

## SYST/OR 438/538 Analytics for Financial Engineering and Econometrics

George Mason University  
Department of Systems Engineering and Operations Research

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Class hour: Monday 7:20-10:00 PM, Merten Hall #1200

Office Hour: Monday 2:00-4:00 PM, or by appointment

**Course Description:** This course introduces the basic analytics for financial engineering and econometrics, topics include financial transactions and econometric data management, correlation, linear and multiple regressions for financial and economic predictions, financial time series analysis, portfolio theory and risk analysis. It will provide a foundation of basic theory and methodology as well as applied examples with techniques to analyzing large financial and econometric data. Hand-on experiments with *R* will be emphasized throughout the course.

**Prerequisites:** Graduate standing (Undergraduate engineering math: Calculus, probability theory, statistics, and some basic computer programming skills. Some background in stochastic process and differential equation would also be helpful.)

### **Textbooks:**

#### **Required:**

1. David Ruppert, “*Statistics and Data Analysis for Financial Engineering*,” Springer, 2<sup>nd</sup> edition, 2014.

#### **Recommended References:**

2. Chris Brooks, “*Introductory Econometrics for Finance*,” 3<sup>rd</sup> edition, Cambridge, 2014.
3. W. N. Venables, D. M. Smith, and the R Core Team, “*An Introduction to R*,” <http://cran.r-project.org/doc/manuals/R-intro.pdf>, CRAN, 2014.
4. Ruey Tsay, “*Introduction to Analysis of Financial Data with R*,” Wiley, 2013.
5. Rene Carmona, “*Statistical Analysis of Financial Data in R*,” Springer, 2014.
6. Argimiro Arratia, “*Computational Finance – An Introductory Course with R*,” Atlantis Press, 2014.
7. John. C. Hull, “*Options, Futures, and Other Derivatives*”; 9<sup>th</sup> edition, Prentice-Hall, 2014.
8. Jeffrey M. Wooldridge, “*Introductory Econometrics: A Modern Approach*,” South-Western College Pub, 2012.

9. Paolo Brandimarte, “*Numerical Methods in Finance and Economics*,” 2<sup>nd</sup> edition, Wiley, 2006.

**Optional Readings:**

1. Emanuel Derman, “*My Life as a Quant: Reflections on Physics and Finance*,” Wiley, 2004.
2. William Poundstone, “*Fortune’s Formula*,” Hill and Wang, 2006.
3. Burton G. Malkiel, “*A Random Walk Down Wall Street: The Time-Tested Strategy for Successful Investing*,” Norton, 2011.
4. Michael Lewis, “*Flash Boys*,” Norton, 2014.

**Assignments and Exams:**

There will be five hand-in assignments during the semester, an individual mini term project, as well as a mid-term exam and a final exam, both in-class. The exams will not be open book. However, you will be permitted a two-sided “cheat sheet” with notes and/or formulae.

**Grading:**

The assignments, mini project, mid-term, and final exams constitute 30%, 25%, 20% and 25% of the grades respectively.

**Schedule:**

- Unit #1: Introduction; review of elementary inferential statistics and  $R$  lab
- Unit #2: Basic financial transactions; returns and fixed income securities;
- Unit #3: Exploratory financial data analysis; transformation and kernel density
- Unit #4: Univariate distributions: heavy-tailed and mixture financial models
- Unit #5: Multivariate statistical models: covariance and correlation in financial data
- Unit #6: Linear regression: LSE, MLE, linear prediction in econometrics
- Unit #7: Mid-term exam
- Unit #8: Financial time series modeling: autocorrelation, ARMA, forecasting
- Unit #9: Multivariate models: multivariate time series in finance
- Unit #10: Portfolio theory: risky assets and efficient portfolio
- Unit #11: Capital asset pricing model: CAPM for portfolio analysis
- Unit #12: Factor models and principal components
- Unit #13: Risk management
- Unit #14: Course Review
- Unit #15: Term project presentation
- Unit #16: Final exam