Syllabus Econ 420: Mathematical Economics, Fall 2016

Subject to Revision

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These slides are distributed via Laulima
Learning Objective: To educate the student in Mathematical Economics so she/he can succeed in a global business environment, in particular, in:

- Econ departments of financial and non-financial institutions
- Working as a ‘Quant’
- Academia
- Applying knowledge for trading and investment decisions
Syllabus cont.

Literature:
- Slides on Laulima

Recommended Textbook
“Correlation Risk Modeling and Management”
Gunter Meissner

www.dersoft.com/flyer.pdf

We will program a lot. Bring your laptop to class!!
1. **Game Theory**: Theory of Interactive Behavior and Decision Making (10 Nobel Prizes given)
- The classical game: Prisoner’s Dilemma
- Does it make sense to stop at a red light?
- Ultimatum Game
- Risk aversion Game: Can we exploit the fact that most investors are risk-averse?
- Nash Equilibrium
- Prospect Theory

Conclusion: Is Game Theory “cute but useless”? 

Some basic Math for the course: [www.dersoft.com/mathrefresher.docx](http://www.dersoft.com/mathrefresher.docx)
2. Stochastic Processes:
- The idea: “The future is stochastic, so let’s model it with a stochastic process!”
- The basic element: White noise, programming it
- Popular stochastic processes: Brownian motion, Wiener Process, Generalized Wiener Process
- Geometric Brownian Motion (GBM); A good process for stocks? Programming the GBM with jumps
- Should a stochastic process include Mean Reversion? A test for Mean Reversion
- Inputting fundamental data into stochastic processes! Which ones?
- Which economic variables should be modeled with which stochastic process?
3. Time Series Analysis: ARCH and GARCH, stochastic, non-stochastic; Nobel Prize rewarded
- GARCH – The intuition and the math
- Programming a real world GARCH example
- Estimating GARCH parameters with ML, GDM (Gradient Descent Method)
- Extensions of GARCH: EGARCH, IGARCH, TGARCH, QGARCH, fGARCH
- Applications of GARCH and its extensions. Is there a ‘best GARCH’ model?

4. QRM (Quantitative Risk Management):
- The concept of Coherent Risk Measures
- Pros and Cons of
  - VaR (Value at Risk),
  - ES (Expected Shortfall); Is ES superior to VaR?
  - EVT (Extreme Value Theory)
- The critical impact of Correlation on VaR, ES, and EVT
- Which correlation concept to use? Pearson, Copulas, Stochastic Correlation
Syllabus - Grading

Grading: Participation/Homework 10%
Research Project 30%
Presentation of the Project at the end of each month 20%
Mid term 20%
Final 20%

Point System:

96.66 <= A+ <= 100
93.33 <= A <= 96.66
90.00 <= A- <= 93.33
86.66 <= B+ <= 90.00
83.33 <= B <= 86.66
80.00 <= B- <= 83.33
76.66 <= C+ <= 80.00
73.33 <= C <= 76.66
70.00 <= C- <= 73.33
65.00 <= D+ <= 70.00
60.00 <= D <= 65.00
F <= 60.00
Each student will work on a project, in which the following topics will be

a) Analyzed mathematically
b) Programmed
c) A numerical example assessed

1) Big data: Deus ex machina?; Should Data replace Thought?

2) Excel’s Optimization Tools: GRG (Generalized Reduced Gradient), Simplex LP, Evolutionary

3) Latest Search Procedures: From Newton-Raphson, via Levenberg-Marquardt to stochastic searches

4) ARCH and GARCH – Latest Developments as EGARCH, IGARCH, NGARCH, QGARCH, TGARCH etc. Nobel prize worthy?

5) Mean reversion – How to quantify it? Why is it important?
7) Latest Developments Game theory: Iterative Games, new games

8) Autocorrelation – How to quantify it? What is the relationship to mean reversion?

9) Performing a empirical mean-variance optimization and correlation analysis on a portfolio

10) Correlation Fitting (which distribution can replicate correlation best?)

10a) Stock correlations

10b) Bond correlations

10c) Commodity correlations
14) Test Stochastic Processes for Econ Variables

15) Negative and above unity correlation (which occurs in the discrete Jacobi process)

16) WWR (Wrong Way Risk) – which correlation concept is adequate?

17) EVT (extreme value theory) and correlation; which correlation concept to use?

18) Integrate fundamental variables as GDP growth rate and unemployment into a stochastic process as the GBM

19) What is Monte Carlo simulation? Name the pros and cons

20) Numerical Finance using GPUs - Is it the future? (Chapter 13 in Meissner book)

22) Dispersion trading is a function of correlation!

23) Brute Force or Beautiful math? Are numerical methods (as Monte Carlo) combined with GPUs the future?

24) Is there a correlation between government spending and a lasting growth impact? (Keynesianism)

25) Is there a correlation between money supply (and presumably resulting inflation) and economic growth? (Monetarism)

26) Is there a correlation between income inequality and growth?

27) Is there a correlation between income inequality and crime?

28) Extending GARCH to Stochastic Autocorrelation: ‘SGARCH’

29) Has market leadership changed? I.e. Asia and Europe used to follow the US market. Is it now the other way around?
30) Will their be a spill-over from the BRIC state recessions (except India) to other Economies?

31) Perpetual Prisoner’s Dilemma Game – Will they learn?

32) Finish paper “Asset Modeling, Stochastic Volatility and Stochastic Correlation”

33) Finish paper “A joint Market Risk – Liquidity Risk Model”

34) Is it a good strategy to buy a stock at the close before the ex-dividend date (to get the dividend) and sell it at the close one day later (on the ex-dividend date)?

35) If the Futures contract is up (down) before the opening, should we buy (sell) the market at the open and close the trade at the market close?

36) Screen for stocks who have a high implied vol compared to actual vol, to do Covered Call Writing.
37) Is Chaos Theory still present in the Stock markets? (See File ‘Econ340mine’ slides 87 to 95)

38) “News Trading” – A valuable tool for stock forecasting?

Come up with your own topic! Mathecon related!