Courses Offered in English for Incoming Students
by the Mathematical Institute of BME

Spring 2014

Parameters: CODE, lectures / practical lectures / laboratory / f = term mark, v = exam / ECTS credit points

1. Basis Courses for Students of Engineering

Mathematics A2a – Vector Functions
BMETE90AX02, 4/2/0/v/6


Calculus 2 for Informaticians
BMETE90AX05, 4/2/0/v/7


Mathematics EP2 for Architects
BMETE90AX4, 0/2/0/f/2

surfaces. Separable differential equations, first order linear differential equations. Algebraic form of complex numbers. Second order linear differential equations with constant coefficients. Taylor polynomial of \( \exp(x) \), \( \sin(x) \), \( \cos(x) \). Eigenvalues and eigenvectors of matrices.

**Mathematics A4 – Probability Theory**
BMETE90AX08, 2/2/0/f/4


**Numerical Methods for Engineers**
BMETE91AX30, 1/1/0/f/2


2. **Advanced Courses for Students of Engineering**

**Mathematics M1c - Differential Equations**
BMETE90MX44, 2/1/0/v/3, Thursdays, 12-14 Building H, Room 61


**Mathematics M1 – Differential Equations and their Numerical Methods**
BMETE90MX46, 4/2/0/v/8

methods. Comparing explicit and approximate dynamics, error estimate between exact and
approximate solutions. Retarded equations. Partial differential equations. The standard initial and
boundary value problems of mathematical physics. Separation of variables. Fourier series as
coordinate representation in Hilbert space. The method of finite differences for the heat equation:
error estimate and the maximum principle.

3. Advanced Courses for Students in Mathematics

Limit- and Large Deviation Theorems of Probability Theory
BMETE95MM10, 3/1/0/v/5

Limit theorems: Weak convergence of probability measures and distributions. Tightness:
HellyPtohorov theorem. Limit theorems proved with bare hands: Applications of the reflection
principle to random walks: Paul Lévy’s arcsine laws, limit theorems for the maximum, local time and
hitting times of random walks. Limit theorems for maxima of i.i.d. random variables, extremal
distributions. Limit theorems for the coupon collector problem. Proof of limit theorem with method of
momenta. Limit theorem proved by the method of characteristic function. Lindeberg’s theorem and
its applications: Erdős-Kac theorem: CLT for the number of prime factors. Stable distributions. Stable
limit law of normed sums of i.i.d. random variables. Characterization of the characteristic function of
symmetric stable laws. Weak convergence to symmetric stable laws. Applications. Characterization of
characteristic function of general (non-symmetric) stable distributions, skewness. Weak convergence
in non-symmetric case. Infinitely divisible distributions: Lévy-Hinchin formula and Lévy measure. Lévy
measure of stable distributions, self-similarity. Poisson point processes and infinitely divisible laws.
Infinitely divisible distributions as weak limits for triangular arrays. Applications. Introduction to Lévy
processes: Lévy-Hinchin formula and decomposition of Lévy processes. Construction with Poisson
point processes (a la Ito). Subordinators and Lévy processes with finite total variation, examples. Stable
processes. Examples and applications. Large deviation theorems: Introduction: Rare events and large
deviations. Large deviation principle. Computation of large deviation probabilities with bare hands:
application of Stirling’s formula. Combinatorial methods: The method of types. Sanov’s theorem for
finite alphabet. Large deviations in finite dimension: Bernstein’s inequality, Chernoff’s bound, Cramer’s
theorem. Elements of convex analysis, convex conjugation in finite dimension, Cramer’s theorem in R^d.
Gartner-Ellis theorem. Applications: large deviation theorems for random walks, empirical distribution
of the trajectories of finite state Markov chains, statistical applications. The general theory: general
large deviation principles. The contraction principle and Varadhan’s lemma. large deviations in
topological vector spaces and function spaces. Elements of abstract convex analysis. Applications:
Schilder’s theorem, Gibbs conditional measures, elements of statistical physics.

Dynamical Systems
BMETE93MM02, 3/1/0/v/5

Continuous-time and discrete-time dynamical systems, continuous versus discrete: first return
map, discretization. Local theory of equilibria: Grobman–Hartman lemma, stableunstable-
center manifold, Poincaré’s normal form. Attractors, Liapunov functions, LaSalle principle,
phase portrait. Structural stability, elementary bifurcations of equilibria, of fixed points, and
of periodic orbits, bifurcation curves in biological models. Tent and logistic curves, Smale
horseshoe, solenoid: properties from topological, combinatorial, and measure theoretic viewpoints. Chaos in the Lorenz model.

**Mathematical Statistics and Information Theory**  
BMETE95MM05, 3/1/0/v/5


**Extreme Value Theory**  
BMETE95MM16, 2/0/0/v/3


4. **A Course of the Program Mathematica for Everyone**

**Applied Computational Analysis**  
BMETE927205, 0/0/2/f/3, Tuesdays, 14-16 Building H, Room 27

It is about the application of the program Mathematica (see e.g. http://demonstrations.wolfram.com) in the fields of engineering, physics, chemistry and mathematics - depending on the audience. Those enrolled will get a copy of the program for personal use. The main goal is to produce and present a program at the end of the course about your own work (which you may--are even encouraged--to use in other subjects).