University of Dayton School of Engineering

APPROVED MATHEMATICS COURSES

December 12, 2019

The following list of approved graduate courses may be taken by engineering Master's or Doctoral students to meet the math requirements of their degree. All selections from the list must be approved by the student's adviser before it can be considered part of the student's program of study.

CME 581 Advanced Chemical Engineering Calculations I — 3 credits
Applications of ordinary and partial differential equations to engineering problems. Classical methods of solution. **Prerequisite(s):** MTH 219 or permission of instructor.

CME 582 Advanced Chemical Engineering Calculations II — 3 credits
Analyses and solutions of engineering problems described by differential equations. Numerical methods of solution.

CME 583 Process Modeling — 3 credits
Mathematical description of physical and chemical processes, solution methods, and prediction interpretation. Engineering applications. **Prerequisite(s)**: CME 582 or equivalent.

ECE 503 Random Processes — 3 credits
Random variables as applied to system theory, communications, signal processing and controls. Topics include advanced engineering probability, random variables, random vectors and an introduction to random processes. **Prerequisite(s):** ECE 340 or equivalent.

ECE 568 Detection and Estimation — 3 credits
This course will provide a fundamental understanding of detection, estimation, and their use in solving engineering problems. Students will be able to solve problems involving hypothesis testing, develop a discrete time signal detector, and compute optimum parameter estimates. Students will become familiar with foundational concepts of likelihood ratio, randomized decision, sufficient statistic, Cramer-Rao bounds, and risk estimation. Students will also develop understanding of linear least square estimation, minimum mean square estimation, minimum mean absolute error estimation, maximum a posteriori estimation, maximum likelihood estimation, minimum variance unbiased estimation, empirical Bayes estimation, and minimum risk shrinkage operator estimation, expectation-maximization algorithm. **Prerequisite(s):** ECE 503.

ECE 569 Advanced Random Processes — 3 credits
This course will provide students with a fundamental understanding of probability, random variables and random processes, and their use in solving engineering problems. Students will be able to solve problems involving various noise processes and their probability distributions, describe random signals, and will analyze linear systems with stochastic inputs. Some advanced topics such as Wiener filtering, Kalman filtering, and Karhunen-Loeve decomposition will be covered. **Prerequisite(s):** ECE 503.

ECE 642 Optimal Control and Estimation — 3 credits
Introduction to optimal control, starting with dynamic programming for stochastic optimal control; continuous time optimal control, including Pontryagin's Maximum Principle and its application to the linear case, leading to linear optimal control. **Prerequisite(s):** ECE 509 or permission of instruction.

ENM 500 Probability & Statistics for Engineers — 3 credits
This is an introductory course in the concepts and applications of probability and statistics. Emphasis is on applications and examples that an engineer or analyst would encounter in practice. Probability is presented as the fundamental tool for modeling uncertainty as well as the logical connection between a population of data and its samples. Descriptive statistics are introduced to describe and characterize data. Inferential statistics provide the means of generalizing to a population from a sample, thus enabling solutions and conclusions that otherwise would not be obtained. Modern software provides the leverage to tackle problems of realistic size and complexity. The concepts and methods covered have direct application to forecasting, queuing, inventory, production, scheduling, equipment replacement, reliability, availability, quality control, experimental design, robust engineering, six sigma, and more. **Prerequisite(s):** an undergraduate course sequence in calculus.

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ENM 561 Design & Analysis of Experiments — 3 credits

This course introduces advanced topics in experimental design and analysis, including full and fractional factorial designs, response surface analysis, multiple and partial regression, and correlation. **Prerequisite(s):** ENM 500 or equivalent.

EOP 503 Optical Information Processing — 3 credits

2D linear systems and Fourier transforms; analysis of diffraction using transfer function, impulse response and transport of intensity; optical elements for imaging and Fourier transformation; transfer functions of coherent and incoherent systems, design of complex spatial filters and holograms; optical information processing; 3D imaging. Prerequisite(s): Acceptance into the graduate EOP department or permission of the department chair.

MEE 522 Geometric Methods in Kinematics — 3 credits

Trajectories and velocities of moving bodies are designed and analyzed via the principles of classical differential and algebraic geometry. Fundamentals include centrodes, instantaneous invariants, resultants and center point design curves. Curves, surfaces, metrics, manifolds and geodesics in spaces of more than three dimensions are analyzed to study multi-parameter systems.

MTH 403 Boundary Value Problems — 3 Credits

Introduction to the Sturm-Liouville problem. Fourier trigonometric series, Fourier integrals, Bessel functions, and Legendre polynomials. The heat equation, wave equation and Laplace's equation with applications. Solutions by the product method.

Prerequisite(s): MTH 219.

MTH 404 Complex Variables — 3 credits

Functions of a complex variable, conformal mapping, integration in the complex plane. Laurent series and residue theory. **Prerequisite(s):** MTH 219.

MTH 430 Real Analysis — 3 credits

Continuation of MTH 330. Topics include the theory of convergence of sequences and series of functions in the context of metric spaces, uniform continuity, uniform convergence and integration. **Prerequisite(s):** MTH 330.

MTH 527 Biostatistics — 3 credits

Introduction to statistical concepts and skills including probability theory and estimation, hypothesis tests of means and proportions for one or two samples using normal or t-distributions, regression and correlation, one- and two-way ANOVA, selected nonparametric tests.

MTH 531 Difference Equations and Applications — 3 credits

The calculus of finite differences, first order equations, linear equations and systems, z-transform, stability, boundary value problems for nonlinear equations, Green's function, control theory and applications.

MTH 532 Difference Equations and Applications — 3 credits

The calculus of finite differences, first order equations, linear equations and systems, z-transform, stability, boundary value problems for nonlinear equations, Green's function, control theory and applications.

MTH 535 Partial Differential Equations — 3 credits

Classification of partial differential equations; methods of solution for the wave equation, Laplace's equation, and the heat equation; applications. **Prerequisite(s):** MTH 403 or equivalent.

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MTH 543 Linear Models — 3 credits

Least square techniques, lack of fit and pure error, correlation, matrix methods, F test, weighted least squares, examination of residuals, multiple regression, transformations and dummy variables, model building, ridge regression, stepwise regression, multiple regression applied to analysis of variance problems. **Prerequisite(s):** MTH 368 or equivalent.

MTH 544 Time Series — 3 credits

Estimation and elimination of trend and seasonal components; stationary time series, autocovariance, autocorrelation and partial autocorrelation functions; spectral analysis; modeling and forecasting with ARMA processes; nonstationary and seasonal time series. **Prerequisite(s):** Courses in single and multivariate calculus; courses in statistics and probability; courses in linear algebra.

MTH 547 Statistics for Experimenters — 3 credits

Covers those areas of design of experiments and analysis of quantitive data that are useful to anyone engaged in experimental work. Designed experiments using replication and blocking. Use of transformations. Applications of full and fractional factorial designs. Experimental design for developing quality into products using Taguchi methods. **Prerequisite(s):** MTH 367 or equivalent.

MTH 551 Methods of Mathematical Physics — 3 credits

Linear transformations and matrix theory, linear integral equations, calculus of variations, eigenvalue problems. **Prerequisite(s):** MTH 403 or equivalent.

MTH 552 Methods of Applied Mathematics — 3 credits

Dimensional analysis and scaling, regular and singular perturbation methods with boundary layer analysis, the stability and bifurcation of equilibrium solutions, other asymptotic methods. **Prerequisite(s):** MTH 403 or equivalent.

MTH 555 Numerical Analysis I — 3 credits

Solutions of nonlinear equations, Newton's methods, fixed point methods, solutions of linear equations, LU decomposition, iterative improvement, QR decomposition, SV decomposition. **Prerequisite(s):** (CPS 132 or 150) or equivalent; MTH 302 or equivalent.

MTH 556 Numerical Analysis II — 3 credits

Interpolating functions, numerical differentiation, numerical integration including Gaussian quadrature, numerical solutions of differential equations. **Prerequisite(s):** (CPS 132 or 150) or equivalent; MTH 219 or equivalent.

MTH 558 Financial Mathematics I, Discrete Model — 3 credits

Discrete methods in financial mathematics. Topics include introduction to financial derivatives, discrete probability theory, discrete stochastic processes (Markov chain, random walk, and Martingale), binomial tree models for derivative pricing and computational methods (European and American options), forward and futures, and interest rate derivatives. **Prerequisite(s):** MTH 411 or equivalent.

MTH 559 Financial Mathematics II, Continuous Model — 3 credits

Discrete methods in financial mathematics. Continuous methods in financial mathematics. Topics include review of continuous probability theory, Ito's Lemma, the Black-Scholes partial differential equation, option pricing via partial differential equations, analysis of exotic options, local and stochastic volatility models, American options, fixed income and stopping time. Computational methods are introduced. **Prerequisite(s):** MTH 558.

MTH 563 Computational Finance — 3 credits

The purpose of this course is to introduce students to numerical methods and various financial problems that include portfolio optimization and derivatives valuation that can be tackled by numerical methods. Students will learn the basics of numerical analysis, optimization methods, Monte Carlo simulations and finite difference methods for solving PDEs. **Prerequisite(s):** MBA 621 or permission of instructor.

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MTH 565	Linear Algebra Vector spaces, linear transformations and matrices; determinants, inner product spaces, invariant direct- sum decomposition and the Jordan canonical form.	3 credits
MTH 571	Topology I An axiomatic treatment of the concept of a topological space; bases and subbases; connectedness, compactness; continuity, homeomorphisms, separation axioms and countability axioms; convergence in topological spaces.	3 credits
MTH 590	Topics in Mathematics This course, given upon appropriate occasions, deals with specialized material not covered in the regular courses. May be taken more than once as topics change. Prerequisite(s): Permission of advisor.	3 credits