University of New Hampshire - The Graduate School
https://gradschool.unh.edu

Department of Mathematics and Statistics
https://ceps.unh.edu/mathematics-statistics

Graduate Certificate in

INDUSTRIAL STATISTICS

Program Requirements

A Graduate Certificate in Industrial Statistics is awarded for completion of four courses as follows:

Three Required Courses: chosen from

MATH 836: Advanced Statistical Methods for Research
MATH 837: Statistical Quality Improvement (SQI)
MATH 839: Applied Regression Analysis
MATH 840: Design of Experiments I

Note that all of these have as a prerequisite an introductory statistics course, such as MATH 835: Statistical Methods for Research.

One Elective Course: chosen from the remaining course of the above list and from

MATH 838: Data Mining and Predictive Analytics
MATH 841: Biostatistics and Life Testing
MATH 843: Time Series Analysis
MATH 844: Design of Experiments II (DOE II)
MATH 855: Probability and Stochastic Processes
MATH 941: Bayesian and Computational Statistics
MATH 944: Spatial Statistics

or any other approved special topics course in the area of industrial statistics.
Other special topics courses are occasionally offered and may be added to the list of elective courses.

All of the courses of the Required Courses list and most courses of the Elective Courses list are currently offered either synchronously over the Internet using a live web conferencing tool (hybrid on-line), or asynchronously ("fully") on-line.

Typical Schedule of Offerings

Spring: 836, 838, 840, **Fall**: 837, 839, 840 , 855
Every other year alternating: Spring: 841 & 843, **Fall:** 941 & 944

Program Coordinator

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Application

Apply on-line via the UNH Graduate School: https://gradschool.unh.edu look for Academic Programs: type "Statistics" und Find Your Program. Transcripts and Statement of purpose are required for this Graduate Certificate.

Answers to Frequently Asked Questions about Graduate Certificates

- Individuals holding a Bachelor's degree are eligible to apply for admission to a graduate certificate program
- Applicants may or may not already be enrolled in a graduate degree program at UNH.
- Application for matriculation into the certificate program should be made no later than the beginning of the second course to be taken for the certificate.
- A maximum of one graduate course taken at UNH prior to matriculating may be applied to the certificate.
- Courses can be applied to only one certificate program but may be applied towards the UNH masters in Statistics. Some courses may also be applied to other UNH graduate programs contingent upon approval by the respective program.
- Tuition for in-state students is the same as per credit rate for in-state graduate degree students. Out-of-state rate is 10% higher.
- A grade of B- or higher must be earned in these courses in order for them to be counted towards the certificate.

Certificate Program Instructors and their Area of Expertise

Michelle Capozzoli, Ph.D.	Biostatistics, Engineering Statistics, On-line Learning
Veronica Hupper, Ph.D.	Spatial Statistics, Statistics Education, On-line Learning.
Linyuan Li, Ph.D.	Wavelets, Life Time Distributions, Long Memory Processes
Ernst Linder, Ph.D.	Environmental Statistics, Spatial & Spatial Temporal Statistics, Climate Extremes, Bayesian and Computational Statistics
Joseph C. Poythress	High-dimensional data, network analysis, statistical computing.
Philip Ramsey, Ph.D.	Design of Experiments Six Sigma, Process Control, Data Mining, Predictive Analytics

Course Descriptions

MATH 836 - Advanced Statistical Methods for Research Credits: 3.00 An introduction to multivariate statistical methods, including principal components, discriminant analysis, cluster analysis, factor analysis, multidimensional scaling, and MANOVA. Additional topics include generalized linear models, general additive models, depending on the interests of class participants. This course completes a solid grounding in modern applications of statistics used in most research applications. The use of statistical software, such as JMP, or R, is fully integrated into the course. **Prerequisites:** MATH 835 or MATH 839.

MATH 837 - Statistical Methods For Quality Improvement Credits: 3.00 Introduces scientific data collection and analysis with an emphasis on industrial and service provider applications. Topics include descriptive and graphical statistical methods, confidence intervals and hypothesis testing, regression, ANOVA, statistical process control (SPC), failure modes and effects analysis (FMEA), Six-Sigma concepts and methods, introduction to reliability, quality tools, MSA, and process capability studies, introduction to Lean methodology, such as 5S, Kaizen, and VSM. Use of a statistical software package is an integral part of the course.
Prerequisites: Basic introductory statistics.

MATH 838 – Data Mining and Predictive Analytics Credits: 3.00 An introduction to supervised and unsupervised methods for exploring large data sets and developing predictive models. Unsupervised methods include: market basket analysis, principal components, clustering, and variables clustering. Important statistical and machine learning methods (supervised learning) include: Classification and Regression Tress (CART), Random Forests, Neural Nets, Support Vector Machines, Logistic Regression and Penalized Regression. Additional topics focus on metamodeling, validation strategies, bagging and boosting to improve prediction or classification, and ensemble prediction from a set of diverse models. Required case studies and projects provide students with experience in applying these techniques and strategies. The course necessarily involves the use of statistical software and programming languages. Prereq: MATH 835 or basic introductory statistics.

MATH 839 - Applied Regression Analysis Credits: 3.00 Statistical methods for the analysis of relationships between response and input variables: simple linear regression, multiple regression analysis, residual analysis model selection, multi-collinearity, nonlinear curve fitting, categorical predictors, introduction to analysis of variance, analysis of covariance, examination of validity of underlying assumptions, logistic regression analysis. Emphasizes real applications with use of statistical software. **Prerequisites:** Basic introductory statistics.

MATH 840 - Design of Experiments I Credits: 3.00 First course in design of experiments with applications to quality improvement in industrial manufacturing, engineering research and development, or research in physical and biological sciences. Experimental factor identification, statistical analysis and modeling of experimental results, randomization and blocking, full factorial designs, random and mixed effects models, replication and sub-sampling strategies, fractional factorial designs, response surface methods, mixture designs, and screening designs. Focuses on various treatment structures for designed experimentation and the associated statistical analyses. Use of statistical software. **Prerequisites:** Basic introductory statistics.

MATH 841 - Survival Analysis Credits: 3.00 Explorations of models and data-analytic methods used in medical, biological, and reliability studies. Event-time data, censored data, reliability models and methods, Kaplan-Meier estimator, proportional hazards, Poisson models, loglinear models. Suitable statistical software, such as SAS, JMP, or R, are used.
Prerequisites: Basic introductory statistics. (Offered in alternate years.)

MATH 843 - Time Series Analysis Credits: 3.00 An introduction to univariate time series models and associated methods of data analysis and inference in the time domain and frequency domain. Topics include: Auto regressive (AR), moving average (MA), ARMA and ARIMA processes, stationary and non-stationary processes, seasonal ARIMA processes, auto-correlation and partial auto-correlation functions, identification of models, estimation of parameters, diagnostic checking of fitted models, forecasting, spectral density function, periodogram and discrete Fourier transform, linear filters. parametric spectral estimation, dynamic Fourier analysis. Additional topics may include wavelets and long memory processes (FARIMA) and GARCH Models. The use of statistical software, such as JMP, or R, is fully integrated in to the course.
Prerequisites: MATH 835 or MATH 839. Offered in alternate years in the spring.

MATH 844 - Design of Experiments II Credits: 3.00 Second course in design of experiments, with applications in quality improvement and industrial manufacturing, engineering research and development, research in physical and biological sciences. Covers experimental design strategies and issues that are often encountered in practice complete and incomplete blocking, partially balanced incomplete blocking (PBIB), partial confounding, intra and inter block information, split plotting and strip plotting, repeated measures, crossover designs, Latin squares and rectangles, Youden squares, crossed and nested treatment structures, variance components, mixed effects models, analysis of covariance, optimizations, space filling designs, and modern screening design strategies.
Prerequisites: MATH 840; or permission.

MATH 855 - Probability and Stochastic Processes Credits: 3.00 Introduction to the theory of probability, random variables, expectation, discrete and continuous probability distributions, joint probability distributions, conditional distributions; correlation, Markov chains, introduction to stochastic processes, birth-death processes, moment-generating functions, limit theorems.
Prerequisites: Basic introductory statistics.

MATH 941 - Bayesian and Computational Statistics Credits: 3.00 Current approaches to Bayesian modeling and data analysis and related statistical methodology based on computational simulation. Fundamentals of Bayesian estimation and hypothesis testing; multi-level and hierarchical Bayesian modeling for correlated data. Introduction to Markov chain Monte Carlo based estimation approaches such as the Gibbs sampler and the Metropolis-Hastings alogorithm.
Prerequisites: Intermediate statistics including transformation of variables (calculus based), bivariate and multivariate normal distribution, maximum likelihood estimation; working knowledge of linear regression and analysis of variance; basic linear algebra: vectors and matrices.

MATH 944 - Spatial Statistics Credits: 3.00 Frequentist and Bayesian methods for estimation of characteristics measured in space (usually 2-dimensional Euclidean space). Spatial averaging. Spatial point processes: models for clustering and inhibition. Cluster detection. Point referenced data: variogram estimation, Kriging, spatial regression. Lattice based data: spatial auto-regression, Markov random field models. Spatial regression models. Non-Gaussian response variables. Hierarchical Bayesian spatial models and Markov chain Monte Carlo methods. Multivariable spatial models. **Prerequisites:** Intermediate statistics including basics of maximum likelihood estimation; linear regression modeling including familiarity with matrix notation, basic concepts of calculus including partial derivatives.