

**991. Research Seminar in Work and Organization**

Fall, Winter, Spring. 2(2-0) May re-enroll for a maximum of 6 credits. Thirty graduate credits and approval of instructor. An advanced seminar devoted to analysis of designs used in current research in work and organization.

**999. Research**

Fall, Winter, Spring, Summer. Variable credits. Approval of department.

**SOIL SCIENCE**

**SLS**

**College of Agriculture and Natural Resources**

**202. Soils and Man's Environment**

Winter. 3(3-0) Interdepartmental with Fisheries and Wildlife and Resource Development Departments and Natural Resources. Use of soil-water resources in a technological society as it relates to environmental quality. Nature of pollution problems and their possible solutions. Food production and world population.

**210. Fundamentals of Soil Science**

Fall, Spring. 5 credits. Principles of the origin and development of soils. Relationship of properties to utilization and soil fertility to plant composition and animal health. Emphasis is placed on changing soils to serve man.

**331. Soil Management**

Winter. 4(4-0) 210. Management of soils, drainage and irrigation, organic matter, tillage, rotation, conservation practices, soil reaction, lime, fertilizers, and micronutrients. Soil management vs. soil conservation. Special study in general crops, horticultural crops, greenhouse crops, turf and organic soils.

**390. Soil Conservation and Land Use**

Spring. 3(3-0) 210. Soil resources of the United States and methods and plans for soil conservation including control of erosion. Interpretation of soil survey maps and land evaluation for farm crops, fruits, forestry, engineering and wildlife. Soil judging.

**410. Special Soil Problems**

Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 5 credits. Approval of department.

**420. Seminar**

Winter. 1(1-0) May re-enroll for a maximum of 4 credits. Interdepartmental and administered jointly with Crop Science.

**424. Forest Soils**

Spring. 4(3-3) 210; FOR 220. Interdepartmental with and administered by the Forestry Department. Interrelationships of forest site and the growth of forests. Classification and productivity of forest soils. Effects of silvicultural and forest management practices on the soil. Two-day field trip required.

**430. Soil Fertility and Fertilizers**

Winter. Summer of even-numbered years. 5(4-1) 210. Assessment of the fertility of soils and alteration of fertility by the use of fertilizers, lime, manure, and cropping systems. The role of colloids in ion fixation and exchange. Soil and tissue tests. The history, technology, and use of fertilizers.

**442. Soil Microbiology**

(481.) Spring. 4(3-2) MPH 200; 301 or 401. Interdepartmental with and administered by the Microbiology and Public Health Department. Major groups of microorganisms of importance in soils are studied with emphasis on ecological, biochemical, and physical aspects.

**470. Soil Classification and Mapping**

Fall, Spring; Summer of odd-numbered years. 4(0-8) 210 or approval of department. Classification of soils. Interpretation of profiles in relation to land utilization for farm crops, fruits, forestry, highway-airfield engineering, county and township planning, urban development and wildlife. Preparation of land use reports based upon soil maps of assigned areas.

**480. Soil Geography and Land Use of the World**

Winter. 4(4-0) 210 or approval of department. Survey of the great soil groups and their use throughout the world, their location, significant characteristics, how they are and can be utilized, and the relation of each to food and population increase.

**488. The Impact of Animal Resource Management Upon the World's Developing Nations**

Winter. 3(4-0) For course description, see Interdisciplinary Courses.

**810. Advanced Studies in Soil Science**

Fall, Winter, Spring, Summer. 1 to 5 credits. May re-enroll for a maximum of 6 credits. Approval of department. Areas of study include chemistry, fertility, geography, management, microbiology, micropedology, organic soils, physics, physical chemistry, and soils of the tropics.

**820. Seminar**

Fall, Winter, Spring. 1(1-0) May re-enroll for a maximum of 3 credits.

**825. Clay Mineralogy**

(945.) Winter. 4(3-4) 840, 850 or approval of department. Interdepartmental with and administered by the Geology Department. Structures and properties of clays; their origins, occurrence, and utilization. Methods of studying clays including x-ray diffraction, differential thermal analysis, infrared absorption and other chemical and physical techniques.

**840. Soil Physics**

Fall. 5(3-6) 430; CEM 162 or approval of department. Physical properties of soil (texture, structure, consistency, aeration, water, temperature, etc.), their quantitative measurement, and relation to plant growth, and agronomic and engineering practices.

**850. Soil Chemistry**

Winter. 5(3-6) 430; CEM 162, 383; or approval of department. Chemistry of mineral weathering and soil formation, ion activities, ionic exchange and equilibrium reactions, soil pH, specific elements and their chemical analysis, and availability of nutrients to plants.

**860. Soil Biochemistry**

Spring of even-numbered years. 4 credits. 850; MPH 442. Biochemical transformations of mineral nutrients and of natural and exotic organic materials in soils, considered in relation to chemical, physical and ecological systems in the complex soil environment.

**870. Origin and Classification of Soils**

Winter. 4(3-2) 470, 840, or approval of department. Genesis, morphology and classification of major soils of the world. Relationships among soils in natural and cultural landscapes. How soil properties affect their use, management and conservation. Land classifications for various purposes.

**880. Soils and Land Use in Tropical and Subtropical Regions**

Spring. 3(3-0) Approval of department. Interdepartmental with Agriculture. Problem oriented studies of soils and land use in the tropics and subtropics in relation to their genesis, morphology, taxonomy, and management.

**899. Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**930. Soil Fertility**

Spring. 4(4-0) 850 or approval of department. Fundamental concepts in soil fertility and nutrient uptake by plants; history and development of field plot and greenhouse techniques; research methods in soil fertility; and origin, utilization and management of organic soils.

**999. Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**SOUTH ASIAN LANGUAGES**

See Linguistics and Oriental and African Languages.

**SPANISH**

See Romance Languages.

**STATISTICS AND PROBABILITY**

**STT**

**College of Natural Science**

Courses are classified as follows:

Courses with the last two digits more than 40 require minimum prerequisites of MTH 215.

Courses with the last two digits less than 40 require fewer mathematics prerequisites.

Introductory courses are further classified as follows:

121, 123—sequence for Business Administration students.

201—survey course.

421, 422, 423—minimal sequence for students planning to use statistical methods in their research.

441, 442, 443—minimal sequence in theory of statistics. Qualified students should take the 861, 862, 863 sequence instead.

861, 862, 863—sequence for students preparing to do advanced work in statistics.

881, 882, 883—sequence in analytic probability theory and stochastic processes at graduate mathematics level.

**121. Introduction to Probability**

Fall, Winter, Spring, Summer. 4(5-0)  
MTH 111. Credit may not be earned in more than one of the following: 121, 201, 421.

Set and algebra of sets. Chance experiments, outcomes and events. Probabilities of events. Conditional probability, independent trials, Bayes' theorem. Introduction to statistical inference relevant to business decision problems.

**123. Statistics in Business Decision-Making**

Fall, Winter, Spring. 4(2-2) 121.  
Statistical inference and decision-making under uncertainty. Summarization of information and statistical tests. Statistical decision rules and their evaluation in terms of expected cost. Risk.

**201. Statistical Methods**

Fall, Winter, Spring, Summer. 4(4-0)  
MTH 108 or 111. Primarily for students in psychology, sociology, anthropology, political science, economics, agriculture, and forestry. Credit may not be earned in more than one of the following: 121, 201, 421.

Descriptive statistics, elementary probability and combinatorics. The binomial distribution. Random variables, their expectations and variances. Central Limit Theorem, estimation and inference. Simple tests based on the binomial, normal, t, chi-square and F distributions.

**316. Fundamentals of Statistical Inference**

Fall, Winter, Spring, Summer. 4(5-0)  
121. Primarily for students in the College of Business. Interdepartmental with the Marketing and Transportation Administration Department.

Description of sample data, applications of probability theory, sampling, estimation, tests of hypotheses.

**317. Quantitative Business Research Methods**

Fall, Winter, Spring, Summer. 4(3-2)  
316. Interdepartmental with and administered by the Marketing and Transportation Administration Department.

Application of statistical techniques to business decision-making. Topics covered include applications of linear regression and correlation, analysis of variance, selected non-parametric tests, time series, and index numbers.

**341. Probability for Teachers**

Spring. 4(4-0) MTH 301 or approval of department.

Primarily for majors in mathematical education. Probability theory will be studied as a mathematical structure. Although some examples of the use of the theory will be discussed (as the use of some theorems is discussed in a course in plane geometry) the major emphasis will be on understanding the structure of probability theory.

**351. Introduction to Statistics**

Spring. 4(4-0) MTH 214.  
Probability models, discrete random variables, the binomial, hyper-geometric and Poisson distributions, statistical inference based on the binomial distribution, continuous random variables, test of hypothesis and confidence intervals based on the normal distribution.

**421. Statistics I**

Fall, Winter, Spring, Summer. 4(4-0)  
MTH 108. Credit may not be earned in more than one of the following: 121, 201, 421. This course and 422, 423 form a one year sequence in statistics for those without a calculus background; 421 provides an introduction to a few of the main ideas of probability and statistics. The course sequences 441-2-3 and 861-2-3 form one year sequences in statistics for those with a calculus background. Those expecting to use statistics in their graduate research should complete one of the full year sequences.

Descriptive statistics, elementary probability and combinatorics. The binomial distribution. Random variables, their expectations and variances. The Central Limit Theorem, Estimation and inference. Simple tests based on the binomial, normal, t, chi-square and F distributions.

**422. Statistics II**

Fall, Winter, Spring, Summer. 3(3-0)  
201 or 421.

Nonparametric tests: sign test, Wilcoxon's rank sum test, Spearman's rank correlation test, run tests. Multiple regression analysis. Least squares estimation and tests for simple linear hypotheses.

**423. Statistics III**

Fall, Winter, Spring, Summer. 3(3-0)  
422.

Application of multiple regression analysis to analysis of variance problems. Design of experiments including randomized block designs. Latin squares, factorial designs, and balanced incomplete block designs.

**441. Probability and Statistics I: Probability**

Fall, Winter, Spring, Summer. 4(4-0)  
MTH 215.

Mathematical probability as a basis for the theory of statistics. Discrete and continuous probability models, conditional probability and independence, random variables, central limit theorem, sampling distributions.

**442. Probability and Statistics II: Inference**

Winter, Spring. 4(4-0) 441; MTH 334 or concurrently.

Estimation, confidence intervals, tests of hypotheses, linear hypotheses.

**443. Probability and Statistics III: Inference**

Fall, Spring. 4(4-0) 442.

Multiple linear regression, analysis of variance, goodness of fit tests, certain non-parametric tests.

**490. Statistical Problems**

Fall, Winter, Spring. 1 to 6 credits.  
Approval of department.

Individualized study adapted to the preparation and interests of the student.

**825. Sample Surveys**

Fall. 3(3-0) 423 or 442 or 862.

Application of statistical sampling theory to survey designs involving simple random, stratified, and systematic samples; sub-sampling, double sampling; ratio and regression estimates; other topics.

**826. Nonparametric Statistics**

Spring. 4(4-0) 442 or 862.

Current tests of hypotheses which may be made without specification of the underlying distribution. Rank tests and tests based on permutation of observations. Tolerance and confidence sets. Large-sample distributions. Applications to research in the social and natural sciences.

**833. Mathematical Programming**

Spring. 3(3-0) EC 800, or 812A,  
MTH 334. Interdepartmental with the Agricultural Economics and Economics Departments and administered by the Agricultural Economics Department.

Linear programming. Theory of linear economic models. Topics in nonlinear programming.

**841. Linear Statistical Models**

Fall. 4(4-0) 443 or 863.

Use of linear statistical models. Curve fitting, simple and multiple regression analysis, multiple and partial correlation coefficients, the analysis of variance, simultaneous confidence intervals, more complex experimental designs.

**852. Methods in Operations Research I**

Winter. 3(3-0) 441 or 861.

Optimization techniques and probability models with a wide variety of applications: linear programming, including special problems; network analysis, including PERT; dynamic programming; game theory; queuing theory. Acquaintance with matrices advisable.

**853. Methods in Operations Research II**

Spring. 3(3-0) 852.

Continuation of 852. Inventory theory; Markov chains with applications; simulation as adjunct to mathematical models; advanced topics in linear programming; non-linear programming.

**861. Probability and Statistics I: Discrete Probability**

Fall. 4(4-0) MTH 424 or concurrently.

Combinatorial analysis, discrete probability spaces, conditional probability and independence, Bernoulli trials, random variables, expectations, generating functions, laws of large numbers.

**862. Probability and Statistics II: Continuous Probability**

Winter. 4(4-0) 861; MTH 425 or concurrently.

Distribution functions, density, moment generating function, multivariate distributions, transformations, various important special distributions, central limit theorem.

**863. Probability and Statistics III: Inference**

Spring. 4(4-0) 862; MTH 426 or concurrently.

Introduction to methods of estimation and testing hypotheses based on probability.

**864. Stochastic Models in Biology**

Fall. 3(3-0) 441 or 861.

Stochastic processes. Selected topics from growth processes, epidemic theory, prey-predator models, mathematical genetics.

**865. Theory of Experimental Designs**

Fall. 4(4-0) 863 and MTH 831 or approval of department.

Experimentation: Cochran's theorem; review of sampling theory; simple designs and statistical analyses; factorial designs and confounding and the group theoretic aspects of these designs; geometrical problems of construction of sets of Latin and Graeco-Latin squares.

**871. Statistical Decision Theory I**

Fall. 4(4-0) 863; MTH 821 or concurrently.

The general statistical decision problem. Concepts of loss function, risk, admissibility, completeness, minimax and Bayes procedures and reductions due to sufficiency and invariance. The minimax and complete class theorems. Some distributions and sufficient statistics.

**872. Statistical Decision Theory II**  
Winter. 4(4-0) 871; MTH 822 or concurrently.

Exponential families, complete sufficient statistics. Invariant statistical decision problems. Estimation of parameters and testing statistical hypotheses.

**873. Statistical Decision Theory III**  
Spring. 4(4-0) 872; MTH 927 or concurrently; or approval of department.

Continuation of hypotheses testing, the two-sample problem, confidence sets, and the general linear hypothesis. Multiple decision problems.

**876. Statistical Inference in Economics I**

Fall. 3(3-0) 443 or 863; EC 812A or 801; or approval of department. Interdepartmental with the Agricultural Economics and Economics Departments and administered by the Economics Department.

Review and extension of single-equation regression models. Properties of least-squares estimators under alternative specifications. Problems of analyzing nonexperimental data. Errors in variable, autoregressive and heteroscedastic models.

**877. Statistical Inference in Economics II**

Winter. 3(3-0) EC 876 or approval of department. Interdepartmental with the Agricultural Economics and Economics Departments and administered by the Economics Department.

Specification interpretation and estimation of simultaneous equation models. Nonlinear models. Bayesian approach to estimation problems. Recent developments in econometrics.

**878. Statistical Inference in Economics III**

Spring. 3(3-0) EC 877 or approval of department. Interdepartmental with the Agricultural Economics and Economics Departments and administered by the Economics Department.

Validation and application of dynamic econometric models. Bayesian approach to estimation problems. Recent developments in econometric methods and in applied econometric research.

**881. Probability and Stochastic Processes I**

Fall. 3(3-0) MTH 821 or concurrently.

Discrete probability models, dependence and independence, random variables and expectation. Exponential and uniform densities. Special densities and mixtures. Multivariate densities. Probability distributions in  $\mathbb{R}^r$ .

**882. Probability and Stochastic Processes II**

Winter. 3(3-0) MTH 822 or concurrently.

Laws of large numbers, applications in analysis. Basic limit theorems. Markov processes and semi-groups. Renewal theory. Random walks in  $\mathbb{R}^1$ .

**883. Probability and Stochastic Processes III**

Spring. 3(3-0) MTH 823 or concurrently.

Laplace transforms, Tauberian theorems, resolvents. Applications of Laplace transforms, Characteristic functions. Application of Fourier methods to random walks. Harmonic analysis.

**886. Stochastic Processes and Technological Applications**

Winter. 3(3-0) 441 or 861.

Discrete stochastic processes. Markov chains, birth and death processes, branching processes. Selected technological applications.

**887. Stochastic Models in the Physical Sciences**

Spring. 3(3-0) 886 or approval of department.

Selected models from the physical sciences. These may include topics from the theory of queues, the theory of dams, and branching processes in cosmic ray theory.

**890. Statistical Problems**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**899. Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**927. Theory of Measure and Integration**

Spring. 4(4-0) MTH 861. Interdepartmental with and administered by the Mathematics Department.

Introduction to the theory of integration over abstract spaces. Topics include: measure spaces; measurable and integrable functions; modes of convergence, theorems of Egoroff, Lusin, Riesz-Fischer, Lebesgue; absolute continuity, and the Radon-Nikodym theorem; product measures and Fubini's theorem. Applications to some of the classical theories of integration and summability.

**971. Advanced Theory of Statistics I**

Fall. 4(4-0) 873; 981 or concurrently.

Continuation of 873; more general treatment of topics using measure theory and measure-theoretic probability.

**972. Advanced Theory of Statistics II**

Winter. 4(4-0) 971; 982 or concurrently.

Statistical convergence theorems. Variables and distributions in  $n$ -space. Asymptotic and exact sampling distributions. Tests of significance.

**973. Advanced Theory of Statistics III**

Spring. 4(4-0) 972.

Continuation of 972.

**981. Advanced Theory of Probability I**

Fall. 4(4-0) 863; MTH 927 or approval of department.

Measures on infinite product spaces and Kolmogorov's consistency theorem. Distributions and characteristic functions. Independence. Series of independent random variables.

**982. Advanced Theory of Probability II**

Winter. 4(4-0) 981 or approval of department.

Central limit problem: the classical limit problem, the bounded variances case, and limit laws for infinitely divisible random variables. Conditional probabilities and expectations. Martingales with discrete time.

**983. Advanced Theory of Probability III**

Spring. 4(4-0) 982 or approval of department.

Ergodic theory; individual and  $L_p$  ergodic theorems. Second order processes, weakly and strongly stationary processes. Foundations; separability and measurability of processes; properties of sample functions. Continuous time martingales. Processes with independent increments.

**995. Advanced Topics in Statistics**  
Fall, Winter, Spring. Variable credit.

**999. Research**  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

## STUDIO ART

See Art.

## SYSTEMS SCIENCE

See Electrical Engineering and Systems Science.

## TELEVISION AND RADIO T R

### College of Communication Arts

**100. Foundations of Broadcasting**  
(271.) Fall, Spring, Summer. 3(3-0)

Origin, development, nature, and function of radio and television in modern society.

**201. Fundamentals of Radio Broadcasting**  
(272.) Fall, Winter, Spring, Summer.

4(2-4) 100. Sophomore television-radio majors.

Basic orientation to the radio studio, with laboratory experiences in production, writing, and performance.

**202. Fundamentals of Television Broadcasting**  
(353.) Fall, Winter, Spring. 4(2-4)

201.

Basic orientation to the television studio, with laboratory experiences in production, writing, and performance.

**280. History of the Motion Picture**  
Fall, Winter. 4(2-4) Sophomores.

Development of the motion picture from its beginning to the present, emphasizing social background and cultural values. Screening of significant films from various periods and countries.

**333. Television Directing**  
(433.) Fall, Winter, Spring, Summer.

4(2-4) 202 and approval of department.

Television producing and directing methods with assigned experiences in the television studios.

**335. Television and Radio Audience Studies**

Winter, Summer. 3(3-0) Juniors.

Analysis and evaluation of broadcast audience measurement services and other feedback systems. Broadcast audience characteristics, attitudes and behavior.

**350. Advanced Radio Production**  
(450.) Spring. 4(2-4) 201 and approval of department.

Planning, coordinating and producing the radio program. Emphasis on documentary and studio productions utilizing original ideas and methods.