

The Applied and Computational Mathematics (ACM) Program at the Johns Hopkins University will offer the graduate courses listed below in the fall semester (3 September 2008 to 13 December 2008) at locations in the Baltimore–Washington area (Howard and Montgomery Counties, Maryland).

Subject to meeting admission criteria, a non-degree candidate may register as a special student to take one or more courses to enhance mathematical and statistical skills. These courses are scheduled at times convenient for the working adult. Registration and general information is at <http://www.epp.jhu.edu>. Information specific to the ACM Program is at <http://catalog.epp.jhu.edu/>; specific course information is available at the course homepages <http://www.epp.jhu.edu/course-homepages/>. For further information related to academic requirements and course content, please contact Dr. James Spall, Program Chair, at james.spall@jhuapl.edu or 240-228-4960.

625.403 Statistical Methods and Data Analysis

Instructor: Allan McQuarrie

Time and location: Thursday, 7:20 – 10:00PM, Applied Physics Laboratory (southern Howard County)

This course introduces commonly used statistical techniques. The intent of this course is to provide an understanding of statistical techniques and a “tool box” of methodologies. Statistical software (PC version) is used so students can apply statistical methodology to practical problems in the workplace. Intuitive developments and practical use of the techniques are emphasized rather than theorem/proof developments. Topics include the basic laws of probability and descriptive statistics, conditional probability, random variables, expectation, discrete and continuous probability models, joint and sampling distributions, hypothesis testing, point estimation, confidence intervals, contingency tables, logistic regression, and linear and multiple regression.

Prerequisite: Multivariate calculus.

625.409 Matrix Theory

Instructor: Matthew Koch

Time and location: Thursday, 4:30 – 7:10PM, Applied Physics Laboratory (southern Howard County)

In this course, topics include the methods of solving linear equations, Gaussian elimination, triangular factors and row exchanges, vector spaces (linear independence, basis, dimension, and linear transformations), orthogonality (inner products, projections, and Gram-Schmidt process), determinants, eigenvalues and eigenvectors (diagonal form of a matrix, similarity transformations, and matrix exponential), singular value decomposition, and the pseudoinverse. The course also covers applications to statistics (least squares fitting to linear models, covariance matrices) and to vector calculus (gradient operations and Jacobian and Hessian matrices). Matlab software will be used in some class exercises.

Prerequisite: Multivariate calculus.

625.414 Linear Optimization (New course Fall '08)

Instructor: Beryl Castello

Time and location: Tuesday, 4:30 – 7:10PM, Applied Physics Laboratory (southern Howard County)

Optimization is the act of obtaining the best result while satisfying given constraints. This course focuses mainly on linear programming and the geometry of linear systems. Though “straightforward” in nature, linear programs have a wide variety of real world applications such as production planning, worker scheduling, and resource allocation. Linear programming is used in a number of fields: manufacturing, transportation, and military operations are just a few. In this course, we will cover solution techniques for linear programs including the simplex method, the revised simplex method, the dual simplex method, and, time permitting, interior point methods. We will also investigate linear programming geometry and duality, theorems of the alternative, and sensitivity analysis. In parallel with our theoretical development we will consider how to formulate mathematical programs for a variety of applications including familiar network models such as the assignment, transshipment, transportation, shortest path and maximum flow problems. We will also present some methods and applications for integer programming problems (e.g., branch and bound and cutting plane methods) and discuss the role of multiobjective linear programming and goal programming in this area.

Prerequisites: Multivariate calculus, linear algebra. Some real analysis would be good but is not required

625.423 Introduction to Operations Research: Probabilistic Models

Instructor: Jacqueline Akinpelu

Time and location: Wednesday, 4:30 – 7:10PM, Applied Physics Laboratory (southern Howard County)

This course provides an introduction to some of the more useful OR models that exploit basic concepts and principles of probability and statistics. Although the course is organized around mathematical models and methods, the focus is on practical solutions to real operational problems; sufficient theory is provided to develop understanding of fundamental results. Topics may vary, being selected from the fields of Markov chains, queueing theory, decision theory, Bayesian networks, reliability and maintenance, activity networks, Markov decision processes, and inventory theory.

Prerequisites: Multivariate calculus and a course in probability and statistics (such as 625.403).

625.438 Neural Networks

Instructor: Mark Fleischer

Time and location: Thursday, 7:20 – 10:00PM, Montgomery County Center (Rockville, MD)

This course provides an introduction to concepts in neural networks and connectionist models. Topics include parallel distributed processing, learning algorithms, and applications. Specific networks discussed include Hopfield networks, bidirectional associative memories, perceptrons, feedforward networks with back propagation, and competitive learning networks, including self-organizing and Grossberg networks. Software for some networks is provided.

Prerequisite: Multivariate calculus.

625.463 Multivariate Statistics and Stochastic Analysis (New course Fall '08)

Instructor: H. (James) Hung

Time and location: Wednesday, 7:20 – 10:00PM, Applied Physics Laboratory (southern Howard County)

Multivariate analysis arises with observations of more than one variable when there is some probabilistic linkage between the variables. In practice, most data collected by researchers in virtually all disciplines are multivariate in nature. In some cases, it might make sense to isolate each variable and study it separately. In most cases, however, the variables are interrelated in such a way that analyzing the variables in isolation may result in failure to uncover critical patterns in the data. Multivariate data analysis consists of methods that can be used to study several variables at the same time so that the full structure of the data can be observed and key properties can be identified. This course covers estimation, hypothesis tests, and distributions for multivariate mean vectors and covariance matrices. We also cover popular multivariate data analysis methods including multivariate data visualization, maximum likelihood, principal components analysis, multiple comparisons tests, multidimensional scaling, cluster analysis, discriminant analysis and multivariate analysis of variance, multiple regression and canonical correlation, and analysis of repeated measures data.

Prerequisites: Linear algebra, multivariate calculus, and one semester of graduate probability and statistics (e.g. 625.403). Coursework will include computer assignments.

625.480 Cryptography

Instructor: George Nakos

Time and location: Tuesday, 7:20 – 10:00PM, Applied Physics Laboratory (southern Howard County)

An important concern in the information age is the security, protection, and integrity of electronic information, including communications, electronic funds transfer, power system control, transportation systems, and military and law enforcement information. Modern cryptography, in applied mathematics, is concerned not only with the design and exploration of encryption schemes (classical cryptography) but with the rigorous analysis of any system that is designed to withstand malicious attempts to tamper with, disturb, or destroy it. This course introduces and surveys the field of modern cryptography. After mathematical preliminaries from probability theory, algebra, computational complexity, and number theory, we will explore the following topics in the field: foundations of cryptography, public key cryptography, probabilistic proof systems, pseudorandom generators, elliptic curve cryptography, and fundamental limits to information operations.

Prerequisites: Linear algebra and an introductory course in probability and statistics such as 625.403 Statistical Methods and Data Analysis.

625.717 Advanced Differential Equations: Partial Differential Equations

Instructor: Ronald Farris

Time and location: Wednesday, 7:20 – 10:00PM, Applied Physics Laboratory (southern Howard County)

This course presents practical methods for solving partial differential equations (PDEs). The course covers solutions of hyperbolic, parabolic and elliptic equations in two or more independent variables. Topics include Fourier series, separation of variables, existence and uniqueness theory for general higher order equations, eigenfunction expansions, finite difference and finite element numerical methods, Green's functions, and transform

methods. MATLAB, a high-level computing language, is used throughout the course to complement the analytical approach and to introduce numerical methods.

Prerequisites: 625.404 Ordinary Differential Equations or equivalent graduate-level ODE class and knowledge of eigenvalues and eigenvectors from matrix theory. (Note: The standard undergraduate-level ODE class is not sufficient to meet the prerequisites for this class.)

625.725 Theory of Statistics I

Instructor: Mostafa Aminzadeh

Time and location: Wednesday, 4:30 – 7:10PM, Applied Physics Laboratory (southern Howard County)

This course covers mathematical statistics and probability. Topics covered include discrete and continuous probability distributions, expected values, moment-generating functions, sampling theory, convergence concepts, and the central limit theorem. This course is a rigorous treatment of statistics that lays the foundation for 625.726 and other advanced courses in statistics.

Prerequisites: Multivariate calculus and 625.403 Statistical Methods and Data Analysis or equivalent.

625.740 Data Mining (Formerly 625.775)

Instructor: Vural (Al) Aksakalli

Time and location: Thursday, 7:20 – 10:00PM, Applied Physics Laboratory (southern Howard County)

Data mining is a relatively new term used in the academic and business world, often associated with the development and quantitative analysis of very large databases. Its definition covers a wide spectrum of analytic and information technology topics, such as machine learning, pattern recognition, artificial intelligence, statistical modeling, and efficient database development. This course will review these broad topics, and cover specific analytic and modeling techniques such as data cleaning techniques, principal components, regression, decision trees, neural networks, support vector machines, nearest neighbor, clustering, association rules, generalization error, and the holdout, cross-validation, and bootstrap methods. Mathematics underlying these techniques will be discussed and their application to real-world data will be illustrated. Because use of the computer is extremely important when "mining" large amounts of data, we will make substantial use of data mining software tools to learn the techniques and analyze datasets.

Prerequisites: Multivariate calculus, linear algebra and matrix theory (e.g., 625.409), and a course in probability and statistics (such as 625.403). This course will also assume familiarity with multiple linear regression and basic ability to program.

The following courses provide mathematical background and review and are not offered for graduate credit. These courses are offered with reduced tuition.

625.250 Applied Mathematics I (not for graduate credit)

Instructor: James D'Archangelo

Time and location: Wednesday, 7:20 – 10:00PM, Applied Physics Laboratory (southern Howard County)

This course covers the fundamental mathematical tools required in applied physics and engineering. The goal is to present students with the mathematical techniques used in engineering and scientific analysis and to demonstrate these techniques by the solution of relevant problems in various disciplines. Areas include vector analysis, linear algebra, matrix theory, and complex variables.

Prerequisites: Differential and integral calculus.

625.260 Introduction to Linear Systems (not for graduate credit)

Instructor: Pablo Iglesias

Time and location: Monday, 7:20 – 10:00PM, Applied Physics Laboratory (southern Howard County)

This course is designed primarily for students who do not have a bachelor's degree in electrical engineering. It provides prerequisite material needed before entering many of the systems and telecommunications courses offered in the Master of Science in Electrical Engineering program. The course may also be useful to those in other fields with general interests in linear systems analysis. Topics include signal representations, linearity, time-variance, convolution, and Fourier series and transforms. Coverage includes both continuous and discrete-time systems. Practical applications in filter design, modulation/demodulation, and sampling are introduced.

Prerequisites: Differential and integral calculus.