Master of Science in Statistics

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The graduate program in statistics is designed to provide students with a broad knowledge of the concepts and practice of statistics and related fields. Students are prepared to assume positions of responsibility and expertise. Graduates may find employment involving diverse statistics-related activities in business, industry, government, regulatory agencies, insurance companies, biotechnology firms, and marketing research firms. Graduates possess a good foundation to pursue further advanced studies in statistical sciences and allied disciplines.

Program Description

The graduate program is offered in a flexible 4+1 format where currently enrolled undergraduate students in mathematics and other disciplines at USM may earn both an undergraduate degree and the M.S. degree in statistics in five years. Candidates planning to earn both the undergraduate and the graduate degrees in five years are advised to take MAT 281 Probability and MAT 282 Statistical Inference in the sophomore year, take upper-level undergraduate courses in relevant concentrations in the junior year, and take graduate-level courses in the senior year. The student will receive graduate standing (full matriculation) after satisfactory completion of all requirements for the undergraduate degree. Candidates holding baccalaureate degrees from accredited institutions may join the program directly at the master's level.

Admission Requirements

Applications from students with undergraduate degrees in business, computer science, education, mathematics, statistics, engineering, or one of the behavioral or social sciences are encouraged. It is required that the applicant has completed the following USM courses: MAT 153 Calculus B, MAT 281 Probability, and MAT 282 Statistics or their equivalents. Conditional admission status may be granted to students who do not fully meet these requirements, but have a good working knowledge of statistical methods. Upon successful completion of preparatory coursework, the student will be granted regular admission status.

Currently enrolled students at USM may apply for admission anytime after attaining junior standing by applying directly to the Office of Graduate Admissions. Additional requirements include copies of all transcripts, current vitae, a personal statement, a GPA of 2.75 or better, and two letters of recommendation.

A student already holding a baccalaureate degree from an accredited institution may apply directly to the Office of Graduate Admissions. Additional requirements include copies of all transcripts, current vitae, a personal statement, a GPA of 3.0 or better, GRE scores, and three letters of recommendation. Applicants whose first language is not English are required to submit TOEFL scores.

Application Deadlines

The program has a rolling admission policy. However, deadlines for candidates seeking financial support are March 15 for the fall semester and October 15 for the spring semester. Students applying to the graduate program by January 15 are eligible to apply for a tuition waiver for the next academic year.

Degree Requirements

The gradute program has three tracks. The highlight of the program is the new Professional Science Master's Program in Biostatistics. The other two tracks are Applied Statistics and Operations Research/Applied Mathematics.

Program Tracks

The graduate program is truly interdisciplinary, providing the student with the opportunity to tailor programs specifically to individual interests. Students may customize their program of study. A list of possible concentrations and relevant courses is listed below:

1. Track One: Professional Science Master's Program in Biostatistics

The University of Southern Maine is offering a new Professional Science Master's (PSM) program as part of the Master's of Science in Statistics. The PSM is a new

type of two-year graduate program in the sciences and mathematics that equips students for work in public and private business sectors.

This track provides formal training in applied statistical methods that are commonly used in biomedical, bioinformatics, environmental, and health-related fields. The program emphasizes solving real-world problems that influence health by focusing on up-to-date statistical methodologies and their implementation with strong statistical programming capability. The areas of study include biostatistical study designs, modeling, and the reporting of rigorous statistical results for scientific decision making. Statistical areas of study include clinical trials, experimental design, categorical and longitudinal data analysis, and survival analysis. Internship, technical writing, and management skills are required components of the program. Graduates will ideally find positions in professional settings such as health care agencies, governmental agencies, and the pharmaceutical industry, among others.

Requirements for Biostatistics Track

I. Core Courses: 15 credits

AMS	535	Epidemiology (3 cr)
AMS	677	Regression Models in Biostatistics (3 cr)
		or
STA	587	Categorical Data Analysis (3 cr)
STA	574	Statistical Programming (3 cr)
STA	580	Applied Statistical/Biostatical Methods (3 cr)
STA	583	Sample Survey Design and Analysis (3 cr)

II. Extra Disciplinary Credits: 5 credits

Ethics

STA	501	Ethical Issues in Biostatistics (2 cr)

Management. Select one of the following courses;

MBA	670	Management Science (3 cr)
HPM	636	Health Information Management (3 cr)
OPR	561	Deterministic Models in Operations Research (3 cr)

III. Practical Experience: 3 credits

STA	575	Graduate Internship and Writing (3 cr)

IV. Electives: Choose 9 credits of the following

STA/OPR	562	Stochastic Modeling (3 cr)
STA/OPR	563	Simulation Modeling and Analysis (3 cr)
STA	582	Introduction to Longitudinal Data Analysis (3 cr)
STA	584	Advanced Design and Analysis of Experiments (3 cr)
STA	585	Linear Models and Forecasting (3 cr)
STA	589	Survival Analysis (3 cr)
STA	591	Topics in Biostatistics (3 cr)

2. Track Two: Applied Statistics

Required Courses:

STA	574	Statistical Programming (3 cr)
STA	580	Applied Statistical/Biostatical Methods (3 cr)

Choose from these additional courses:

STA/OPR	562	Stochastic Modeling (3 cr)
STA/OPR	563	Simulation Modeling and Analysis (3 cr)
STA/OPR	575	Graduate Internship and Writing (var cr)
STA	581	Statistical Quality Control (3 cr)
STA	582	Introduction to Longitudinal Data Analysis (3 cr)
STA	583	Sample Survey Design and Analysis (3 cr)
STA	584	Advanced Design and Analysis of Experiments (3 cr)
STA	585	Linear Models and Forecasting (3 cr)
STA	587	Categorical Data Analysis (3 cr)
STA	589	Survival Analysis (3 cr)
STA	591	Topics in Biostatistics (3 cr)

3. Track Three: Operations Research/Applied Mathematics

Required Courses:

OPR	561	Deterministic Models in Operations Research (3 cr)
OPR/STA	562	Stochastic Modeling (3 cr)
OPR/STA	563	Simulation Modeling and Analysis (3 cr)
STA	580	Applied Statistical/Biostatical Methods (3 cr)

Choose from these additional courses:

OPR/STA	564	Queueing Networks (3 cr)
OPR/MAT	571	Graph Theory (3 cr)
OPR/STA	575	Graduate Internship and Writing (var cr)
STA	581	Statistical Quality Control (3 cr)
STA	582	Introduction to Longitudinal Data Analysis (3 cr)
STA	583	Sample Survey Design and Analysis (3 cr)
STA	584	Advanced Design and Analysis of Experiments (3 cr)
STA	585	Linear Models and Forecasting (3 cr)
STA	587	Categorical Data Analysis (3 cr)
STA	589	Survival Analysis (3 cr)
STA	591	Topics in Biostatistics (3 cr)

Requirements for Tracks Two and Three

The requirements for the M.S. degree in statistics consist of a minimum of 30 credit hours. At least 18 credit hours must be graduate courses offered by the graduate program, excluding graduate internship credits, independent study credits, or thesis/project credits. A student meeting the above requirements has the flexibility of taking additional courses subject to the following policies: at most six of the required credits may be earned by taking pre-approved relevant upper level undergraduate courses. Moreover, the student may earn up to three credits by way of internship with local industry. The program will provide guidance in locating internship opportunities.

Reauirements for All Tracks

In addition to the specific track requirements all degree students will be subject to the following requirements.

1. For students within the 4+1 format, at most two pre-approved relevant graduate courses may be used for both the undergraduate and graduate degrees. At least 18 credit hours should be taken by students after full matriculation.
2. All courses applied toward the graduate degree must be completed within six years of enrollment in the graduate program with a cumulative GPA of 3.0 or better. Otherwise, additional coursework must be taken to fulfill program requirements.
3. Our program policies allow a student to earn up to three graduate independent-study credits under the supervision of a faculty member associated with our graduate program. With the approval of the graduate committee, a student may transfer a maximum of six credit hours for graduate work completed at other institutions or in other graduate programs at USM, including those listed in concentrations.
4. A student must register for at least one course every semester to maintain continuous enrollment. Students who do not maintain continuous enrollment will be dropped from the program and will have to reapply for admission to continue. Students who anticipate being unable to take classes may apply in writing for a fixed-term leave of absence.
5. A student whose grade point average (GPA) falls below 3.0 will be placed on academic probation. In this case a student will be allowed 12 semester hours to raise their GPA to, or above, the 3.0 minimum by taking only graduate-level courses. Students unsuccessful in raising their GPA during a probationary period may be dismissed from the program.

Master's Thesis Project Procedure

Students can earn up to 6 credits by completing a master's thesis/project. If a student chooses to do a master's thesis/project, he/she must select one of the following:

Option I: Master's Thesis. The student must write a master's thesis (STA/OPR/MAT 590).

Option II: Master's Project. The student must complete a master's project (STA/OPR/MAT 590).

Once an option has been selected, the student with his/her advisor must submit a proposal to the Graduate Committee for approval. The thesis/project must be approved by the Graduate Committee in advance.

Once the thesis/project topic has been approved by the Graduate Committee, the student must select a Thesis/Project Committee in consultation with his/her advisor. The Thesis/Project Committee will consist of at least three members, including the advisor. At most, one member of the Thesis/Project Committee may be from outside the Department of Mathematics and Statistics. The Graduate Committee will approve the Thesis/Project Committee.

Although the thesis/project work will be done under the direct supervision of the advisor, the student is expected to keep all committee members apprised of its progress. Once the thesis/project is completed, the student will produce a document describing his/her work. This document must adhere to the format specified by the Graduate Committee. Each Thesis/Project Committee member must be supplied with a copy of this document for review and approval at least two weeks before the intended date of defense.

The defense of the thesis/project should occur no less than 60 days after the approval of the Thesis/Project Committee and will consist of an oral presentation of its content to the University community. The Master's Thesis/Project requirement will be considered fulfilled when the thesis/project has been defended and the final document has been approved by all members of the Thesis/Project Committee.

The entire procedure for the fulfillment of the Master's Project requirement is the same as in the Master's Thesis, except that the project may be in the form of an expository paper in an area of mathematics/statistics/operations research, or it may be a solution of a practical problem in one of these areas, possibly related to the student's employment.

Financial Aid

A limited number of teaching assistantships and tuition waivers is available to students receiving regular graduate admission. Requests for an assistantship and/or a tuition waiver should accompany the application.

Graduate Certificate in Statistics

The Department also offers a graduate certificate in statistics for those candidates who are interested in attaining a working knowledge of statistical methodologies. Interested candidates should apply to the Graduate Admissions Office and submit current vitae, copies of all undergraduate/graduate transcripts, and at least one letter of recommendation. Applicants must hold a baccalaureate degree from an accredited institution with a cumulative GPA of at least 2.75, and must have completed MAT 153, MAT 281, MAT 282 or their equivalents. To earn the graduate certificate, a candidate must earn a minimum of 15 credits in statistics, at least 12 of which are at the graduate level. A cumulative GPA of 3.0 or better is required in these courses, and they must be completed within six years of enrollment (which is defined as the date when the application for admission to the graduate certificate is accepted by the Graduate Committee). Courses taken for the certificate may also be used toward the master's degree in statistics, as long as they are completed within six years of enrollment in the graduate program (Master of Science in Statistics).

Note: Academic matters not addressed by the *Program Description* should be referred to the Graduate Committee in writing (official letter) for prompt resolution.

MAT 501 Ethical Issues in Biostatistics
This course examines a variety of ethical controversies in biotechnology, medicine, and the environment. It also examines the major ethical principles in conducting biomedical research including ethical aspects related to the production and use of biomedical statistical analyses. Cr 2.

OPR/MAT 561 Deterministic Models in Operations Research
Formulation and analysis of deterministic models in operations research, linear programming, integer programming, project management, network flows, dynamic programming, non-linear programming, game theory, and group projects on practical problems from business and industry. Prerequisite: MAT 152 or MAT 295 or permission of instructor. Cr 3.

OPR/STA 562 Stochastic Modeling in Operations Research
Formulation and analysis of stochastic models in operations research, Markov chains, birth-death models, Markov decision models, reliability models, inventory models, applications to real world problems, and group projects on practical problems from business and industry. Prerequisite: MAT 281 or MAT 380 or permission of instructor. Cr 3.

OPR/STA/MAT 563 System Modeling and Simulation
Basic simulation methodology, general principles of model building, model validation and verification, random number generation, input and output analysis, simulation languages, applications to computer and communication networks, manufacturing, business, and engineering will be considered, and group projects on practical problems from business and industry. Prerequisite: MAT 281 or MAT 380 or permission of instructor. Cr 3.

OPR/STA 564 Queuing Networks
Queuing and stochastic service systems, birth-death processes, Markovian queues, open and closed Jackson networks, priority queues, imbedded Markov chain models, optimal control and design, stochastic scheduling, applications to computer and communication networks, manufacturing, business, and engineering will be considered, and projects on practical problems from business and industry. Prerequisite: MAT 281 or MAT 380 or permission of instructor. Cr 3.

MAT/OPR 571 Graph Theory
This course considers various properties of graphs and diagraphs and includes applications to optimization questions and networks. Prerequisite: MAT 290 or permission of instructor. Cr 3.

STA 574 Statistical Programming
This course focuses on statistical programming using software SAS and/or STATA. Topics include, but are not limited to, data management, database programming, statistical graphics, generating statistical reports, Basic statistical procedures (routine), modifying and creating MACROs (Routines) for non-standard statistical methods, etc. Prerequisite: MAT 212 or MAT 282 or permission of instructor. Cr 3.

STA/OPR/MAT 575 Graduate Internship and Writing
The course is intended to give students work experience with statistical data analysis through paid or unpaid internship opportunities. The student is expected to spend a minimum of 10 weeks working with area businesses on statistical problems approved by the graduate committee. The student will submit to the graduate committee a formal written report on the internship experience. The report format should adhere to all the elements of a formal project/ thesis. At least one oral presentation to the public is expected before the student receives a pass/fail grade. Students within the Biostatistics track are required to take 3 credits; two for the internship experience and one for the writing component. Cr var.

STA 580 Applied Statistical/Biostatistical Methods
Basics in distribution theory (focus on CLT and Sampling distributions); standard one-, two-sample problems (both parametric and nonparametric); one-, two-way ANOVA; estimation and testing theory (focus on normal theory and the principles of likelihood), various chi-square tests (Wald, Likelihood ratio, and Score tests); and analysis of contingency tables. Prerequisites: MAT 153 and MAT 282. Cr 3.

STA 581 Statistical Quality Control
Methods and philosophy of statistical process control, control charts for variables, control charts for attributes, CUSUM and EWMA control charts, some other statistical process control techniques, process capability analysis, and certain process design and improvements with experimental design. Prerequisite: MAT 282. Cr 3.

STA 582 Introduction to Longitudinal Data Analysis
This is an introductory course on how to use statistical techniques to analyze longitudinal (repeated measures) data and interpret the results from such analysis. The course will focus primarily on application of the various statistical models covered, with direct application illustrated using standard statistical software. Topics include random or mixed-effects models (also called HLM or multilevel models); covariance pattern models; generalized estimating equations (GEE) models; and missing data in longitudinal studies. Cr 3.

STA 583 Sample Survey Design and Analysis
In this course, students will develop an understanding of alternative probability sample designs and the statistical and practical factors that impact design choices. Develop the ability to select an estimator for a population parameter and an estimator of its

variance, given a sample design and auxiliary information (covariates). Introduce statistical principles and methods used to study disease and its prevention or treatment in human populations in clinical trials, including phase I to IV clinical trials. Ways of treatment allocation that will ensure valid inference on treatment comparison will be discussed. Other topics include sample size calculation and early stopping of a clinical trial and noncompliance. Prerequisite: MAT 282. Cr 3.

STA 584 Advanced Design and Analysis of Experiments
Topics covered include: one-way and two-way layouts, factorial experiments, fractional replications in factorial experiments, BIB and PBIB designs, and repeated measure design. Prerequisite: MAT 282. Cr 3.

STA 585 Linear Models and Forecasting
This is an introductory regression and forecasting modeling course. Topics include basic concepts of linear models and forecasting, simple and multiple linear regression, model building and diagnostics, time series regression and smoothing, and forecasting time series with ARIMA (Autoregressive Integrated Moving Average) and Box-Jenkins models. Prerequisite: MAT 282. Cr 3.

STA 587 Categorical Data Analysis
Topics to be examined include: two-way tables, generalized linear models, logistic and conditional logistic models, loglinear models, fitting strategies, model selection, and residual analysis. Prerequisite: MAT 282. Cr 3.

STA 589 Survival Analysis
Survival and reliability concepts, mathematics of survival models, parametric and non-parametric estimates from complete and censored data, Kaplan-Meier estimators, regression models including Poisson regression and Cox's proportional hazards model, time-dependent covariates, and analysis of rates. Prerequisite: MAT 282. Cr 3.

STA/OPR/MAT 590 Master's Project/Thesis
The project must be approved by the graduate program committee in advance. Offered only as a pass/fail course. Prerequisites: full graduate standing and faculty approval. Cr 6.

STA 591 Topics in Biostatistics
Course will be offered on demand. Based on students' interests, the course may cover one or more of the following topics: clinical trials, computer intensive statistical methods, statistical methods in bioinformatics, environmental statistics, or a combination of these topics. Prerequisites: full graduate standing and faculty approval. Cr 3.

STA/OPR/MAT 599 Independent Study
An opportunity for graduate students to pursue areas not currently offered in the graduate curriculum. Cr 3.