FACULTY OF PURE AND APPLIED MATHEMATICS

BASIC SCIENCE COURSES

- prof. dr hab. inż. Krzysztof Bogdan

  MAT 1308 Introduction to the Practice of Statistics

  We discuss basic concepts and methods of statistical analysis of data, and illustrate them with multimedia and computer software. This fast-paced, well-organized course is suitable for students with mere basic mathematical preparation, but with high academic standards of work, and with enthusiasm for science (grades from math courses may be used to estimate these). The course will use an influential mainstream textbook of Moore and McCabe (a Polish counterpart is a book by Koronacki and Mielniczuk). In class we speak only English, and I expect the students to freely answer, ask questions, state opinions, and bring their data. Registration is limited by the capacity of the classroom and the teaching load on the lecturer. Additional information: http://www.im.pwr.wroc.pl/~bogdan/

- dr hab. inż. Anna Jaśkiewicz, prof. PWr.

  MAT 1592 Game Theory

  Game theory models conflict and cooperation between rational decision-making players. It has applications in a wide variety of areas, including statistical decision theory, economics and business, biology and political sciences. The course will cover both non-cooperative and cooperative games. In particular, the following topics will be analyzed: static games (zero-sum and non-zero-sum), Nash equilibria, correlated equilibria, games with incomplete information (auctions), games in an extensive form as well as the Nash bargaining problem and the Shapley value as an illustration of cooperative models.

- prof. dr hab. Krzysztof Stempak

  MAT 1307 Selected Problems of Functional Analysis

  Students will get acquainted with selected parts of advanced functional analysis, including notions of unbounded operators, distributions and Sobolev spaces. The spectral theorem for unbounded self-adjoint operators will be presented. Applications to a description of mathematical model of quantum mechanics and to partial differential equations will be given.

- dr inż. Łukasz Płociniczak

  MAT 1310 Applied Partial Differential Equations

  The course gives a broad overview of the mathematical field of Partial Differential Equations (PDEs) considered from the applied point of view. We will be concerned with conservation laws, heat equation, Laplace's and Poisson's equations, wave equation and shortly talk about Navier-Stokes equations. The stress will be put on derivation and solving various problems in physics, biology and other sciences. The student will learn some basic yet powerful methods of finding explicit solutions to a large class of PDEs.

- prof. dr hab. inż. Tomasz Downarowicz

  MAT 1306 Dynamical Systems and Ergodic Theory

The goal of the course is to familiarize the student with basic notions and theorems of the theory of dynamical systems, both topological and measure-preserving. The Birkhoff Ergodic Theorem, mixing and weak mixing, connections between topological and Kolmogorov-Sinai entropy are the most important examples of the course's topics. The student should be prepared to read and understand more advanced textbooks in the area of dynamics.

- dr inż. Piotr Kowalczyk

  MAT Piecewise-smooth Dynamical Systems – Bifurcation Analysis and Numerical Simulations

  Dynamical systems theory has proved a powerful tool to analyze and understand the behaviour of a diverse range of problems. There is now a well developed qualitative approach to dynamical systems that typically relies on the system evolution being defined by a smooth function of its arguments. In some problems, however, various terms are non-smooth functions of their arguments (for example, electrical circuits that have switches, mechanical systems in which components impact with each other (such as gears), or many problems in the social and financial sciences where continuous change can trigger discrete actions). There, functions are piecewise smooth but time or event driven in the sense that smoothness is lost at instantaneous events at some discrete time instances, for example the application of a switch. They have fascinating dynamics with significant practical application and a rich underlying mathematical structure.

HUMANITIES AND MANAGEMENT COURSES

- dr inż. Przemysław Scherwentke

  MAT 1311 Professional Document Preparation in the LaTeX System

  LaTeX is a powerful document description language built on top of TeX. The course introduces the use of LaTeX for producing academic documents. At the end of the course, students will be ready to produce a conference or journal paper including well-formatted tables, figures, and equations. We will also cover how to extend this to produce other documents, such as dissertations and beamer presentations.

SPECIALIZED COURSES

- dr hab. inż. Jacek Małecki

  MAT 1309 Stochastic Integral and the Theory of Martingales

  The aim of the course is to present basis of the stochastic analysis such as the Itô integral with respect to Wiener process and continuous square integrable martingales. Those concepts will be then extended to more general stochastic integrals and local martingales. Student will learn how to use the tools of stochastic analysis such as Itô formula to solve mathematical and physical problems.

- dr hab. Wiesław Dudek, prof. PWr.

  MAT 1313 Abstract Algebra

  The course is devoted to the problems of modern universal algebra. The classes of algebras defined by equality, free and quotient algebras and their connections with lattices of congruences will be discussed. We will also discuss algebraic aspects of Latin squares and their applications in coding theory.

- dr hab. inż. Krzysztof Burnecki, prof. PWr.

  MAT 1302 Monte Carlo Methods in Mathematical Modeling

  The course concerns Monte Carlo methods and their applications in different areas. It begins with the history of the Monte Carlo method and presentation of its theoretical foundations. A classical application of the Monte Carlo simulations to multidimensional integration is discussed. Next, variance reduction methods like Control Variate Method, Antithetic Variates and Importance Sampling are presented in detail. Quasi-Monte Carlo and Markov chain Monte Carlo methods are also explained. All methods are illustrated on various examples ranging from statistical hypothesis testing to risk management and engineering.

- prof. dr hab. inż. Krzysztof Bogdan

  MAT 1312 Stochastic Analysis

  We discuss stochastic calculus based on random Poisson measures and jump stochastic processes. We prove Mecke-Palm formulas and give their applications. We present moment formulas for Poisson-Skorokhod integrals, Lévy system etc. In the second part of the course we construct Lévy processes, and discuss their properties and applications, focusing on potential theory and nonlocal partial differential equations. The applications include boundary value problems and estimates of harmonic functions, Green function and heat kernels. In the third part of the course we discuss stochastic differential equations driven by jump Lévy processes. Additional information can be found at: http://www.im.pwr.wroc.pl/~bogdan/

- dr hab. inż. Agnieszka Wyłomańska, prof. PWr.

  MAT Mathematical Methods in the Analysis of Experimental Data

  During the course students will have the opportunity to learn of new methods of real data analysis. The classical time series techniques will be presented however the new developments in the field will be demonstrated as well. Most of the classical methods in time series analysis techniques are based on the Gaussian-based behavior. Assumption of Gaussianity is insufficient to many real phenomena. The novel techniques in the time series method do not require Gaussianity of real data therefore they are be more general and can applied to much more phenomena than the classical methods. The course is dedicated to wide audience of PhD students from different faculties of Wroclaw University of Science and Technology who are planning to apply the time series techniques in their research.

ADDITIONAL M.Sc. LEVEL COURSES THAT CAN BE TAKEN BY Ph.D. STUDENTS

- prof. dr hab. Zbigniew Palmowski

  MAT 1361 Economathematics

  This course provides the necessary mathematical methods to model various financial markets and to price standard and exotic derivatives. The main focus is on the classical continuous-time models such as the Black-Scholes, Vasicek or Cox–Ingersoll–Ross model. Also, some more advanced fractional models will be discussed in some detail.

- dr hab. inż. Krzysztof Burnecki, prof. PWr.

  MAT 1580 Computer simulations of stochastic processes

  The course deals with the advanced methods of simulating and analyzing stochastic processes. The emphasis is put on the class of stochastic differential equations with the broad family of noises. The students will learn how to simulate various important processes and how to apply the introduced methods in the analysis of real-life data.

- dr inż. Piotr Więcek

  MAT 1588 Optimization Theory

  This course introduces the student to optimization theory and its use in economics and other applied sciences. Various optimization methods, such as gradient methods, steepest descent method or Newton's method, will be introduced and discussed in detail. The student will also learn various aspects of linear programming and its extensions.