSR451, INSR851, STAT851) Fundamentals of Actuarial Science I. (A) Lemaire. Prerequisite(s): MATH 104, STAT 430. STAT 430 can be taken concurrently with INSR 451/STAT 451.

This course is the usual entry point in the actuarial science program. It is required for students who plan to concentrate or minor in actuarial science. It can also be taken by others interested in the mathematics of personal finance and the use of mortality tables. For future actuaries, it provides the necessary knowledge of compound interest and its applications, and basic life contingencies definition to be used throughout their studies. Non-actuaries will be introduced to practical applications of finance mathematics, such as loan amortization and bond pricing, and premium calculation of typical life insurance contracts. Main topics include annuities, loans and bonds; basic principles of life contingencies and determination of annuity and insurance benefits and premiums.

452. (INSR452, INSR852, STAT852) Fundamentals of Actuarial Science II. (B) Lemaire. Prerequisite(s): INSR 451/STAT 451.

This specialized course is usually only taken by Wharton students who plan to concentrate in actuarial science and Penn students who plan to minor in actuarial mathematics. It provides a comprehensive analysis of advanced life contingencies problems such as reserving, multiple life functions, multiple decrement theory with application to the valuation of pension plans.

453. (INSR453, INSR853, STAT853) Actuarial Statistics. (A) Lemaire. Prerequisite(s): MATH 104, MATH 114, STAT 430, STAT 431.

This course covers models for insurer's losses, and applications of Markov chains. Poisson processes, including extensions such as non-homogeneous, compound, and mixed Poisson processes are studied in detail. The compound model is then used to establish the distribution of losses. An extensive section on Markov chains provides the theory to forecast future states of the process, as well as numerous applications of Markov chains to insurance, finance, and genetics. The course is abundantly illustrated by examples from the insurance and finance literature. While most of the students taking the course are future actuaries, other students interested in applications of statistics may discover in class many fascinating applications of stochastic processes and Markov chains.

454. (INSR454, INSR854, STAT854) Applied Statistical Methods for Actuaries. (B) Lemaire. Prerequisite(s): MATH 104, MATH 114, STAT 430, STAT 431.

One half of the course is devoted to the study of time series, including ARIMA modeling and forecasting. The other half studies modifications in random variables due to deductibles, co-payments, policy limits, and elements of simulation. This course is a possible entry point into the actuarial science program. No INSR coure is a pre-requisite for INSR 834. The Society of Actuaries has approved INSR 834 for VEE credit on the topic of time series.

471. (STAT701) Intermediate Statistics. (B) Foster. Prerequisite(s): STAT 102 or 112 or 431.

This is a course in modern methods in statistics. It will focus on regression, time series, data mining and machine learning. The regression module will extend your knowledge of building multiple regressions. The time series module will introduce you to some ideas in finance. The last two modules will show how these ideas can be applied to large data sets that are more frequently found in the modern age. Throughout the class data based on finance, retail credit, global warming, and the "wikipedia" will be discussed.

472. (STAT712) Decision Making under Uncertainty. (M) Stine. Prerequisite(s): STAT 102 or 112 or 431.

Fundamentals of modern decision analysis with emphasis on managerial decision making under uncertainty and risk. The basic topics of decision analysis are examined. These include payoffs and losses, utility and subjective probability, the value of information, Bayesian analysis, inference and decision making. Examples are presented to illustrate the ideas and methods. Some of these involve: choices among investment alternatives; marketing a new product; health care decisions; and costs, benefits, and sample size in surveys.

473. (STAT953) Bioinformatics. (B) Ewens. Prerequisite(s): Good background in probability and statistics at the approximate level of STAT 430 and STAT 431. The material will follow the class textbook, Ewens and Grant "Statistical Models in Bioinformatics", Springer, second edition, 2005.

An introduction to the use of statistical methods in the increasingly important scientific areas of genomics and bioinformatics. The topics to be covered will be decided in detail after the initial class meeting, but will be taken from the following: - background probability theory of one and many random variables and of events; background statistical inference theory, classical and Bayesian; Poisson processes and Markov chain; the analysis of one and many DNA sequences, in particular shotgun sequencing, pattern analysis and motifs; substitution matrices, general random walk theory, advanced statistical inference, the theory of BLAST, hidden Markov models, microarray analysis, evolutionary models.

474. Modern Regression for the Social and Environmental Sciences. (B) Berk. Prerequisite(s): STAT 102 or 112 or equivalent.

Function estimation and data exploration using extensions of regression analysis: smoothers, semiparametric and nonparametric regression, and supervised machine learning. Conceptual foundations are addressed as well as hands-on use for data analysis.

475. (BSTA775, STAT920) Sample Survey Design. (M) Small. Prerequisite(s): STAT 102 or 112 or 431.

This course will cover the design and analysis of sample surveys. Topics include simple sampling, stratified sampling, cluster sampling, graphics, regression analysis using complex surveys and methods for handling nonresponse bias.

476. (MKTG476, MKTG776) Applied Probability Models in Marketing. (C) Fader. Prerequisite(s): High comfort level with basic integral calculus, and recent exposure to a formal course in probability and statistics such as STAT 430 is strongly recommended.

This course will expose students to the theoretical and empirical "building blocks" that will allow them to construct, estimate, and interpret powerful models of customer behavior. Over the years, researchers and practitioners have used these models for a wide variety of applications, such as new product sales, forecasting, analyses of media usage, and targeted marketing programs. Other disciplines have seen equally broad utilization of these techinques. The course will be entirely lecture-based with a strong emphasis on real-time problem solving. Most sessions will feature sophisticated numerical investigations using Microsoft Excel. Much of the material is highly technical.

500. (BSTA550, PSYC611) Applied Regression and Analysis of Variance. (A) Rosenbaum. Prerequisite(s): STAT 102 or 112 or equivalent.

An applied graduate level course in multiple regression and analysis of variance for students who have completed an undergraduate course in basic statistical methods. Emphasis is on practical methods of data analysis and their interpretation. Covers model building, general linear hypothesis, residual analysis, leverage and influence, one-way anova, two-way anova, factorial anova. Primarily for doctoral students in the managerial, behavioral, social and health sciences.

501. (PSYC612) Introduction to Nonparametric Methods and Log-linear Models. (B) Rosenbaum. Prerequisite(s): STAT 102 or 112 or equivalent.

An applied graduate level course for students who have completed an undergraduate course in basic statistical methods. Covers two unrelated topics: loglinear and logit models for discrete data and nonparametric methods for nonnormal data. Emphasis is on practical methods of data analysis and their interpretation. Primarily for doctoral students in the managerial, behavioral, social and health sciences. May be taken before STAT 500 with permission of instructor.

502. (EDUC683) Survey Methods and Design. (B) Boruch. Prerequisite(s): STAT 520 or equivalent.

Methods and design of field surveys in education, the social sciences, criminal justice research, and other areas. It treats methods of eliciting information through household, mail, telephone surveys, methods of assuring privacy, enhancing cooperation rates and related matters. Fundamentals of statistical sampling and sample design are covered. Much of the course is based on contemporary surveys sponsored by the National Center for Education Statistics and other federal, state, and local agencies.

510. (STAT430) Probability. (A) Foster. Prerequisite(s): A one year course in calculus.

Elements of matrix algebra. Discrete and continuous random variables and their distributions. Moments and moment generating functions. Joint distributions. Functions and transformations of random variables. Law of large numbers and the central limit theorem. Point estimation: sufficiency, maximum likelihood, minimum variance. Confidence intervals.

512. (STAT432) Mathematical Statistics. (B) Staff. Prerequisite(s): STAT 430 or 510 or equivalent.

An introduction to the mathematical theory of statistics. Estimation, with a focus on properties of sufficient statistics and maximum likelihood estimators. Hypothesis testing, with a focus on likelihood ratio tests and the consequent development of "t" tests and hypothesis tests in regression and ANOVA. Nonparametric procedures.

520. Applied Econometrics I. (A) Small. Prerequisite(s): MATH 114 or equivalent and an undergraduate introduction to probability and statistics.

This is a graduate course in applied econometrics. Topics include multiple linear regression, the bootstrap, quantile regression, instrumental variables, maximum likelihood and probit regression.

521. Applied Econometrics II. (B) Shaman. Prerequisite(s): STAT 520.

This is a course in econometrics for graduate students. The goal is to prepare students for empirical research by studying econometric methodology and its theoretical foundations. Students taking the course should be familiar with elementary statistical methodology and basic linear algebra, and should have some programming experience. Topics include ordinary least squares estimation, the bootstrap and jackknife, instrumental variables, systems of equations, M-estimation, maximum likelihood, the generalized method of moments, discrete response models, and time series analysis.

530. (MATH546) Probability. (A) Steele. Prerequisite(s): STAT 430 or 510 or equivalent.

Measure theory and foundations of Probability theory. Zero-one Laws. Probability inequalities. Weak and strong laws of large numbers. Central limit theorems and the use of characteristic functions. Rates of convergence. Introduction to Martingales and random walk.

531. (MATH547) Stochastic Processes. (B) Steele. Prerequisite(s): STAT 530.

Markov chains, Markov processes, and their limit theory. Renewal theory. Martingales and optimal stopping. Stable laws and processes with independent increments. Brownian motion and the theory of weak convergence. Point processes.

541. Statistical Methodology. (A) Buja. Prerequisite(s): STAT 431 or 520 or equivalent; a solid course in linear algebra and a programming language.

This is a course that prepares 1st year PhD students in statistics for a research career. This is not an applied statistics course. Topics covered include: linear models and their high-dimensional geometry, statistical inference illustrated with linear models, diagnostics for linear models, bootstrap and permutation inference, principal component analysis, smoothing and cross-validation.

542. Bayesian Methods and Computation. (B) Jensen. Prerequisite(s): STAT 430 or 510 or equivalent or permission of instructor.

Sophisticated tools for probability modeling and data analysis from the Bayesian perspective. Hierarchical models, mixture models and Monte Carlo simulation techniques.

550. Mathematical Statistics. (A) Small. Prerequisite(s): STAT 431 or 520 or equivalent; comfort with mathematical proofs (e.g., MATH 360).

Decision theory and statistical optimality criteria, sufficiency, point estimation and hypothesis testing methods and theory.

551. Introduction to Linear Statistical Models. (B) Brown. Prerequisite(s): STAT 550.

Theory of the Gaussian Linear Model, with applications to illustrate and complement the theory. Distribution theory of standard tests and estimates in multiple regression and ANOVA models. Model selection and its consequences. Random effects, Bayes, empirical Bayes and minimax estimation for such models. Generalized (Log-linear) models for specific non-Gaussian settings.

552. (BSTA820) Advanced Topics in Mathematical Statistics. (A) Staff. Prerequisite(s): STAT 550 and 551.

A continuation of STAT 550.

553. Machine Learning. (B) Staff. Prerequisite(s): STAT 510 and 512 or equivalent.

This course gives a broad overview of the machine learning and statistical pattern recognition. Some topics will be rather glanced over while others will be considered in-depth. Topics include supervised learning (generative/discriminative models, parametric/nonparametric, neural networks, support vector machines, boosting, bagging, random forests), online learning (prediction with expert advice), learning theory (VC dimension, generalization bounds, bias/variance trade-off), unsupervised learning (clustering, k-means, PCA, ICA). Most of the course concentrates on the supervised and online learning.

701. (STAT471) Advanced Statistics for Management. (B) Foster. Prerequisite(s): STAT 621 or equivalent.

This is a course in modern methods in statistics. It will focus on regression, time series, data mining and machine learning. The regression module will extend your knowledge of building multiple regressions. The time series module will introduce you to some ideas in finance. The last two modules will show how these ideas can be applied to large data sets that are more frequently found in the modern age. Throughout the class data based on finance, retail credit, global warming, and the "wikipedia" will be discussed.

711. (STAT435) Forecasting Methods for Management. (B) Shaman. Prerequisite(s): STAT 621 or equivalent.

This course provides an introduction to the wide range of techniques available for statistical forecasting. Qualitative techniques, smoothing and decomposition of time series, regression, adaptive methods, autoregressive-moving average modeling, and ARCH and GARCH formulations will be surveyed. The emphasis will be on applications, rather than technical foundations and derivations. The techniques will be studied critically, with examination of their usefulness and limitations.

712. (STAT472) Decision Making Under Uncertainty. (M) Stine. Prerequisite(s): STAT 520 or STAT 621 or equivalent.

Fundamentals of modern decision analysis with emphasis on managerial decision making under uncertainty and risk. The basic topics of decision analysis are examined. These include payoffs and losses, utility and subjective probability, the value of information, Bayesian analysis, inference and decision making. Examples are presented to illustrate the ideas and methods. Some of these involve: choices among investment alternatives; marketing a new product; health care decisions; and costs, benefits, and sample size in surveys.

851. (INSR451, INSR851, STAT451) Fundamentals of Actuarial Science I. (A) Lemaire. Prerequisite(s): One semester of calculus.

This course is the usual entry point in the actuarial science program. It is required for students who plan to concentrate or minor in actuarial science. It can also be taken by others interested in the mathematics of personal finance and the use of mortality tables. For future actuaries, it provides the necessary knowledge of compound interest and its applications, and basic life contingencies definition to be used throughout their studies. Non-actuaries will be introduced to practical applications of finance mathematics, such as loan amortization and bond pricing, and premium calculation of typical life insurance contracts. Main topics include annuities,loans and bonds; basic principles of life contingencies and determination of annuity and insurance benefits and premiums.

852. (INSR452, INSR852, STAT452) Fundamentals of Actuarial Science II. (B) Lemaire. Prerequisite(s): STAT 851 or INSR 829.

This specialized course is usually only taken by Wharton students who plan to concentrate in actuarial science and Penn students who plan to minor in actuarial mathematics. It provides a comprehensive analysis of advanced life contingencies problems such as reserving, multiple life functions, multiple decrement theory with application to the valuation of pension plans.

853. (INSR453, INSR853, STAT453) Actuarial Statistics. (A) Lemaire. Prerequisite(s): Two semesters of Statistics.

This course covers models for insurer's losses, and applications of Markov chains. Poisson processes, including extensions such as non-homoeneous, compount, and mixed Poissonprocesses are studied in detail. The compound model is then used to establish the distribution of losses. An extensive section on Markov chains provides the theory to forecast future states of the process, as well as numerous applications of Markov chains to insurance, finance, and genetics. The course is abundantly illustrated by examples from the insurance and finance literature. While most of the students taking the course are future actuaries, other students interested in applications of statistics may discover in class many fascinating applications of stochastic processes and Markov chains.

854. (INSR454, INSR854, STAT454) Applied Statistical Methods for Actuaries. (B) Lemaire. Prerequisite(s): One semester of probability.

One half of the course is devoted to the study of time series, including ARIMA modeling and forecasting. The other half studies modifications in random variables due to deductibles, co-payments, policy limits, and elements of simulation. This course is a possible entry point into the actuarial science program. No INSR course is a pre-requisite for INSR 854. The Society of Actuaries has approved INSR 854 for VEE credit on the topic of time series.

900. Advanced Probability. (M) Staff. Prerequisite(s): STAT 531 or equivalent.

The topics covered will change from year to year. Typical topics include the theory of large deviations, percolation theory, particle systems, and probabilistic learning theory.

901. (OPIM931) Stochastic Processes II. (M) Staff. Prerequisite(s): OPIM 930 or equivalent.

Martingales, optimal stopping, Wald's lemma, age-dependent branching processes, stochastic integration, Ito's lemma.

910. (BSTA852) Forecasting and Time Series Analysis. (K) Stine. Prerequisite(s): STAT 520 or 541 or equivalent.

Fourier analysis of data, stationary time series, properties of autoregressive moving average models and estimation of their parameters, spectral analysis, forecasting. Discussion of applications to problems in economics, engineering, physical science, and life science.

915. Nonparametric Inference. (M) Staff. Prerequisite(s): STAT 520 or equivalent.

Statistical inference when the functional form of the distribution is not specified. Nonparametric function estimation, density estimation, survival analysis, contingency tables, association, and efficiency.

920. (BSTA775, STAT475) Sample Survey Methods. (M) Small. Prerequisite(s): STAT 520, 541 or 550 or permission of instructor.

This course will cover the design and analysis of sample surveys. Topics include simple random sampling, stratified sampling, cluster sampling, graphics, regression analysis using complex surveys and methods for handling nonresponse bias.

921. Observational Studies. (A) Small. Prerequisite(s): STAT 520, 541 or 550 or permission of instructor.

This course will cover statistical methods for the design and analysis of observational studies. Topics will include the potential outcomes framework for causal inference; randomized experiments; matching and propensity score methods for controlling confounding in observational studies; tests of hidden bias; sensitivity analysis; and instrumental variables.

924. Advanced Experimental Design. (M) Staff. Prerequisite(s): STAT 552.

Factorial designs, confounding, incomplete blocks, fractional factorials, random and mixed models, response surfaces.

925. Multivariate Analysis: Theory. (M) Ma. Prerequisite(s): STAT 530, 550 and 552 or permission of instructor.

This is a course that prepares PhD students in statistics for research in multivariate statistics and high dimensional statistical inference. Topics from classical multivariate statistics include the multivariate normal distribution and the Wishart distribution; estimation and hypothesis testing of mean vectors and covariance matrices; principal component analysis, canonical correlation analysis and discriminant analysis; etc. Topics from modern multivariate statistics include the Marcenko-Pastur law, the Tracy-Widom law, nonparametric estimation and hypothesis testing of high-dimensional covariance matrices, high-dimensional principal component analysis, etc.

926. Multivariate Analysis: Methodology. (M) Buja. Prerequisite(s): STAT 541 or permission of instructor.

This is a course that prepares PhD students in statistics for research in multivariate statistics and data visualization. The emphasis will be on a deep conceptual understanding of multivariate methods to the point where students will propose variations and extensions to existing methods or whole new approaches to problems previously solved by classical methods. Topics include: principal component analysis, canonical correlation analysis, generalized canonical analysis; nonlinear extensions of multivariate methods based on optimal transformations of quantitative variables and optimal scaling of categorical variables; shrinkage- and sparsity-based extensions to classical methods; clustering methods of the k-means and hierarchical varieties; multidimensional scaling, graph drawing, and manifold estimation.

927. (BSTA854) Bayesian Statistical Theory and Methods. (M) Zhao. Prerequisite(s): STAT 551.

A course in Bayesian statistical theory and methods. Axiomatic developments of utility theory and subjective probability, and elements of Bayesian theory.

928. Statistical Learning Theory. (B) Kakade, Rakhlin. Prerequisite(s): Probability and linear algebra.

Statistical learning theory studies the statistical aspects of machine learning and automated reasoning, through the use of (sampled) data. In particular, the focus is on characterizing the generalization ability of learning algorithms in terms of how well they perform on "new" data when trained on some given data set. The focus of the course is on: providing the fundamental tools used in this analysis; understanding the performance of widely used learning algorithms; understanding the "art" of designing good algorithms, both in terms of statistical and computational properties. Potential topics include: empirical process theory; online learning; stochastic optimization; margin based algorithms; feature selection; concentration of measure.

932. (BSTA653) Survival Models and Analysis Methods for Medical and Biological Data. (M) Zhao. Prerequisite(s): STAT 551.

Parametric models, nonparametric methods for one-and two-sample problems, proportional hazards model, inference based on ranks. Problems will be considered from clinical trials, toxicology and tumorigenicity studies, and epidemiological studies.

933. Analysis of Categorical Data. (M) Rosenbaum. Prerequisite(s): STAT 541 and 551.

Likelihood equations for log-linear models, properties of maximum likelihood estimates, exact and approximate conditional inference, computing algorithms, weighted least squares methods, and conditional independence and log-linear models. Applied topics, including interpretation of log-linear and logit model parameters, smoothing of tables, goodness-of-fit, and incomplete contingency tables.

940. Advanced Inference I. (M) Staff. Prerequisite(s): STAT 551.

The topics covered will change from year to year. Typical topics include sequential analysis, nonparametric function estimation, robustness, bootstrapping and applications decision theory, likelihood methods, and mixture models.

941. Advanced Inference II. (M) Staff. Prerequisite(s): STAT 940.

A continuation of STAT 940.

SM 950. Quantitative Consulting Seminar. (B) Waterman. Prerequisite(s): No prerequisites, but please talk to the instructor to determine your fit with the course.

The Practicum offers the opportunity for small combined teams of PhD's and MBA to work on "real life" quantitative consulting projects. These projects are drawn from both business and University sources. The emphasis is on providing a relevant and comprehensible solution to the client's problem. In-class brainstorming sessions, client presentations and written reports give students the opportunity to test for the existence of an intersection between their quantitative and communication skills.

SM 951. Statistical Practice II. (M) Staff. Prerequisite(s): STAT 540, 541, 550 and 551.

A continuation of STAT 950.

953. (STAT473) Bioinformatics. (B) Ewens. Prerequisite(s): Good background in probability and statistics at the approximate level of STAT 430 and STAT 431. The material will follow the class textbook, Ewens and Grant "Statistical Models in Bioinformatics", Springer, second edtion, 2005.

An introduction to the use of statistical methods in the increasingly important scientific areas of genomics and bioinformatics. The topics to be covered will be decided in detail after the initial class meeting, but will be taken from the following: - background probability theory of one and many random variables and of events; background statistical inference theory, classical and Bayesian; Poisson processes and Markov chain; the analysis of one and many DNA sequences, in particular shotgun sequencing, pattern analysis and motifs; substitution matrices, general random walk theory, advanced statistical inference, the theory of BLAST, hidden Markov models, microarray analysis, evolutionary models.

955. Stochastic Calculus and Financial Applications. (A) Steele. Prerequisite(s): STAT 530 or equivalent.

Selected topics in the theory of probability and stochastic processes.

956. Financial and Economic Time Series. (B) Steele. Prerequisite(s): A graduate course in statistics or econometrics. Familiarity with linear algebra.

This graduate course introduces students to the time series methods and practices which are most relevant to the analysis of financial and economic data. The course will address both theoretical and empirical issues. Extensive use will be made of the S-Plus Statistical Language, but no previous experience of S-Plus will be required. The course begins with a quick review of ARIMA models. Most of the course is devoted to ARCH, GARCH, threshold, switching Markov, state space, and nonlinear models.

SM 957. Seminar in Data Analysis. (M) Staff. Prerequisite(s): STAT 541, 551, 552, 925, or equivalents; permission of instructor.

Survey of methods for the analysis of large unstructured data sets: detection of outliers, Winsorizing, graphical techniques, robust estimators, multivariate problems.

SM 991. Seminar in Advanced Application of Statistics. (C) Staff.

This seminar will be taken by doctoral candidates after the completion of most of their coursework. Topics vary from year to year and are chosen from advance probability, statistical inference, robust methods, and decision theory with principal emphasis on applications.