APPLIED MATHEMATICS (AMAT)

AMAT 120 Applied Calculus A (4 credits)
Prerequisite(s): A score of 76 or higher on the ALEKS Placement Assessment, or MATH 111 with a grade of C- or higher. Derivative of a function and its interpretation. Analytic computation of the derivative. Applications of the derivative, including optimization. Antiderivatives and initial-value problems. Riemann integral and its interpretation. Evaluation of integrals by the Fundamental Theorem of Calculus. Applications of the integral. Computational software will be used to solve problems. Equivalent course MATH 116 effective through Spring 2020. Satisfies Mathematics GenEd requirement; satisfies SEEDS Quantitative Reasoning student learning outcome in alignment with Educated Citizenry value.

AMAT 220 Applied Calculus B (4 credits)
Prerequisite(s): AMAT 120 or MATH 122 with a grade of C- or better, or equivalent. Analytic and numerical methods of integration. Applications of Integrals. Taylor expansion and applications. Sequences and series, including power series. Introduction to differential equations and applications. Computational software will be used to solve problems.

AMAT 240 Introduction to Linear Algebra (4 credits)
Prerequisite(s): Departmental approval or a score of 76 or higher on the ALEKS Placement Assessment; or MATH 111, MATH 122, or AMAT 120 with a grade of C- or higher. Linear algebra and its applications. Topics include matrices, determinants, vector spaces, eigenvalues and eigenvectors, orthogonality and inner product spaces. Applications include network analysis, Markov chains, and systems of linear differential equations. Computational linear algebra will be used to solve problems. Computational software will be used to solve problems. Equivalent course MATH 235 effective through Spring 2020.

AMAT 262 Mathematics of Finance I (3 credits)
Prerequisite(s): AMAT 120 or equivalent may be taken as prerequisite or corequisite. Introduction to the fundamental concepts of financial mathematics, focusing on the time value of money and cash flows. Topics covered include theory of interest, annuities, loans and amortization, fixed income securities and derivatives, general cash flows and weighted rate of return, and the term structure of interest rates. Relevant spreadsheet software skills and applications are taught in conjunction with theory. Equivalent course AMAT 364 effective through Summer 2021.

AMAT 345 Applied Probability (3 credits)
Prerequisite(s): AMAT 220 or equivalent with departmental approval. Introduction to probability theory with applications. Topics include probability space, conditional probability and independence, Bayes' theorem, random variables and their distributions, moment generating functions, normal distribution and central limit theorem, Markov chains and branching process, exponential distribution and Poisson process, renewal process, random walk and Brownian motion. Simulations will be performed with computational software.

AMAT 350 Applied Mathematics I (3 credits)
Prerequisite(s): AMAT 220 and AMAT 240 or equivalent. Introduction to ordinary differential equations (ODE) and complex analysis. Topics covered include 1D and 2D ODEs, systems of linear ODEs, Laplace transforms, equilibria and stability of ODEs, and an overview of complex analysis including complex numbers, the complex plane, elementary complex functions, analytic functions, residue calculus, and contour integration. Computational software will be used to solve problems.

AMAT 356 Mathematical Modeling (3 credits)
Prerequisite(s): AMAT 240 or equivalent with departmental approval; and AMAT 345 and MATH 222 may be taken as a prerequisite or corequisite. Introduction to mathematical modeling. Topics include the nature of modeling biological, chemical, and physical systems. Mathematical techniques include dimensional analysis, phase plane analysis, and solution methods for ordinary and partial differential equations. Specific systems may include mechanical locomotion, meteorology and climatology, chemical reactions, viscous fingering, population growth, and dendritic growth. Computational software will be used to solve problems.

AMAT 360 Numerical Computing (3 credits)
Prerequisite(s): AMAT 220 and AMAT 240; or equivalent with departmental approval. Introduction to the mathematical and algorithmic foundations of numerical computing. Topics covered include error analysis, data fitting including interpolation, numerical solution of linear and nonlinear equations of one variable as well as systems of equations, and numerical differentiation and integration. Applications will include a variety of problems from the sciences, engineering, and economics.

AMAT 362 Mathematics of Finance II (3 credits)
Prerequisite(s): AMAT 262 or equivalent with departmental approval; and AMAT 220 may be taken as a prerequisite or corequisite. Introduction to financial derivatives and asset dynamics. Topics covered include the mathematical theory of forward and futures contracts, swaps, hedging with derivatives, discrete asset dynamics, European and American options, binomial and trinomial lattice models, Black-Scholes option pricing formula, and the option Greeks. Equivalent course AMAT 464 effective through Summer 2021.

AMAT 368 Mathematical Biology I (3 credits)
Prerequisite(s): AMAT 220 or equivalent. Introduction to mathematical modeling in the biological and medical sciences. Dynamical systems will be used to describe population biology, population genetics and evolution, and the dynamics of infectious disease. Emphasis is on applications and mathematical techniques for determining solutions. Computational software will be used to solve problems.

AMAT 430 Applied Analysis (3 credits)
Prerequisite(s): AMAT 350; or equivalent with department approval. Introduction to classical analysis and its applications. Topics includes the real number system, point set topology, numeric sequences and series, continuous functions, differentiation, Riemann integration, functional sequence and series, uniform convergence and interchange of limit operations.

AMAT 450 Applied Mathematics II (3 credits)
Prerequisite(s): AMAT 350 and MATH 222; or equivalent with departmental approval. Introduction to Fourier series, the discrete Fourier transform, Fourier transform, basic distributions in Fourier theory (delta and Heaviside distributions), and linear partial differential equations (PDE), including heat equation, wave equation, and Laplace's equation. Introduction to stochastic differential equations. Computational software will be used to solve problems.

AMAT 460 Mathematics of Portfolio Theory (3 credits)
Prerequisite(s): AMAT 240 and AMAT 345 or equivalent with departmental approval; and FINC 221 may be taken as prerequisite or corequisite. Introduction to the mathematics of portfolio optimization and risk management. Topics covered include portfolio mean-variance analysis and optimization, the capital asset pricing model (CAPM), risk measures such as value at risk (VaR) and conditional value at risk (CVaR). Relevant spreadsheet software skills, programming language, and applications are taught in conjunction with theory.

AMAT 466 Continuous-Time Financial Mathematics (3 credits)
Prerequisite(s): AMAT 345, AMAT 350 and AMAT 362 or equivalent with departmental approval. Introduction to stochastic calculus and financial applications. Topics covered include binomial trees and discrete parameter martingales, Brownian motion, martingales in continuous time, stochastic integration and Ito's formula, the Black-Scholes model, vanilla and exotic options, and Monte Carlo simulation for option valuation. Relevant spreadsheet software skills and computer programming are taught in conjunction with theory.

AMAT 468 Mathematical Biology II (3 credits)
Prerequisite(s): AMAT 368; or equivalent with departmental approval. Introduction to mathematical modeling in the biological and medical sciences. Dynamical systems will be used to describe pattern formation, biological oscillators and switches, and biological circuits. Emphasis is on applications and mathematical techniques for determining solutions. Computational software will be used to solve problems.

AMAT 472 Dynamics and Bifurcation (3 credits)
Prerequisite(s): AMAT 350; or equivalent with departmental approval. Introduction to nonlinear dynamical systems. Topics covered include an overview of discrete and continuous dynamics including bifurcation theory. Computational software will be used to solve problems.

AMAT 490 Seminar (1 credit)
Prerequisite(s): AMAT 350; or equivalent with departmental approval. Attendance at the Applied Mathemats and Statistics Colloquium. May be repeated for a maximum of 3 hours.

AMAT 495 Special Topics in Applied Mathematics (3 credits)
Prerequisite(s): Departmental approval. Topics in applied mathematics not otherwise offered in the regular curriculum of applied mathematics program offerings.

AMAT 497 Applied Mathematics Research I (1-3 credits)
Prerequisite(s): Departmental approval. This course provides an opportunity for students to pursue an individualized course of study and research in a particular topic of Applied Mathematics under the supervision and guidance of an instructor.

AMAT 498 Applied Mathematics Research II (1-3 credits)
Prerequisite(s): Departmental approval. This course provides an opportunity for students to pursue an individualized course of study and research in a particular topic of Applied Mathematics under the supervision and guidance of an instructor.

AMAT 499 Co-Op in Applied Mathematics (3 credits)
Prerequisite(s): AMAT 350 and department approval. Application of conceptual ideas from Applied Mathematics in a real work environment. The Co-Op experience is a semester of full- or part-time work under the guidance of a workplace supervisor and a faculty advisor.

AMAT 502 Applied Mathematics for Computational Science (4 credits)
Restriction(s): May not be used for credit by Applied Mathematics, Statistics. Introduction to the mathematical foundations of computational science, covering three subjects: linear algebra, probability, and statistics. Topics include linear systems, vector spaces and inner products, matrix manipulations, linear transformations, eigenvectors, singular value decomposition, probability space, counting rules, Bayes' Theorem, probability distributions, point estimation, maximum likelihood estimation, confidence intervals, and entropy.

AMAT 530 Scientific and Numerical Computing I (3 credits)
Prerequisite(s): AMAT 240 or equivalent. Introduction to the mathematical and algorithmic foundations of numerical computing, and the practical implementation of solutions to scientific problems. Topics covered include error analysis, data fitting including interpolation, numerical solution of linear and nonlinear equations of one variable as well as systems of equations, numerical differentiation and integration, Monte Carlo simulation, and symbolic computing. Applications will include a variety of problems from the sciences, engineering, and economics.

AMAT 532 Applied Linear Algebra (3 credits)
Prerequisite(s): AMAT 240 or equivalent. Introduction to the theory and techniques of linear algebra. Topics covered include vector spaces and linear transformations, including inner product, matrix representations, binary and quadratic forms, eigenvectors, canonical forms, and functions of matrices. Applications include singular value decomposition, least squares approximation, and linear programming/optimization.

AMAT 534 Data-Driven Modeling and Computation (3 credits)
Prerequisite(s): AMAT 240 or equivalent. Introduction to the computational methods needed to perform data driven modeling and analysis of scientific problems. Topics covered include an overview of statistical methods including hypothesis testing, time-frequency analysis using fast Fourier transform (FFT) and wavelets with application to filtering and averaging, image processing, model reduction using singular value decomposition (SVD), principal component analysis (PCA), and dynamic mode decomposition (DMD), and an introduction to machine learning and compressed sensing.

AMAT 536 Applied Probability and Stochastic Processes (3 credits)
Prerequisite(s): AMAT 345 or PHYS 320 or equivalent. Introduction to applied probability and stochastic processes. Topics covered include an overview of probability including random variables, expected values, random walks, probability densities, moment-generating functions, and normal variable theorems, Wiener process, Ornstein-Uhlenbeck processes, Langevin equations, Markov processes, Poisson process, and applications including survivability and reliability.

AMAT 540 Scientific and Numerical Computing II (3 credits)
Prerequisite(s): AMAT 530 or equivalent. Introduction to the mathematical and algorithmic foundations of numerical computing, and the practical implementation of solutions to scientific problems involving numerical linear algebra and the solution of differential equations. Topics covered include direct methods for solving linear systems, iterative techniques, approximation of eigenvalues, and solution of ordinary differential equation initial-value problems using Runge-Kutta methods and multistep methods. Applications will include a variety of problems from the sciences, engineering, and economics.

AMAT 542 Methods of Applied Mathematics (3 credits)
Prerequisite(s): AMAT 350 or equivalent. Introduction to a selection of methods of applied mathematics. Topics covered include an overview of complex analysis including contour integration and residue calculus, calculus of variations, regular and singular perturbation theory including multiple-scales analysis and matched asymptotics.

AMAT 544 Applied Differential Equations (3 credits)
Prerequisite(s): AMAT 350 or equivalent. Introduction to the solution of ordinary and partial differential equations which arise as models in scientific applications. Topics covered include linear systems of ordinary differential equations including Floquet theory, Sturm-Liouville equations, Fourier solution of linear partial differential equations, method of characteristics, and hyperbolic conservation laws.

AMAT 546 Mathematical Biology (3 credits)
Prerequisite(s): AMAT 345 or PHYS 320; and AMAT 350; or equivalent. Introduction to mathematical modeling of biological and biomedical phenomena. Topics covered include population genetics, enzyme kinetics, protein networks, epidemiology, pharmacokinetics, and pattern formation.

AMAT 548 Nonlinear Dynamics (3 credits)
Prerequisite(s): AMAT 350 or equivalent. Introduction to nonlinear dynamics. Topics covered include an overview of discrete and continuous dynamics including bifurcation theory in one, two, and higher dimensions.

AMAT 550 Mathematics of Investment and Risk Management (3 credits)
Prerequisite(s): AMAT 345 and FINC 221 or departmental approval. Introduction to the mathematics of portfolio optimization and risk management. Topics covered include portfolio mean-variance analysis and optimization, the capital asset pricing model (CAPM), risk measures such as value at risk (VaR) and conditional value at risk (CVaR). Relevant spreadsheet software skills, programming language, and applications are taught in conjunction with theory.

AMAT 552 Stochastic Calculus for Finance (3 credits)
Prerequisite(s): AMAT 362 or departmental approval. Introduction to stochastic calculus and financial applications. Topics covered include binomial trees and discrete parameter martingales, Brownian motion, martingales in continuous time, stochastic integration and Ito's formula, the Black-Scholes model, vanilla and exotic options, and Monte Carlo simulation for option valuation. Relevant spreadsheet software skills and computer programming are taught in conjunction with theory.

AMAT 649 Independent Study (3 credits)
Prerequisite(s): Departmental approval. Independent study under the direction of a faculty member, offering the opportunity to pursue extensions of an existing course or courses. Approval must be obtained beforehand. May be repeated once for a maximum of six semester hours provided the topic is different.

AMAT 650 Seminar (1 credit)
Attendance at the Mathematical Sciences Colloquium. May be repeated for a maximum of 3 credits.

AMAT 696 Internship (3 credits)
Prerequisite(s): Permission of graduate program coordinator. Culminating project-based internship undertaken by students in their last year of study. The internship project focuses on a specific topic of interest to the student that incorporates and applies what they have learned throughout their time in the MS Applied Mathematics program.

AMAT 697 Capstone (3 credits)
Prerequisite(s): Permission of graduate program coordinator. Culminating project-based experience undertaken by students in their last year of study. The capstone project focuses on a specific topic of interest to the student that incorporates and applies what they have learned throughout their time in the MS Applied Mathematics program.

AMAT 698 Master's Thesis (3 credits)
Prerequisite(s): Departmental approval. Independent thesis research under faculty advisement. Students must follow the MSU Thesis Guidelines, which may be obtained from the Graduate School. Students should take AMAT 699 if they do not complete AMAT 698 within the semester.

AMAT 699 Master's Thesis Extension (1 credit)
Prerequisite(s): AMAT 698 and permission of GPC; Continuation of Master's Thesis Project. Thesis Extension will be graded as IP (in Progress) until thesis is completed, at which time a grade of Pass or Fail will be given. Independent thesis research under faculty advisement. Students must follow the MSU Thesis Gidelines, which may be obtained from the Graduate School. Students should take AMAT 699 again if they do not complete AMAT 699 within the semester.