APPLIED COMPUTATIONAL MATHEMATICS AND STATISTICS (ACMS)

ACMS 10091 Statistics for Business I (3 Credit Hours)
For achieving a qualifying score on the appropriate Advanced Placement (AP) exam, students earn credit for this course as the exam credit equivalent of ACMS 10145. A conceptual introduction to the science of data for students of business. Descriptive statistics: graphical methods, measures of central tendency, spread, and association. Basic probability theory and probability models for random variables. Introduction to statistical inference: confidence intervals and hypothesis tests. Many examples will be based on real, current business and economics datasets. Calculations will be illustrated in Microsoft Excel.

ACMS 10140 Elements of Statistics (3 Credit Hours)
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 10141 Honors Introduction to Probability and Statistics (3 Credit Hours)
A conceptual introduction to probability and statistics for students in the Glynn Honors program. The course will cover Probability: basic probability theory and probability models for random variables; Descriptive statistics: graphical and numerical summaries of data; and Statistical Inference: sampling distributions, confidence intervals, hypothesis tests and linear regression. Credit will not be given if the student takes both ACMS 1014X and either ACMS 10145 or 10140
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 10145 Statistics for Business I (3 Credit Hours)
A conceptual introduction to the science of data for students of business. Descriptive statistics: graphical methods, measures of central tendency, spread, and association. Basic probability theory and probability models for random variables. Introduction to statistical inference: confidence intervals and hypothesis tests. Many examples will be based on real, current business and economics datasets. Calculations will be illustrated in Microsoft Excel.
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 10150 Elements of Statistics II (3 Credit Hours)
The goal of this course is to give students an introduction to a variety of the most commonly used statistical tools. A hands-on approach with real data gathered from many disciplines will be followed. Topics include inferences based on two samples, analysis of variance, simple linear regression, categorical data analysis, and non-parametric statistics. This course counts only as general elective credit for students in the College of Science.
Prerequisites: ACMS 10140 or ACMS 10141 or ACMS 10145
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 10550 Applied Calculus I (4 Credit Hours)
Concepts and applications of limits, differentiation, optimization, introduction to integration, and the fundamental theorem of calculus. Concepts will be illustrated using visualizations and animations using a computer algebra system (CAS).
Corequisites: ACMS 11550
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 10560 Applied Calculus II (4 Credit Hours)
Concepts and applications of integration, geometric and power series, and introduction to complex numbers as time allows. Concepts will be illustrated using visualizations and animations using a computer algebra system (CAS).
Prerequisites: MATH 10550 or MATH 10091 or MATH 10850
Corequisites: ACMS 11560
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 11550 Applied Calculus I Lab (0 Credit Hours)
Lab that supplements Applied Calculus I. Course is limited to students intending to major in ACMS
Corequisites: ACMS 10550

ACMS 11560 Applied Calculus II Lab (0 Credit Hours)
Lab that supplements Applied Calculus II. Course is limited to students intending to major in ACMS
Corequisites: ACMS 10560

ACMS 14145 Statistics for Business I (3 Credit Hours)
A conceptual introduction to the science of data for students of business. Descriptive statistics: graphical methods, measures of central tendency, spread, and association. Basic probability theory and probability models for random variables. Introduction to statistical inference: confidence intervals and hypothesis tests. Many examples will be based on real, current business and economics datasets. Calculations will be illustrated in Microsoft Excel.
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 14492 Applied Statistics (3 Credit Hours)
This module introduces students to basic concepts and methods of statistics that will enable them to perform appropriate data analyses to uncover meaningful insights. The statistical software R is taught alongside the material to introduce statistical computing. Students will learn to load raw data, make numerical and graphical summaries of data, and conduct various estimation and testing procedures. Topics include programming in R, descriptive statistics, concepts of probability, random variables and probability distributions, sampling distribution, statistical estimation, hypothesis testing, linear regression, and applications to real-world problems.

ACMS 14498 Research Abroad (3 Credit Hours)
Independent research with UWA Faculty writing Honors Student Paper. The topic is on observing Hidden Markov Models through simulations.

ACMS 20010 Applied Mathematical Financial Economics I (3 Credit Hours)
This course will prepare students to understand call and put options, other financial derivatives and financial strategies such as bull spread, bear spread and others. Financial models such as the binomial model and Black Scholes will also be utilized and students will prepare their own models. Calculus will not be widely used, but an understanding is necessary. This course prepares students for the IFM actuarial exam and also uses present value concepts.
Prerequisites: MATH 10560 or MATH 10092 or MATH 10860

ACMS 20020 Risk, Money, and Quantitative Thinking (Intro to Actuarial Science) (3 Credit Hours)
This course provides an engaging introduction to the fundamental principles behind managing financial uncertainty and making data-driven decisions in a world of risk. Students will be introduced to key actuarial and financial concepts, including the time value of money, probability theory, fundamental business principles, and the foundations of insurance and risk management. Emphasizing practical applications, the course introduces financial risk analysis and actuarial modeling using spreadsheet tools (eg MS Excel), and guest speakers from the industry will provide insights into real-world applications across various financial fields. Designed for students from diverse backgrounds, this course lays the groundwork for future study in actuarial science, finance, and data-driven decision-making, offering an interdisciplinary approach to understanding risk and financial uncertainty. While this course does not prepare the student directly for a specific actuarial credentialing exam it provides a strong grounding for later courses that will (eg Financial Math, Probability, etc)
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 20210 Scientific Computing (3.5 Credit Hours)
An introduction to solving mathematical problems using computer programming in high-level languages such as C.
Prerequisites: MATH 10560 (may be taken concurrently) or MATH 10092 or MATH 10860 (may be taken concurrently) or MATH 10360 (may be taken concurrently) or MATH 14360
Corequisites: ACMS 21210
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning
Enrollment is limited to students with a program in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Actuary, Mathematics, Mathematics (Supp.), Neuroscience and Behavior, Statistics or Statistics (Supp.).

ACMS 20215 R Programming (2 Credit Hours)
In this course, you will learn the foundational skills necessary in R that will enable you to acquire and manipulate data, complete exploratory data analysis (EDA), and create visualizations to communicate your findings. Note: this course is delivered fully online. The course design combines required live weekly meetings online with self-scheduled lectures, problems, assignments, and interactive learning materials. To participate, students will need to have a computer with webcam, reliable internet connection, and a quiet place to participate in live sessions

ACMS 20216 Python Programming (2 Credit Hours)
In this course, you will learn the foundational skills necessary in Python that will enable you to acquire and manipulate data, model data for the purposes of scientific analysis, and create visualizations to communicate your findings. The course will introduce you to efficient scientific computing using NumPy. You will learn how to apply the pandas library to perform a variety of data manipulation tasks, including selecting, subsetting, combining, grouping, and aggregating data. You will also learn how to generate and customize visualizations with matplotlib. The course will give you the basic ideas and intuition behind modern data analysis methods and their applications, with a strong focus on a course project and weekly assignments. Note: this course is delivered fully online. The course design combines required live weekly meetings online with self-scheduled lectures, problems, assignments, and interactive learning materials. To participate, students will need to have a computer with webcam, reliable internet connection, and a quiet place to participate in live sessions.

ACMS 20220 Scientific Computing with Python (3.5 Credit Hours)
This course is an introduction to computer programming using the Python programming language, with an emphasis on solving mathematical and statistical problems.
Prerequisites: MATH 10560 (may be taken concurrently) or MATH 10092 or MATH 10860 (may be taken concurrently) or MATH 10360 (may be taken concurrently) or MATH 14360 (may be taken concurrently)
Corequisites: ACMS 21220
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning

ACMS 20340 Statistics for Life Sciences (3.5 Credit Hours)
An introduction to the principles of statistical inference following a brief introduction to probability theory. This course does not count as a science or mathematics elective for mathematics majors. NOTE: Students may not take more than one of ACMS 20340, BIOS 40411 and MATH 20340. Not open to students who have taken MATH 30540.
Prerequisites: MATH 10360 or MATH 10460 or MATH 10560 or MATH 10092 or MATH 14360
Corequisites: ACMS 21340
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning
Enrollment is limited to students with a major in Pre-Health Studies (Supp.), Biochemistry, Chemistry, Environmental Geosciences, Neuroscience and Behavior, Science- Business or PreProfessional.

ACMS 20350 Introduction to Numerical Analysis (3 Credit Hours)
Introduction to Numerical Analysis is an introductory course that integrates mathematics and scientific computing to address complex real-world problems. The course covers a wide range of topics, including root finding, solutions to linear systems of equations, polynomial interpolation, numerical differentiation and numerical integration, solutions to differential equations, eigenvalues and singular values, and numerical optimization.
Students cannot enroll who have a program in Applied & Comp Math and Stats or Mathematics.

ACMS 20550 Introduction to Applied Mathematics Methods I (3.5 Credit Hours)
An introduction to the methods of applied mathematics. Topics include: basic linear algebra, partial derivatives, Taylor and power series in multiple variables, Lagrange multipliers, multiple integrals, gradient and line integrals, Green's theorem, Stokes theorem and divergence, Fourier series and transforms, introduction to ordinary differential equations. Applications to real-world problems in science, engineering, the social sciences and business will be emphasized in this course and ACMS 20750. Computational methods will be taught. Credit is not given for both ACMS 20550 and PHYS 20451.
Prerequisites: MATH 10560 or MATH 10092 or MATH 10860
Corequisites: ACMS 22550
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning
Students cannot enroll who have a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 20620 Applied Linear Algebra (3 Credit Hours)
The objective of this class is to impart the fundamental knowledge in linear algebra and computational linear algebra that are needed to solve matrix algebra problems in application areas. Appropriate software packages will be used.
Prerequisites: MATH 10550 or MATH 10091
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning
Enrollment is limited to students with a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 20750 Introduction to Applied Mathematical Methods II (3.5 Credit Hours)
The fundamental methods of applied mathematics are continued in this course. Topics include: variational calculus, special functions, series solutions of ordinary differential equations (ODE), orthogonal functions in the solution of ODE, basic partial differential equations and modeling heat flow, vibrating string, and steady-state temperature. Topics in complex function theory include contour integrals, Laurent series and residue calculus, and conformal mapping. The course concludes with a basic introduction to probability and statistics. Credit is not given for both ACMS 20750 and PHYS 20452.
Prerequisites: ACMS 20550 or PHYS 20451 or MATH 20550 or MATH 10093
Corequisites: ACMS 22750
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning
Enrollment is limited to students with a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 21210 Scientific Computing Lab (0 Credit Hours)
Lab for Scientific Computing
Corequisites: ACMS 20210

ACMS 21220 Scientific Computing with Python Lab (0 Credit Hours)
Lab for Scientific Computing with Python.
Corequisites: ACMS 20220

ACMS 21340 Statistics for Life Sciences Lab (0 Credit Hours)
two Lab sessions for Statistics for Life Sciences (ACMS 20340)
Corequisites: ACMS 20340

ACMS 22550 Introduction to Applied Mathematics Methods I Tutorial (0 Credit Hours)
Tutorial for Introduction to Applied Mathematics Methods I
Corequisites: ACMS 20550

ACMS 22750 Introduction to Applied Mathematics Methods II Tutorial (0 Credit Hours)
Tutorial for Introduction to Applied Mathematics Methods II.
Corequisites: ACMS 20750

ACMS 24215 R Programming (2 Credit Hours)
In this course, you will learn the foundational skills necessary in R that will enable you to acquire and manipulate data, complete exploratory data analysis (EDA), and create visualizations to communicate your findings. <p> Note: this course is delivered fully online. The course design combines required live weekly meetings online with self-scheduled lectures, problems, assignments, and interactive learning materials. To participate, students will need to have a computer with webcam, reliable internet connection, and a quiet place to participate in live sessions. <P> Students with other prerequisite courses or equivalent background preparation may enroll by permission of the instructor or permission of the Director of Undergraduate Studies, Professor Alan Huebner (Alan.Huebner.10@nd.edu).
Prerequisites: (ACMS 20210 or CSE 10101 or CDT 30010 or CSE 20133 or CSE 20211 or CSE 20232 or CSE 20311)

ACMS 24216 Python Programming (2 Credit Hours)
In this course, you will learn the foundational skills necessary in Python that will enable you to acquire and manipulate data, model data for the purposes of scientific analysis, and create visualizations to communicate your findings. The course will introduce you to efficient scientific computing using NumPy. You will learn how to apply the pandas library to perform a variety of data manipulation tasks, including selecting, subsetting, combining, grouping, and aggregating data. You will also learn how to generate and customize visualizations with matplotlib. The course will give you the basic ideas and intuition behind modern data analysis methods and their applications, with a strong focus on a course project and weekly assignments. <p> Note: this course is delivered fully online. The course design combines required live weekly meetings online with self-scheduled lectures, problems, assignments, and interactive learning materials. To participate, students will need to have a computer with webcam, reliable internet connection, and a quiet place to participate in live sessions. <P> Students with other prerequisite courses or equivalent background preparation may enroll by permission of the instructor or permission of the Director of Undergraduate Studies, Professor Alan Huebner (Alan.Huebner.10@nd.edu).
Prerequisites: ACMS 20210 or CSE 20133 or CSE 20211 or CSE 20232 or CSE 20311

ACMS 24341 Statistics for Life Sciences (3 Credit Hours)
Theoretical-practical course focused on the fundamentals and techniques to collect, analyze and evaluate quantitative data from the health field necessary for evidence-based nursing practice and scientific research. Develop skills and abilities in the calculation, presentation and analysis of statistical data applied to health. The course uses student-centered methodologies and is assessed through written assessments.

ACMS 24342 Statistic for Life Sciences (3 Credit Hours)
This introductory module, which requires only elementary algebra, is designed to explain and illustrate the statistical ideas and techniques that are an essential skill for a biological scientist engaged in the conduct or interpretation of experimentation. You will discover different types of data distributions and the parameters that define them. You will see how statistics calculated from samples are related to true values in the population from which the sample was drawn. The basic idea of a significance test will be developed and used to adjudicate on the significance, or otherwise, of observed differences. You will also be introduced to the measurement and analysis of the association between variables.

ACMS 30010 Applied Mathematical Financial Economics II (3 Credit Hours)
This course is a continuation of the Financial Economics I material and is the second of a 2-course sequence that prepares students for the Society of Actuaries' Exam MFE (Models for Financial Economics). It is a core exam course for preparing students to become future actuaries. This course prepares students to apply mathematical models to financial assets and manage risk in an insurance setting. The second semester moves to corporate finance issues. This course counts as an ACMS elective
Prerequisites: (MATH 20550 or MATH 10093 or ACMS 20550) and ACMS 20010

ACMS 30440 Probability and Statistics (3 Credit Hours)
An introduction to the theory of probability and statistics, with applications to the computer sciences and engineering. Topics include discrete and continuous random variables, joint probability distributions, the central limit theorem, point and interval estimation and hypothesis testing.
Prerequisites: MATH 20550 or MATH 10093 or ACMS 20550 or MATH 20850 or MATH 24550
Enrollment limited to students in the College of Engineering college.

ACMS 30530 Introduction to Probability (3 Credit Hours)
An introduction to the theory of probability, with applications to the physical sciences and engineering. Topics include discrete and continuous random variables, conditional probability and independent events, generating functions, special discrete and continuous random variables, laws of large numbers and the central limit theorem. The course emphasizes computations with the standard distributions of probability theory and classical applications of them.
Prerequisites: MATH 20550 or MATH 10093 or ACMS 20550 or MATH 20850
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning
Enrollment is limited to students with a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 30540 Statistics A (3 Credit Hours)
An introduction to mathematical statistics. Topics include distributions involved in random sampling, estimators and their properties, confidence intervals, hypothesis testing including the goodness-of-fit test and contingency tables, the general linear model and analysis of variance.
Prerequisites: ACMS 30530 or MATH 30530
Satisfies the following University Core Requirements: WKQR- Core Quantitat Reasoning
Enrollment is limited to students with a program in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 30550 Mathematical Statistics (3 Credit Hours)
An introduction to mathematical statistics. Topics include distributions involved in convergence concepts, estimators and their properties, confidence intervals, hypothesis testing, and linear models and estimation by least squares.
Prerequisites: ACMS 30600

ACMS 30600 Statistical Methods & Data Analysis I (3.5 Credit Hours)
Introduction to statistical methods with an emphasis on analysis of data. Estimation of central values. Parametric and nonparametric hypothesis tests. Categorical data analysis. Simple and multiple regression. Introduction to time series. The SOA has approved this course for VEE credit in Applied Statistics.
Prerequisites: ACMS 30440 or ACMS 30530 or MATH 30530
Corequisites: ACMS 31600
Enrollment is limited to students with a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 30610 Introduction to Financial Mathematics (3 Credit Hours)
The course serves as a preparation for first actuarial exam in financial math- ematics, known as Exam FM or Exam 2. The first part of the course deals with pricing of fixed income securities, such as bonds and annuities. The second part of the course can serve as an introduction to deriva- tive securities such as options and futures. Although the amount of material for both parts is almost the same, Exam FM devotes usually about 2/3 of its questions to Part 1. Therefore, about 2/3 of the course is devoted to Part 1.Topics covered: interest rates, annuities, loans and bonds, forwards, options, hedging, and swaps.
Prerequisites: ACMS 20550 or ACMS 20620 or ACMS 20750 or ACMS 30530

ACMS 30617 SQL For Data Science (1 Credit Hour)
This course will teach students how to use Structured Query Language (SQL) to access and manipulate data stored in databases. Students will learn fundamental commands for filtering records, selecting variables, and merging data tables. Students will also create and modify relational database schemas to store structured data. Students will apply these skills in the context of solving a research question, using SQL to obtain the appropriate data set, and then creating an appropriate analysis or visualization.
Prerequisites: (ACMS 20210 or CSE 10101 or CDT 30010 or CSE 20133 or CSE 20211 or CSE 20232 or CSE 20311 or ACMS 20220) and ACMS 30600

ACMS 30810 Design of Experiments (3 Credit Hours)
In this course, students will learn different methods for designing experiments, analyzing the data, and presenting the results. Topics will include ANOVA, Completely Randomized Designs, Block Designs, Factorial Designs, Split-Plot Designs, Nested Designs, fixed and random effects, contrasts, and covariates.
Prerequisites: ACMS 30600

ACMS 31600 Statistical Methods & Data Analysis I Lab (0 Credit Hours)
Lab for Statistical Methods & Data Analysis I
Corequisites: ACMS 30600

ACMS 34440 Probability and Statistics (3 Credit Hours)
Taught at a host institution. STAT 20060 at UCD; This module introduces the basic concepts of statistical modelling, which particular emphasis on engineeringapplications.Strong emphasis is placed on using the material covered in problem-solvingscenarios.The main sections of the course are:1) Descriptive StatisticsMean, median, mode, range, standard deviation, interquartile range, percentiles.2) Graphical MethodsPie charts, bar graphs, histograms, stem-and-leaf plots, cumulative frequencycurves, Venn diagrams.3) Laws of ProbabilityLaw of total probability, additive rule, multiplicative rule, mutually exclusive events,dependent and independent events, conditional probability, combinations rule,permutations rule, mean and variance of functions of random variables.4) Discrete DistributionsDiscrete random variables, E(X) and Var(X) for X discrete, binomial distribution,poisson distribution, hypergeometric distribution.5) Continuous DistributionsContinuous random variables, density functions, cumulative density functions, E(X)and Var(X) for X continuous, uniform distribution, exponential distribution, normaldistribution, Z values, standard normal distribution, Student's t-distribution.6) Confidence Intervals and Hypothesis TestingSampling distributions, biased and unbiased estimators, significance level, CentralLimit Theorem, large sample confidence interval for a population mean, small sampleconfidence interval for a population mean, large sample confidence interval for apopulation proportion, sample size calculations.7) RegressionCorrelation coefficient, residuals, simple linear regression, correlation and causation,coefficient of determination, making predictions from the regression equation.In addition students are required to complete a sequence of computer laboratorysessions using an interactive package that allows them to simulate commonprobability problems; and use Microsoft Excel to analyse data and perform regressionanalysis. Also taken in Heidelberg.

ACMS 34540 Mathematical Statistics (2.5-3 Credit Hours)
Taught at a host institution. STAT 20100 Inferential Statistics at UCD; Continuous bivariate and multivariate distributions. Covariance and correlation. Chebyshev inequality. Law of Large Numbers Theory of Estimation.Method of moments and maximum likelihood. Point and interval estimationHypothesis Testing. Simple and Composite Hypotheses. Neyman Pearson Lemma and applications. Likelihood ratio tests. Bayesian statistical inference. Loss functions Normal/Normal, Binomial/Beta and Exponential/Gamma models. Probability generating functions. Taught at Trinity - Dublin - ST 1252 Introductin to Statistics II at Trinity College Dublin.On successful completion of this module students should: have a strong grasp of the fundamental statistical ideas of significance tests and confidence intervals, which underpin statistical analysis, be able to apply simple statistical methods to practical problems, be able to explain why statistical methods are so widely applied in both the natural and social sciences, engineering and business, have a sound basis for developing their knowledge of more advanced statistical ideas and methods. Hong Kong University Course Description: Emphasis is on the two major areas of statistical analysis: estimation and hypothesis testing. Through the disciplines of statistical modelling, inference and decision making, students will be equipped with both quantitative skills and qualitative perceptions essential for making rigorous statistical analysis of real-life data.

ACMS 34617 SQL For Data Science (1 Credit Hour)
This course will teach students how to use Structured Query Language (SQL) to access and manipulate data stored in databases. Students will learn fundamental commands for filtering records, selecting variables, and merging data tables. These skills will be applied in the context of solving statistical problems in which students are presented with a research question, use SQL to obtain the appropriate data set, and then use the data to create an appropriate visualization and/or conduct a statistical inference to answer the question.
Prerequisites: ACMS 30600

ACMS 37020 Projects in Actuarial Science (1 Credit Hour)
This course provides students with exposure to real world actuarial science projects, which involve substantial use of probability concepts and financial mathematics throughout. This course will be created in conjunction with an industry partner. Case studies and projects will vary by semester. This course counts for ACMS elective.
Prerequisites: ACMS 30600
Course may be repeated.

ACMS 40100 Mathematical Cryptography with Python (3 Credit Hours)
An introduction to the mathematical foundations of cryptography. Topics include: number theory and basic algebraic structures, select pre-quantum cryptosystems, lattice problems, lattice-based cryptosystems, reduction algorithms, signature schemes, and zero knowledge protocols. Python will be used for the implementation of cryptographic algorithms.
Prerequisites: (ACMS 20620 or MATH 20610) and (ACMS 20220 or ACMS 20216 or ACMS 24216 or ACMS 60052)

ACMS 40210 Scientific Programming (3 Credit Hours)
This course presents a variety of topics associated with programming for scientific computing. Students will be introduced to programming tools that are widely used in scientific computing and data science, as well as learn when and how to use these tools for data visualization, data analysis, and machine learning. The course will also teach students how to program with databases.
Prerequisites: ACMS 20210 or ACMS 20220 or CBE 20258 or CHEM 20262 or CSE 20311 or PHYS 20420

ACMS 40212 Advanced Scientific Computing (3 Credit Hours)
This course covers fundamental material necessary for using high performance computing in science and engineering. There is a special emphasis on algorithm development, computer implementation, and the application of these methods to specific problems in science and engineering.
Prerequisites: ACMS 40390

ACMS 40220 Algorithms and Data Structures for Scientific Computing (3 Credit Hours)
Algorithms and Data Structures for Scientific Computing covers the essential theoretical background for reasoning about algorithms, efficiency and data structures in computation. Students will gain practical experience implementing and applying such algorithms and data structures, with an emphasis on problems that arise in mathematical and scientific contexts.
Prerequisites: ACMS 20220 and (ACMS 20620 or MATH 20610) and (ACMS 30530 or MATH 30530)

ACMS 40390 Numerical Analysis (3 Credit Hours)
An introduction to the numerical solution of ordinary and partial differential equations. Topics include the finite difference method, projection methods, cubic splines, interpolation, numerical integration methods, analysis of numerical errors, numerical linear algebra and eigenvalue problems, and continuation methods.
Prerequisites: (MATH 20750 or MATH 20860 or MATH 30650 or ACMS 20750 or PHYS 20452) and (ACMS 20620 or MATH 20610) and (ACMS 20210 or ACMS 20220)
Enrollment is limited to students with a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 40485 Applied Complex Analysis (3 Credit Hours)
Complex analysis is a core part of applied and computational mathematics. Asymptotic methods for evaluation of functions and integrals, special functions (Gamma, elliptic, Bessel, ...), and conformal mappings arise naturally in applications, e.g., in the solution of physical models from electromagnetism, optics, tumor growth, fluid flow... In this course, an introduction to complex analysis will be given with special regard to those topics occurring in modeling and computation.
Prerequisites: (ACMS 20750 or PHYS 20452 or MATH 40480) and (ACMS 20620 or MATH 20610) and (ACMS 40390 or PHYS 50051 or MATH 40390)

ACMS 40499 Nonlinear and Stochastic Optimization (3 Credit Hours)
This course will provide a practical introduction to algorithms, formulations, and modern software for large-scale numerical optimization. Topics include (nonconvex) nonlinear programming, deterministic global optimization, integer programming, dynamic optimization, and stochastic programming. Multi-objective optimization and mathematical programs with complementarity constraints may be covered based on time and student interests. The target audience is students from engineering, science, and mathematics who wish to incorporate optimization methods into their research. The course will begin with a concise introduction to optimization theory and algorithms. Problem formulation and use of state-of-the-art solvers and modeling environments will be emphasized throughout the course. A background in linear algebra and numerical methods will be helpful but is not necessary. Students should be comfortable programming in Julia, Python, MATLAB, C, or a similar language.

ACMS 40541 Finite Element Methods (3 Credit Hours)
An introduction to the finite element method with applications to structural analysis, heat flow, fluid mechanics, and coupled multiphysics problems. Basics of linear and nonlinear finite element technology (theory and implementation) for continuum problems and engineering structures (bar, beams, frames, plates). Students will build their own finite element code and learn to use commercial software.

ACMS 40630 Nonlinear Dynamical Systems (3 Credit Hours)
Theory of nonlinear dynamical systems has applications to a wide variety of fields, from physics, biology, and chemistry, to engineering, economics, and medicine. This is one of its most exciting aspects - that it brings researchers from many disciplines together with a common language. A dynamical system consists of an abstract phase space or state space, whose coordinates describe the dynamical state at any instant; and a dynamical rule which specifies the immediate future trend of all state variables, given only the present values of those same state variables. Dynamical systems are "deterministic" if there is a unique consequent to every state, and "stochastic" or "random" if there is more than one consequent chosen from some probability distribution. A dynamical system can have discrete or continuous time. The discrete case is defined by a map and the continuous case is defined by a "flow. Nonlinear dynamical systems have been shown to exhibit surprising and complex effects that would never be anticipated by a scientist trained only in linear techniques. Prominent examples of these include bifurcation, chaos, and solitons. This course will be self-contained.
Prerequisites: (ACMS 20750 or MATH 20750 or MATH 30650) and (ACMS 20210 or ACMS 20220)
Enrollment is limited to students with a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 40640 Artificial Neural Networks (3 Credit Hours)
Artificial neural networks are a class of machine learning algorithms inspired by biological neural networks in the brain. In recent years, great strides in the theory and application of artificial neural networks have made them one of the most powerful and popular choices for many machine learning applications. This course will cover the underlying theory and practice of using neural networks for machine learning problems, beginning with simple networks for linear and logistic regression and building up to deep convolutional neural networks. Students will learn to build and train artificial neural networks in Python using the popular PyTorch software package. Students should be comfortable with linear algebra, calculus, and probability/statistics. Experience with Python will not be assumed, but some previous programming experience will be helpful.
Prerequisites: (ACMS 20210 or ACMS 20220) and ACMS 30600 and (ACMS 20620 or MATH 20610 or MATH 20580)

ACMS 40730 Mathematical/Comp Modeling (3 Credit Hours)
Introductory course on applied mathematics and computational modeling with emphasis on modeling of biological problems in terms of differential equations and stochastic dynamical systems. Students will be working in groups on several projects and will present them in class in the end of the course.
Prerequisites: (MATH 20750 or MATH 30650 or ACMS 20750) and (ACMS 20210 or ACMS 20220)
Enrollment is limited to students with a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 40740 Mathematical and Computational Modeling in Neuroscience (3 Credit Hours)
This course will introduce students to some of the most common computational and mathematical models used in neuroscience. In addition to developing a deeper understanding of some biological processes in the brain, students will learn mathematical and computational approaches to studying dynamical systems and modeling physical phenomena. The course is appropriate as an elective for Neuroscience or ACMS majors. The course assumes some experience with linear algebra and probability or statistics, but does not assume any background in biology or neuroscience. Some programming experience is helpful, but not necessary. After completing the course, students will be able to create mathematical models of neural systems, simulate these models in Python, and use mathematical techniques to study the models. Students will also obtain some limited experience with analyzing neural data.
Prerequisites: (MATH 20480 or MATH 20580 or MATH 10094 or MATH 20750 or ACMS 20620 or MATH 20670 or AME 30314 or PHYS 20452) and (PSY 30100 or ACMS 20340 or ACMS 30440 or ACMS 30530 or MATH 30530 or BIOS 40411)
Students cannot enroll who have a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 40750 Partial Differential Equations (3 Credit Hours)
An introduction to partial differential equations. Topics include Fourier series, solutions of boundary value problems for the heat equation, wave equation and Laplace's equation, Fourier transforms, and applications to solving heat, wave and Laplace's equations in unbounded domains.
Prerequisites: MATH 20750 or MATH 30650 or MATH 30850 or ACMS 20750

ACMS 40760 Introduction to Stochastic Modeling (3 Credit Hours)
Stochastic modeling is a technique of presenting data or predicting outcomes that takes into account a certain degree of randomness, or unpredictability. Topics include (i) Short Review of Probability - Major discrete and continuous distributions, properties of random variables. (ii) Conditional probability and conditional expectation, sums of random variables, martingales. (iii) Introduction to Discrete Markov Chains - Transition probability matrix of a Markov chain, some Markov chain models, first step analysis, the absorbing Markov chains, various types and classifications of Markov chains. (iv) Long Run (asymptotic) Behavior of Markov Chains: Limiting distribution, the classification of states, irreducible Markov chains, periodicity of Markov chains, recurrent and transient states, the basic limit theorem of Markov chains. (v) Poisson Processes - The Poisson distribution and the Poisson process, the law of rare events, distributions associated with the Poisson process, the Uniform distribution and Poisson processes. (vi) Continuous Time Markov Chains - Pure birth and death processes and it's limiting behavior. (vii) Introduction to Brownian Motion, Drift and Diffusion, Geometric Brownian motion, Ornstein-Uhlenbeck process and it's long run behavior. (viii) Monte Carlo Simulations for Diffusion.
Prerequisites: ACMS 30440 or ACMS 30530 or MATH 30530
Enrollment is limited to students with a major in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Statistics or Statistics (Supp.).

ACMS 40770 Stochastic Simulation Algorithms (3 Credit Hours)
This course will develop practical techniques for the simulation of stochastic systems. Stochastic models (as opposed to deterministic) do not produce the same outcome from identical input parameters. Extreme weather, the outcome of sporting events, or the fluctuation of asset prices observed in the stock market are examples of natural and human systems that we wish to understand, but that are governed largely by stochastic (or random) processes. This course will develop a suite of computational methods, collectively called Stochastic Simulation Algorithms (SSAs), for understanding the range, or distribution, of outcomes that can arise from stochastic models. The course will emphasize practical implementation and benchmarking of algorithms in Python.

ACMS 40790 Topics in Applied Mathematics (3 Credit Hours)
Selected Topics in Applied and Computational Mathematics
Prerequisites: ACMS 30600 or ACMS 30540

ACMS 40842 Time Series Analysis (3 Credit Hours)
This is an introductory and applied course in time series analysis. Popular time series models and computational techniques for model estimation, diagnostic and forecasting will be discussed. Although the book focuses on financial data sets, other data sets, such as climate data, earthquake data and biological data, will also be included and discussed within the same theoretical framework.
Prerequisites: ACMS 30540 or ACMS 30600
Enrollment is limited to students with a program in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Data Science, Statistics or Statistics (Supp.).

ACMS 40852 Advanced Biostatistical Methods (3 Credit Hours)
This course introduces advanced statistical methods used in biological and biomedical research. Topics include study designs commonly used in health research including case-control, cross-sectional, prospective and retrospective studies; statistical analysis of different data types arising from biological and health research including Gaussian data, categorical data, count data, survival data, correlated/clustered data models, and diagnostic tests. All statistical methods are illustrated with examples from the biology and health sciences. Students are expected to have basic knowledge in R programming, probabilities and distribution theory, descriptive statistics, statistical inferences including hypothesis testing and estimation, and working knowledge of linear regression, before they can register for the course. Upon completion of the course, students are able to recognize and give examples of different types of data arising in biological and health studies, and apply appropriate methods to analyze such data.
Prerequisites: ACMS 30600

ACMS 40855 Spatio-Temporal Statistics for Environmental Applications (3 Credit Hours)
The course aims at providing the foundations of methods for spatio-temporal models for environmental Statistics. The main topic covered will be Gaussian processes in space and time and related notions of stationarity, co-variance functions and optimal interpolation (kriging). Exploratory analysis and inference, with particular emphasis on approximation methods for very large data sets, will be covered in the second part of the course. The last part of the course will be either dedicated to more methodological (e.g. asymptotics for spatial processes) or applied problems (e.g. climate model emulation, air pollution, visualization in Virtual Reality), depending on the class interests.
Prerequisites: ACMS 30600 and (ACMS 30540 or MATH 30540)

ACMS 40875 Machine Learning (3 Credit Hours)
This course introduces a set of the most popular methods for addressing four central problems in machine learning: dimension reduction, regression, classification, and clustering, with the greatest emphasis on classification. Dimension reduction aims to reduce the dimensions of high-dimensional data to make it easier to visualize and analyze. Regression involves predicting a continuous variable, classification concerns predicting a categorical variable, and clustering seeks to divide data into useful or meaningful groups. The topics likely to be covered in the course include the following, although we may need to omit a few each year due to limited lecture time: principal component analysis, multidimensional scaling, tSNE, UMAP, k-means clustering, hierarchical clustering, nearest neighbor classifiers, linear/quadratic discriminant analysis, Naive Bayes, decision trees, and ensemble methods (bagging, random forest, boosting), as well as artificial neural networks. Deep learning will also be seriously discussed in this course, although, due to limited lecture time, we may focus only on a small, carefully selected set of topics, such as self-supervised learning, transformers, BERT, and GPT.
Prerequisites: ACMS 30600 and (ACMS 20620 or MATH 20610 or MATH 20580)
Enrollment is limited to students with a program in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Data Science, Statistics or Statistics (Supp.).

ACMS 40876 Data Science in Practice: Tools and Applications (3 Credit Hours)
Given the growing volume and complexities of real-world data, successful deployment of data science pipelines into practice often require intangible factors, beyond the modeling, including careful formulation of the substantive problem of interest, non-trivial data pre-processing, powerful computational software, intuition into when and why models work or fail to work, effective visualization and communication of the results, awareness of the ethical consequences, and close collaborative efforts. Data Science in Practice: Tools and Applications explores these computational and critical thinking skills necessary to solve data science problems in real-world applications. To this end, this course will guide students through a series of hands-on learning projects based on real scientific datasets. Through these real-data projects, students will gain experience with data pre-processing, advanced visualization tools, unsupervised and supervised learning tasks, interpretability tools, and advanced computing tools that are commonly used in industry such as git, distributed computing, reproducible documentation, and open-source software packaging.
Prerequisites: ACMS 40210 or ACMS 40875 (may be taken concurrently) or ACMS 40640 (may be taken concurrently)

ACMS 40878 Computational Statistics (3 Credit Hours)
This course introduces basic computing methods for statistics. Topics are organized into two major parts: optimization and integral approximation. Optimization techniques are commonly used in statistics for finding maximum likelihood estimators, minimizing risks in a Bayesian decision problem, solving nonlinear least square problems, and a wide variety of other tasks all involving optimizations. Approximation of integrals is frequently required for Bayesian inference, since a posterior distribution may not belong to a familiar distributional family. Integral approximation is also useful in some maximum likelihood inference problems when the likelihood itself is a function of one or more integrals.
Prerequisites: ACMS 20210 and ACMS 30600

ACMS 40950 Topics in Statistics (3 Credit Hours)
Selected advanced topics in Statistics. Possible topics include, but are not limited to, applied logistic and ordinal regression modeling including fitting, building, and interpreting regression models for binary and ordinal response variables, various modeling strategies addressing different sampling and experimental designs such as case-control studies and longitudinal data, advanced experimental designs, survey research, big data analysis, Bayesian analysis, survival analysis, spatial and longitudinal analysis, commonly-used nonparametric statistics, basics of robust statistics, tests of association in contingency tables, permutation tests, the bootstrap, introduction to data mining techniques, etc. Applications in a variety of fields such as medical biology, psychology, global health, psychiatry, etc will be introduced. The topic of the course could vary from one semester to another depending on the interests of the faculty member and the students. The course could potentially involve a student project in the area of the interests of the faculty member and could change from one semester to another. The course will count for science credit, ACMS elective credit as well as STAT major elective credit.
Prerequisites: ACMS 30600 and (ACMS 30540 or MATH 30540)
Enrollment is limited to students with a program in App & Comp Math & Stats (Supp), Applied & Comp Math and Stats, Data Science, Statistics or Statistics (Supp.).

ACMS 44631 Dynamical Systems (3 Credit Hours)
This module provides an introduction to the theory of dynamical systems leading up to the concept of chaos. The course starts by considering one-dimensional flow, identifying fixed points, classifying stability, and introducing the saddle-node, transcritical and pitchfork bifurcations. We then progress to two-dimensional flows, and discuss classification of linear systems, methods of plotting the phase plane, and limit cycles. We will consider the behaviour of conservative systems, reversible systems and Lienard systems and discuss the Poincare-Bedixson theorem and Hopf bifurcations. Finally, we will look at chaotic systems, and study one-dimensional maps, fractals and strange attractors.

ACMS 44790 Topics in Applied Mathematics (3 Credit Hours)
This module will offer both a recap of elements of standard Euclidean geometry and give an introduction to the theory of differential geometry. It will, in particular, give examples of non-Euclidean geometries such as spherical geometry etc.. The differential geometry will cover the modern theory of curves and surfaces. Topics covered will be taken from the following list: CURVES: regular curve, tangent vector, tangent line, reparametrisations, the arc-length function, the Frenet-Serret apparatus and the Frent-Serret theorem for unit speed and non-unit speed curves. SURFACES: Simple surface, tangent plane, tangent space, co-ordinate transformation and definition of a general surface. Level sets as surfaces. The first and second fundamental forms of a simple surface and brief introduction to Guassian curvature.

ACMS 44794 Topics in Applied Mathematics (3 Credit Hours)
The aim of this course is to introduce Machine Learning from the point of view of modern optimisation and approximation theory.

ACMS 44798 Topics in Applied Math: Financial and Actuarial Mathematics (3 Credit Hours)
Mission Statement of the Actuarial Profession: To develop the role and enhance the reputation of the actuarial profession in providing expert and relevant solutions to financial and business problems, especially those involving uncertain future events. This module will show how to solve financial and business problems in actuarial science. The module is divided into five units: 10. Investments 11. Simple Compound Interest Problems 12. Forward Contracts and the No Arbitrage Assumption 13. Term Structure of Interest Rates 14. Stochastic Interest Rate Models. Use of Excel spreadsheets and simple VBA programmes to carry out data analyses and financial modelling.

ACMS 44957 Topics in Statistics: Survival Analysis (3 Credit Hours)
The normal linear model: use of matrices, least squares and maximum likelihood estimation, normal equations, distribution theory for the normal model, hypothesis tests and confidence intervals. Practical aspects of linear models and analysis of variance: multiple regression, categorical variables and interactions, blocks and treatments, orthogonality, model selection (including AIC, but not the derivation of AIC), fit criteria, use of residuals, outliers, leverage, model interpretation. Normal linear mixed models, hierarchical models. Generalised Linear Models: logistic regression, linear exponential families and generalized linear models, scale parameter, link functions, canonical link. Maximum likelihood fitting. Iteratively reweighted least squares. Asymptotic theory: statement and applications to inference, analysis of deviance, model checking, residuals.

ACMS 46800 Directed Readings (0-10 Credit Hours)
Readings not covered in the curriculum which relate to the student's area of interest.
Course may be repeated.

ACMS 48498 Undergraduate Research (0-3 Credit Hours)
Research in collaboration with members of the faculty. Evaluation of performance will be accomplished through regular discussions with the faculty member in charge of the course.
Course may be repeated.

ACMS 48500 Undergraduate Thesis (1-3 Credit Hours)
To produce a thesis that describes work of an undergraduate research project. The undergraduate thesis must go beyond what is found in an undergraduate course, and present a novel approach to a subject.
Course may be repeated.
Enrollment is limited to students with a major in Applied & Comp Math and Stats or Statistics.