Qualifying exam syllabus, 2019
Department of Statistical and Actuarial Sciences

Regression

References:

Montgomery, D. C., Peck, E. A., & Vining, G. G. (2012). Introduction to linear regression analysis, 5th Ed. John Wiley & Sons.

Abraham, B., & Ledolter, J. (2006). Introduction to regression modeling. Thomson Brooks/Cole.

Topics covered:

1. The simple linear regression model
2. The multiple linear regression model
3. Model adequacy checking
4. Transformations and weighting
5. Leverage, and influence diagnostics
6. Polynomial and nonparametric regression
7. Indicator variables
8. Variable selection and model building strategies
9. Multicollinearity

Statistical Inference

References:

Casella, G. and Berger, R.L, (2001, 2nd Ed) Statistical Inference. Brooks/Cole.

Larry Wasserman (Springer, 2004), All of Statistics: A Concise Course in Statistical Inference.

Larry Wasserman (Springer, 2006), All of Nonparametric Statistics.

Topics covered:

1. Properties of a random sample
   Probability, random variables,models, statistical inference and learning, inequalities, convergence of random variables, Slutskys theorem

2. Principles of data reduction
   Sufficiency Principle, Likelihood Principle, Equivariance Principle.

3. Causal inference
   Dependence and independence, causality, counterfactuals, conditional independence, directed and undirected graphs, graphical models

4. Point estimation
   Statistical functionals,parametric inference,Bayesian inference, nonparametric inference, construction of (regression, density, etc.) estimators

5. Hypothesis testing
   Confidence intervals, p-values, multiple hypotheses, Benjamini-Hochberg procedure

6. Interval estimation
   Size, coverage, confidence intervals, confidence bands, non-parametric curve estimation

7. Asymptotic evaluations
   Consistency, asymptotic distribution, efficiency, robustness

Probability

Reference:

Rice, J., Mathematical Statistics and Data Analysis Grimmett, G. And David Stirzaker, D. (2001 3rd Ed). Probability and Random Processes Oxford University Press.

Topics covered:

1. Events and their probabilities

2. Random variables and their distributions

3. Discrete random variables

4. Continuous random variables

5. Generating functions and their applications

6. Convergence of random variables

Financial modeling

References:

Campolieti, Giuseppe, and Roman N. Makarov (2016).Financial mathematics: a comprehensive treatment. CRC Press. Elements in Chapters: 2-7, 10-15, 17.

Complementary books:

Bjrk, Tomas (2009). Arbitrage Theory in Continuous Time. Oxford University Press, Oxford. Chapters: Elements in 2-17, 20-21, 26.

Hull, John C. Options Futures and Other Derivatives, 10th edition (any edition after 7th or so OK). Pearson 2018.

Related courses:

FM 9590A: Stochastic Processes with Applications in Finance and Actuarial Science
FM 9578A: The Mathematics of Financial Options
FM 9521b/4521b: Financial Modelling II

Topics covered:

1. Stochastic Calculus: stochastic processes, multidimensional Brownian motion, conditional expectation, martingales; Ito's processes and Ito's lemma; existence and uniqueness of solutions of Stochastic Differential Equations; Feynman-Kac formula; Girsanov theorem; Euler discrertisation; Monte Carlo simulation.

2. Basic Finance: Basic properties of and financial models for Equities, Forwards, Futures, F/X, Interest Rates, Bonds, and the Yield Curve.

3. Derivative Pricing. Discrete time and continuous time models for equities and interest rates; Equity and Interest rate derivatives, Binomial tree models for pricing; pricing and hedging in continuous time; the Black-Scholes PDE; Risk Neutral Pricing, Equivalent Martingale Measures; risk-neutral valuation and no-arbitrage pricing; self-financing portfolios; Delta Gamma Theta and their financial interpretation. implied volatility surface and volatility models; market risk and credit risk; mean-variance portfolio theory.

4. Simulation Methods. Basics of Monte Carlo methods ? simulation of simple random variables. Pricing of European options. Synthetic and Antithetic variance reduction. Confidence intervals.

Actuarial science

References:

Actuarial Mathematics for Life Contingent Risks, 2nd edition by Dickson, C.M.D., Hardy, M.R., and Waters, H.R. — Chapters 1-7, 11.1-11.4.

Loss Models: From Data to Decisions, 4th edition by Klugmann, S.A., Panjer, H.H., and Willmot, G.E., John Wiley and Sons, Inc. — Chapters 3-20.

Related courses:

AS 3424B: Loss Models I
AS 4824A: Loss Models II
AS 2427B: Life Contingencies I
AS 3429A: Life Contingencies II

Topics covered:

1. Common decrements and their application to insurances and annuities

2. Models used to model decrements used in insurances and annuities

3. Present values and accumulated values using non-stochastic interest rate models

4. Models used to model cash flows of traditional life insurances and annuities

5. Benefit reserves for traditional life insurances and annuities

6. Relationship between expenses and gross premium for traditional life insurance and annuities

7. Non-stochastic interest rate models used to calculate present values and accumulated values of cash flows and calculate present values and accumulated values of cash flows
8. Severity and frequency models
9. Aggregate models
10. Risk measures (VaR and TVaR)
11. Construction of empirical models
12. Construction and selection of parametric models
13. Credibility
14. Simulation