MATHEMATICAL TOOLS FOR ASSET PRICING AND RISK ANALYSIS

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This course is aimed at filling the gap between Mathematics curriculum as taught in undergraduate classes and the level required for deeper understanding of graduate classes in Finance and Economics. It is aimed at Masters level students.

Links with existing PhD level Math classes will be highlighted in order to encourage interested students to take further classes.

List of possible topics (with Finance applications):

(1) Advanced Linear Algebra: eigenvalue and SV decomposition, pseudoinverse, hyperplane separation theorem. Applications to linear regression and Fundamental Theorem of Security Pricing.
(2) Optimizaton and Calculus of Variations: Lagrange multipliers, Euler-Lagrange equations, numerical methods. Applications to utility theory, Capital Asset Pricing Model and maximum likelihood estimation.
(3) Applied Probability topics: Time series, (second-order) stationarity and auto-correlation function, Markov chains, Extreme Value Theory.
(4) Dynamics: linear stability of ODEs and difference equations, generating functions. Applications to dynamical models in Economics and to volatility modeling via auto-regressive processes (AR, ARMA, ARCH).
(5) Basic Stochastic Differential Equations: stochastic integral, standard SDEs (geometric Brownian motion, Ornstein–Uhlenbeck process), Ito lemma, Ito-Taylor expansion, numerical methods (Euler–Murayama, Milstein). Applications to option pricing.
(6) Advanced Finance applications: market risk, credit risk, risk aggregation, pricing under trading costs.