MATHEMATICS (MATH)

MATH 100
Introduction to the Profession
Introduces the student to the scope of mathematics as a profession, develops a sense of mathematical curiosity and problem solving skills, identifies and reinforces the student’s career choices, and provides a mechanism for regular academic advising. Provides integration with other first-year courses. Introduces applications of mathematics to areas such as engineering, physics, computer science, and finance. Emphasis is placed on the development of teamwork skills.

Lecture: 3 Lab: 0 Credits: 3
Satisfies: Communications (C)

MATH 119
Geometry for Architects
Basic Euclidean and analytic geometry in two and three dimensions; trigonometry. Equations of lines, circles and conic sections; resolution of triangles; polar coordinates. Equations of planes, lines, quadratic surfaces. Applications. This course does not count toward business, computer science, engineering, mathematics, or natural science degree programs.

Lecture: 3 Lab: 1 Credits: 3

MATH 122
Introduction to Calculus
Basic concepts of calculus of a single variable; limits, continuity, derivatives, and integrals. Applications. This course does not count toward any business, computer science, engineering, mathematics, or natural science degree programs.

Prerequisite(s): MATH 119
Lecture: 3 Lab: 1 Credits: 3

MATH 130
Thinking Mathematically
This course allows students to discover, explore, and apply modern mathematical ideas. Emphasis is placed on using sound reasoning skills, visualizing mathematical concepts, and communicating mathematical ideas effectively. Classroom discussion and group work on challenging problems are central to the course. Topics from probability, statistics, logic, number theory, graph theory, combinatorics, chaos theory, the concept of infinity, and geometry may be included. This course does not count toward any computer science, engineering, mathematics, or natural science degree programs.

Lecture: 3 Lab: 0 Credits: 3

MATH 131
Mathematics for Sustainability
The course provides students with the mathematical background and quantitative reasoning skills necessary to engage as informed citizens in discussions of sustainability related to climate change, resources, pollution, recycling, economic change, and similar matters of public interest. Introduces mathematical modeling techniques with examples related to environmental and economic sustainability. Emphasis is placed on quantitative reasoning, visualization of mathematical concepts and effective communication, both verbally and textually, through writing projects that require quantitative evidence to support an argument, classroom activities, and group work. Topics range from probability, statistics, decision theory, graph theory, physics, modeling, and algebra.

Lecture: 3 Lab: 0 Credits: 3

MATH 148
Preparation for Calculus
Review of algebra and analytic geometry. Functions, limits, derivatives. Trigonometry, trigonometric functions and their derivatives. Inverse functions, inverse trigonometric functions and their derivatives. Exponential and logarithmic functions. This course does not count toward any mathematics requirements in business, computer science, engineering, mathematics, or natural science degree programs.

Lecture: 4 Lab: 0 Credits: 4

MATH 151
Calculus I

Prerequisite(s): IIT Mathematics Placement score of 151 or MATH 145 with min. grade of C or MATH 148 with min. grade of C
Lecture: 4 Lab: 1 Credits: 5
Satisfies: Communications (C)

MATH 152
Calculus II

Prerequisite(s): MATH 149 with min. grade of C or MATH 151 with min. grade of C
Lecture: 4 Lab: 1 Credits: 5
Satisfies: Communications (C)
MATH 180
Fundamentals of Discrete Mathematics
Basic counting techniques, discrete probability, graph theory, algorithm complexity, logic and proofs, and other fundamental discrete topics. Required for students in the Bachelor of Information Technology and Management degree. This course does not count toward any computer science, engineering, mathematics, or natural science degree program. Credit will only be granted for one of MATH 180, MATH 230, and CS 330.
Lecture: 3 Lab: 0 Credits: 3

MATH 225
Introductory Statistics
An introduction to statistics; data collection, description, visualization and analysis; basic probability; statistical reasoning and inference including hypothesis tests and confidence intervals: t-tests, chi-squared tests, ANOVA, correlation and regression.
Lecture: 3 Lab: 0 Credits: 3
Satisfies: Communications (C)

MATH 230
Introduction to Discrete Math
Sets, statements, and elementary symbolic logic; relations and digraphs; functions and sequences; mathematical induction; basic counting techniques and recurrence. Credit will not be granted for both CS 330 and MATH 230.
Lecture: 3 Lab: 0 Credits: 3
Satisfies: Communications (C)

MATH 251
Multivariate and Vector Calculus
Prerequisite(s): MATH 152
Lecture: 4 Lab: 0 Credits: 4

MATH 252
Introduction to Differential Equations
Prerequisite(s): MATH 152
Lecture: 4 Lab: 0 Credits: 4

MATH 332
Elementary Linear Algebra
Systems of linear equations; matrix algebra, inverses, determinants, eigenvalues, and eigenvectors, diagonalization; vector spaces, basis, dimension, rank and nullity; inner product spaces, orthonormal bases; quadratic forms.
Prerequisite(s): MATH 251*, An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 Lab: 0 Credits: 3

MATH 333
Matrix Algebra and Complex Variables
Vectors and matrices; matrix operations, transpose, rank, inverse; determinants; solution of linear systems; eigenvalues and eigenvectors. The complex plane; analytic functions; contour integrals; Laurent series expansions; singularities and residues.
Prerequisite(s): MATH 251
Lecture: 3 Lab: 0 Credits: 3

MATH 350
Introduction to Computational Mathematics
Study and design of mathematical models for the numerical solution of scientific problems. This includes numerical methods for the solution on linear and nonlinear systems, basic data fitting problems, and ordinary differential equations. Robustness, accuracy, and speed of convergence of algorithms will be investigated including the basics of computer arithmetic and round-off errors. Same as MMAE 350.
Prerequisite(s): (CS 104 or CS 105 or CS 115) and MATH 251 and MATH 252*, An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 Lab: 0 Credits: 3
Satisfies: Communications (C)

MATH 374
Probability and Statistics for Electrical and Computer Engineers
This course focuses on the introductory treatment of probability theory including: axioms of probability, discrete and continuous random variables, marginal vectors, and random variables. Hypothesis testing, chi-squared tests, ANOVA, correlation and regression. Also covered are sums of random variables, marginal, joint, conditional and cumulative probability distributions, moment generating functions, the central limit theorem, sample means, and parameter estimation. Furthermore, random processes and random signals are covered. Examples and applications are drawn from problems of importance to electrical and computer engineers. Credit only granted for one of MATH 374, MATH 474, and MATH 475.
Prerequisite(s): MATH 251
Lecture: 3 Lab: 0 Credits: 3

MATH 380
Introduction to Mathematical Modeling
This course provides an introduction to problem-driven (as opposed to method-driven) applications of mathematics with a focus on design and analysis of models using tools from all parts of mathematics.
Prerequisite(s): (CS 104 or CS 105 or CS 115) and MATH 251 and MATH 252* and MATH 332. An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 Lab: 0 Credits: 3
Satisfies: Communications (C)

MATH 400
Real Analysis
Real numbers, continuous functions; differentiation and Riemann integration. Functions defined by series.
Prerequisite(s): MATH 251
Lecture: 3 Lab: 0 Credits: 3
### MATH 402
**Complex Analysis**
Analytic functions, conformal mapping, contour integration, series expansions, singularities and residues, and applications. Intended as a first course in the subject for students in the physical sciences and engineering.
**Prerequisite(s):** MATH 251
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 405
**Introduction to Iteration and Chaos**
Functional iteration and orbits, periodic points and Sharkovsky's cycle theorem, chaos and dynamical systems of dimensions one and two. Julia sets and fractals, physical implications.
**Prerequisite(s):** (MATH 251 and MATH 252 and MATH 332) or (MATH 252 and MATH 333 and MATH 251)
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 410
**Number Theory**
Divisibility, congruencies, distribution of prime numbers, functions of number theory, diophantine equations, applications to encryption methods.
**Prerequisite(s):** MATH 230
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 420
**Geometry**
The course is focused on selected topics related to fundamental ideas and methods of Euclidean geometry, non-Euclidean geometry, and differential geometry in two and three dimensions and their applications with emphasis on various problem-solving strategies, geometric proof, visualization, and interrelation of different areas of mathematics. Permission of the instructor is required.
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 425
**Statistical Methods**
Concepts and methods of gathering, describing and analyzing data including basic statistical reasoning, basic probability, sampling, hypothesis testing, confidence intervals, correlation, regression, forecasting, and nonparametric statistics. No knowledge of calculus is assumed. This course is useful for students in education or the social sciences. This course does not count for graduation in any mathematics programs. Credit not given for both MATH 425 and MATH 476.
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 430
**Applied Algebra**
Introduction to groups, homomorphisms, group actions, rings, field theory. Applications, including constructions with ruler and compass, solvability by radicals, error correcting codes.
**Prerequisite(s):** MATH 230 or MATH 332*
*An asterisk (*) designates a course which may be taken concurrently.
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 431
**Computational Algebraic Geometry**
Systems of polynomial equations and ideals in polynomial rings; solution sets of systems of equations and algebraic varieties in affine n-space; effective manipulation of ideals and varieties, algorithms for basic algebraic computations; Groebner bases; applications. Credit may not be granted for both MATH 431 and MATH 530.
**Prerequisite(s):** MATH 332 and MATH 230
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 435
**Linear Optimization**
Introduction to both theoretical and algorithmic aspects of linear optimization: geometry of linear programs, simplex method, anticycling, duality theory and dual simplex method, sensitivity analysis, large scale optimization via Dantzig-Wolfe decomposition and Benders decomposition, interior point methods, network flow problems, integer programming. Credit may not be granted for both MATH 435 and MATH 535.
**Prerequisite(s):** MATH 332
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 446
**Introduction to Time Series**
This course introduces the basic time series analysis and forecasting methods. Topics include stationary processes, ARMA models, spectral analysis, model and forecasting using ARMA models, nonstationary and seasonal time series models, multivariate time series, state-space models, and forecasting techniques.
**Prerequisite(s):** MATH 475 with min. grade of C or ECE 511 with min. grade of C
**Lecture:** 3 **Lab:** 0 **Credits:** 3

### MATH 453
**Combinatorics**
Permutations and combinations; pigeonhole principle; inclusion-exclusion principle; recurrence relations and generating functions; enumeration under group action.
**Prerequisite(s):** MATH 230
**Lecture:** 3 **Lab:** 0 **Credits:** 3
MATH 454
Graph Theory and Applications
Directed and undirected graphs; paths, cycles, trees, Eulerian cycles, matchings and coverings, connectivity, Menger’s Theorem, network flow, coloring, planarity, with applications to the sciences (computer, life, physical, social) and engineering.
Prerequisite(s): (MATH 230 and MATH 251) or (MATH 252 and MATH 230)
Lecture: 3 Lab: 0 Credits: 3
Satisfies: Communications (C)

MATH 461
Fourier Series and Boundary-Value Problems
Prerequisite(s): MATH 251 and MATH 252
Lecture: 3 Lab: 0 Credits: 3

MATH 474
Probability and Statistics
Elementary probability theory including discrete and continuous distributions, sampling, estimation, confidence intervals, hypothesis testing, and linear regression. Credit not granted for both MATH 474 and MATH 475.
Prerequisite(s): MATH 251
Lecture: 3 Lab: 0 Credits: 3

MATH 475
Probability
Elementary probability theory; combinatorics; random variables; discrete and continuous distributions; joint distributions and moments; transformations and convolution; basic theorems; simulation. Credit not granted for both MATH 474 and MATH 475.
Prerequisite(s): MATH 251
Lecture: 3 Lab: 0 Credits: 3

MATH 476
Statistics
Estimation theory; hypothesis tests; confidence intervals; goodness-of-fit tests; correlation and linear regression; analysis of variance; nonparametric methods.
Prerequisite(s): MATH 475
Lecture: 3 Lab: 0 Credits: 3
Satisfies: Communications (C)

MATH 477
Numerical Linear Algebra
Fundamentals of matrix theory; least squares problems; computer arithmetic; conditioning and stability; direct and iterative methods for linear systems; eigenvalue problems. Credit may not be granted for both MATH 477 and MATH 577.
Prerequisite(s): MATH 350 or MMAE 350
Lecture: 3 Lab: 0 Credits: 3

MATH 478
Numerical Methods for Differential Equations
Polynomial interpolation; numerical integration; numerical solution of initial value problems for ordinary differential equations by single and multi-step methods, Runge-Kutta, Predictor-Corrector; numerical solution of boundary value problems for ordinary differential equations by shooting method, finite differences and spectral methods. Credit may not be granted for both MATH 478 and MATH 578.
Prerequisite(s): MATH 350 or MMAE 350
Lecture: 3 Lab: 0 Credits: 3

MATH 481
Introduction to Stochastic Processes
This is an introductory, undergraduate course in stochastic processes. Its purpose is to introduce students to a range of stochastic processes which are used as modeling tools in diverse fields of applications, especially in risk management applications for finance and insurance. The course covers basic classes of stochastic processes: Markov chains and martingales in discrete time; Brownian motion; and Poisson process. It also presents some aspects of stochastic calculus.
Prerequisite(s): (MATH 332 and MATH 475) or (MATH 475 and MATH 333)
Lecture: 3 Lab: 0 Credits: 3

MATH 483
Design and Analysis of Experiments
Review of elementary probability and statistics; analysis of variance for design of experiments; estimation of parameters; confidence intervals for various linear combinations of the parameters; selection of sample sizes; various plots of residuals; block designs; Latin squares; one, two, and 2^k factorial designs; nested and cross factor designs; regression; nonparametric techniques.
Prerequisite(s): MATH 476
Lecture: 3 Lab: 0 Credits: 3

MATH 484
Regression
This course introduces the basic statistical regression model and design of experiments concepts. Topics include simple linear regression, multiple linear regression, least square estimates of parameters; hypothesis testing and confidence intervals in linear regression, testing of models, data analysis and appropriateness of models, generalized linear models, design and analysis of single-factor experiments.
Prerequisite(s): MATH 474 with min. grade of C or (MATH 476 with min. grade of C and MATH 475 with min. grade of C)
Lecture: 3 Lab: 0 Credits: 3
Satisfies: Communications (C)

MATH 485
Introduction to Mathematical Finance
This is an introductory course in mathematical finance. Technical difficulty of the subject is kept at a minimum while the major ideas and concepts underlying modern mathematical finance and financial engineering are explained and illustrated. The course covers the binomial model for stock prices and touches on continuous time models and the Black-Scholes formula.
Prerequisite(s): MATH 475
Lecture: 3 Lab: 0 Credits: 3
MATH 486  
**Mathematical Modeling I**  
The course provides a systematic approach to modeling applications from areas such as physics and chemistry, engineering, biology, and business (operations research). The mathematical models lead to discrete or continuous processes that may be deterministic or stochastic. Dimensional analysis and scaling are introduced to prepare a model for study. Analytic and computational tools from a broad range of applied mathematics will be used to obtain information about the models. The mathematical results will be compared to physical data to assess the usefulness of the models. Credit may not be granted for both MATH 486 and MATH 522.  
**Prerequisite(s):** MATH 251 and MATH 332 and MATH 252  
**Lecture: 3 Lab: 0 Credits: 3**  
**Satisfies:** Communications (C)

MATH 487  
**Mathematical Modeling II**  
The formulation of mathematical models, solution of mathematical equations, interpretation of results. Selected topics from queuing theory and financial derivatives.  
**Prerequisite(s):** MATH 252  
**Lecture: 3 Lab: 0 Credits: 3**

MATH 488  
**Ordinary Differential Equations and Dynamical Systems**  
Boundary-value problems and Sturm-Liouville theory; linear system theory via eigenvalues and eigenvectors; Floquet theory; nonlinear systems: critical points, linearization, stability concepts, index theory, phase portrait analysis, limit cycles, and stable and unstable manifolds; bifurcation; and chaotic dynamics.  
**Prerequisite(s):** MATH 252 and MATH 251  
**Lecture: 3 Lab: 0 Credits: 3**

MATH 489  
**Partial Differential Equations**  
**Prerequisite(s):** MATH 252  
**Lecture: 3 Lab: 0 Credits: 3**

MATH 491  
**Reading and Research**  
Independent reading and research. **Instructor permission required.**  
**Credit:** Variable  
**Satisfies:** Communications (C)

MATH 497  
**Special Problems**  
Special problems.  
**Credit:** Variable  
**Satisfies:** Communications (C)