

TOPICS FOR ENTRANCE EXAMS, MASTER'S PROGRAMME

Study programme: Mathematics

Study branches: Financial and Insurance Mathematics

1. Mathematical analysis

- Limits of a sequence, function.
- Convergence of infinite series.
- Investigating properties of real functions of a single real variable (domain, continuity, asymptotes, monotonicity, derivatives, local and global maxima, minima, convexity, concavity).
- Differential and partial derivatives. Absolute extremes, extremes on a set.
- Integrals of functions of one and multiple real variables. Substitutions, integration by parts. Fubini's theorem. Integral with respect to a measure (Lebesgue, counting measure, product measures).

2. Probability and statistics

- Distribution function, density, moments of random variables.
- Transformations of random variables.
- Basic probability distributions (normal, exponential, gamma, binomial, Poisson, geometric): densities, expectations, variances.
- Weak law of large numbers, central limit theorem, Slutski theorem, continuous transformations, the delta method.
- Unbiasedness and consistency of estimators, foundations of hypothesis testing, Neyman-Pearson lemma.
- Fisher information, Rao-Cramér Theorem, maximum likelihood estimators and their asymptotic properties. Wald test, score test, likelihood ratio test.
- Construction of confidence intervals.

3. Finance

- Time value of money. Valuation interest rate (cost of capital). Valuation of cash flows and their measures (duration, convexity, internal rates of returns). Comparison of investment projects. Term structure of interest rates: spot and forward interest rates.
- Financial bonds. Clean and dirty (fair) price of a bond, yield to maturity, accrued interest.
- Financial derivatives, forwards, options, swaps, PUT-CALL parity.
- Risk measures: standard deviation, value at risk (VaR). Parametric and nonparametric estimation of VaR.
- Markowitz theory of portfolio. Return, logarithmic return, expected return, and risk of a portfolio. Construction of a minimum-variance portfolio with prescribed expected return under short sales allowed and nonexistence of a riskless asset.