

Master of Science in Statistics & Operations Research
Program code: 048010

INTRODUCTION

The Department of Statistics and Operations Research (College of Science) offers a Master of Science program in **Statistics and Operations Research**. Research requirements include both thesis and non-thesis options. Current research interests of the faculty include: Non-Parametric Statistics, Linear Models, Stochastic Processes, Probability Theory, Distribution Theory, Multivariate analysis, Demography, Quality Control, Sampling, Simulation, Queuing Theory, Inventory Models, and Mathematical Programming.

According to the University Council decision dated 4/2/2007, Thesis students admitted with effect from September 2007 are exempted from the comprehensive examination.

PROGRAM REQUIREMENTS (non-thesis option in parenthesis)**31 (34) TOTAL COURSE CREDITS****1 (1) SEMINAR (1 credit each)**

- 0480-529 Seminar in Statistics
- 0480-569 Seminar in Operations Research

12 (15) COMPULSORY (3 credits each)

- 0480-502 Theory of Statistics I
- 0480-524 Statistical Modeling
- 0480-549 Optimization
- 0480-550 Stochastic Processes
- 0480-585 Statistical Methods in Research
(for students outside the Statistical & Operation Program)
- 0480-593 Project (non-thesis option only).

6(12) ELECTIVES (3 credits each)

- 0480-501 Probability Theory
- 0480-503 Theory of Statistics II
- 0480-504 Multivariate Statistical Analysis
- 0480-511 Bayesian Analysis
- 0480-512 Statistical Theory of Reliability
- 0480-513 Topics in Statistics
- 0480-515 Statistical Computing

- 0480-521 Time Series Analysis
- 0480-522 Linear Statistical Models I
- 0480-523 Linear Statistical Models II
- 0480-551 General Systems Theory
- 0480-552 Optimization of Continuous System
- 0480-553 Optimization of Discrete Systems
- 0480-554 Queues and Inventories
- 0480-562 Operations Research Project
- 0480-563 Simulation
- 0480-565 Topics in Operations Research

3 (6) FREE ELECTIVES

The remaining credit hours may be elected from any 500 level graduate courses offered by the Program of Statistics and Operations Research or the Program of Mathematics with the approval of the Program Director.

9 COMPULSORY COURSES

- 0480-597 Thesis (0)
- 0480-598 Thesis (0)
- 2000-599 Thesis (9)

COURSE DESCRIPTION

**0480-501: PROBABILITY THEORY
CR: 3**

Measure-theoretic probability, random variables, univariate and multivariate distribution functions, expectation, characteristic functions, independence, the zero-one-law, the continuity theorem, modes of convergence. Sums of independent random variables, laws of large numbers, central limit theorems, conditional expectation.

**0480-502: THEORY OF STATISTICS I
CR: 3**

Criteria and methods of estimation: minimum variance unbiased estimators, properties. General Procedures: Bayes estimation, minimax estimation, fiducial probability, principle of invariance estimation of parameters, maximum likelihood estimators, method of scoring, hypotheses testing, non parametric estimation.

**0480-503: THEORY OF STATISTICS II
CR: 3 PR: 0480-502**

Asymptotic theory, Cramer-Rao type inequalities, asymptotic properties of maximum likelihood estimate, sequential analysis, estimation and hypothesis testing, decision theory and problem of identification.

**0480-504: MULTIVARIATE STATISTICAL ANALYSIS
CR: 3**

The multivariate normal, inferences about mean and covarianced matrix, Wishart distribution, Hotelling T-square, multivariate analysis of variance, classification techniques, principal components, factor analysis.

**0480- 507: FOUNDATIONS OF OPERATIONS RESEARCH
CR: 3**

(Pre 1989/1990 was offered as 0410-590)
Operations research methodologies such as linear programming, integer programming, nonlinear

programming, dynamic programming, networks, queueing and inventory, decision analysis, simulation, Markov chains. This course will not be counted for elective credits.

0480-508: FOUNDATIONS OF STATISTICS

CR: 3

Univariate and multivariate probability distributions, sampling distributions, maximum likelihood estimation, Rao-Cramer lower bound, efficient estimators, sufficiency, interval estimation, uniformly powerful tests, likelihood ratio tests, regression models. This course will not be counted for elective credits.

0480-511: BAYESIAN ANALYSIS

CR: 3

Theories of probability: comparative, subjective, frequentist and quantitative probability. Decision theory: loss, utility and decision functions, no data problems. Distributions: prior, likelihood, posterior, fiducial and predictive. Methods of constructing prior distributions: personal, non-informative, Jeffery's prior, conjugate prior and maximum posterior distributions. Bayesian-statistical inference: point and interval estimation, testing, non-parametric procedures and analysis of contingency tables. Robustness of Bayes methods.

0480-512: STATISTICAL THEORY OF RELIABILITY

CR: 3

Structural properties of coherent Systems. Reliability of coherent systems. Parametric families of distributions of direct importance in reliability theory. Classes of life distributions based on notions of aging. Concepts helpful in the study of maintenance policies. Implementing coherent structure theory for complex systems.

0480-513: TOPICS IN STATISTICS

CR: 3

Special topics not covered in other courses. May be repeated for credit under different subtitles.

0480-515: STATISTICAL COMPUTING

CR: 3

Techniques of advanced computational statistics, numerical optimization and integration, simulation and Monte Carlo methods including Markov chain Monte Carlo, bootstrapping, smoothing/density

estimation, regression analysis, and other modern topics.

0480-521: TIME SERIES ANALYSIS

CR: 3

Stationary and non-stationary models, auto-covariance and auto correlation functions, spectral density, linear models, identification, estimation and forecasting, estimation of spectral densities, analysis of time series data.

0480-522: LINEAR STATISTICAL MODELS I

CR: 3

Distribution of quadratic forms, non-central t, chi-square, non-normal cases, regression models, polynomial and trigonometric models.

0480-523: LINEAR STATISTICAL MODELS II

CR: 3

Experimental design models, one-factor and two-factors, incomplete block models and tests for interaction, components-of-variance models.

0480-524: STATISTICAL MODELING

CR: 3

Matrix preliminaries, normal linear models, multivariate normal, distributions of quadratic forms, full-rank and non-full-rank linear models, inference for categorized data, analysis of contingency tables, generalized linear models, logistic regression, logit models for multi-category responses, log-linear models, with applications using R.

0480-529: SEMINAR IN STATISTICS

CR: 1

0480-549: OPTIMIZATION

CR: 3

Unconstrained optimization, constrained optimization, Integer programming and stochastic programming.

0480-550: STOCHASTIC PROCESSES

CR: 3

Markov chains, random walk, run problems, birth and death processes, Processes with independent increments, Poisson and Gaussian Processes, applications, models in science, engineering and social sciences.

**0480-551: GENERAL SYSTEMS THEORY
CR: 3**

Definition and classification of systems, goal seeking behaviour and memory characteristics of systems, methods of systems description, interdependence analysis, entropic content of systems and the law of requisite variety and systems design and analysis.

**0480-552: OPTIMIZATION OF CONTINUOUS SYSTEMS
CR: 3**

The optimization problem, the simplex method for linearizable models, duality in optimization, quadratic and convex mathematical programming, dynamic linear models, Markovian decision processes.

**0480-553: OPTIMIZATION OF DISCRETE SYSTEMS
CR: 3**

Integer programming and combinatorial models, network models, dynamic programming and sequential analysis.

**0480-554: QUEUES AND INVENTORIES
CR: 3**

Persuasiveness of waiting lines and inventories, structure and analysis of queues and inventories, optimal control of waiting lines and inventories.

**0480-562: OPERATIONS RESEARCH PROJECT
CR: 3**

Phases of the operations research study. The student with the instructor identify a real-life significant problem and conduct on it a full operations research study.

**0480-563: SIMULATION
CR: 3**

The need for computer simulation of processes, building a simulation model generating phenomena, design of simulation experiments, application of simulation, computer languages.

**0480-565: TOPICS IN OPERATIONS RESEARCH
CR: 3**

Special topics not covered in other courses. May be repeated for credit under different subtitles.

**0480-569: SEMINAR IN OPERATIONS RESEARCH
CR: 1**

**0480-585: STATISTICAL METHODS IN RESEARCH
CR: 3**

1. Descriptive statistics,
2. Probability distribution,
3. Estimation,
4. Hypothesis testing,
5. Linear models covering "Regression models" and "Analysis of Variance models" (for standard experimental designs),
6. Generalized Linear Models,
7. Logistic regression,
8. Logit models,
9. Log-linear models,
10. Nonparametric methods,
11. Contingency tables,
12. Multivariate Analysis.

**0480-593: PROJECT
CR: 3**

The student undertakes an independent project on a research topic of theoretical and/or experimental focus under the supervision of a faculty member listed in the supervisory list of the College of Graduate Studies. The objective is to provide the student with an opportunity to integrate and apply the knowledge gained throughout the course of study in a practical problem. The student must document the project in a scientific report following standard research writing guidelines and give a public presentation to the project examination committee.

**0480-597: THESIS
CR: 0**

**0480-598: THESIS
CR: 0**

**2000-599: THESIS
CR: 9**