CHICAGO BOOTH
The University of Chicago Booth School of Business

Syllabus

(Last updated: March 27, 2015)

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Class Times:	Section 02: Wednesday	1:30 - 4:30 pm	Harper Center (C08)
	Section 03: Thursday	1:30 - 4:30 pm	Harper Center (C08)

Course Website: https://chalk.uchicago.edu/

Course Objectives

Perhaps more aptly titled "Optimization for the Management Student," this course is designed to teach students the basic optimization tools and analytic problem solving skills required for decision making in business (or any other aspect of your life). We will learn how to:

- *Structure a decision problem*: identifying the objective, decision alternatives (i.e., outputs), input parameters, and sources of uncertainty.

- *Build a mathematical model to formalize the decision problem*: We will learn about

    1. *Optimization models (linear, nonlinear)* - for resource allocation (how to utilize available resources optimally)
    2. *Decision tree models* - for multiperiod sequential decision making
    3. *Simulation models* - for risk analysis and incorporating uncertainty in problem parameters.

- *Analyze model solution*: Is the decision fairly robust, or very sensitive to the input parameters of the model? What is the managerial interpretation of the model solution?

- *Use Microsoft Excel as a platform for model building, solution, and analysis*: In addition to standard Excel tools such as Goal Seek and Data Table, we will learn to use important Excel add ons such as Sensitivity Toolkit, Solver, SolverTable, Precision Tree, @RISK, and RiskOptimizer. These tools can also be used in other Booth classes.

The lectures will be structured as a brief introduction to an optimization model (its strengths, weaknesses) followed by an interactive discussion of a few (3-5) chosen *toy problems* from areas including operations, marketing, finance, and strategy. We will develop the optimization models for these problems and implement them in Excel.

Review Sessions:	**Midterm:**	TBD
	Final:	TBD

Prerequisites

1. *Basic Statistics:* Any previous or concurrent exposure to statistics at the level of 41000 will be helpful. Basic statistical concepts such as random variables, probability distributions, variance, covariance will be used. We will briefly review the important concepts when necessary, but will not spend a lot of time trying to teach such concepts.

2. *Basic Finance/Accounting:* Although the example models discussed in this class cross many functions of business, very little prior background in those areas is sufficient. Basic financial concepts such as net present value, discounted cash flow analysis, stocks and options, and so on will often be used. We will briefly review the important concepts when necessary, but will not spend a lot of time trying to teach such concepts. Our emphasis would be on applying analytical modeling techniques to analyze the business problem on hand and demonstrate how such concepts can be used in our models.

3. *Basic Excel:* I will assume that students have some familiarity with Excel, but are not an Excel expert. For example, the following are expected:

    - knowing how to enter and copy simple formulas involving relative and absolute cell addresses (`A1` and `$A$1`)
    - how to use general-purpose Excel functions (for example, the `IF()` function)
    - how to draw different types of graphs (bar/line) in Excel

4. *Props:* This course involves in-class software demonstrations and "hands-on" practices. To get the most out of the lectures, and to minimize the number of hours spent outside lectures, students are expected to bring their laptop to class each week.

Assignment 0:

1. Excel refresher

    (a) Visit http://www.gcflearnfree.org/excel2010 and go through Lessons 1-11, 14, 17.
    (b) Next, visit http://www.gcflearnfree.org/excelformulas and go through Lessons 1-10.
       (Going through the other lessons on the website for self-edification is recommended but not required)
    (c) Finally, go through the following blog entries linked from http://www.gcflearnfree.org/excel2010/more-resources :
       Double-Check Your Excel Formulas, *How to Use Excel's VLOOKUP Function*, *Use SUMPRODUCT to Calculate Weighted Averages*

2. Review from Powell and Baker: Appendix 1 (4th Ed.)
   (For 3rd Ed. : Chapter 3, Chapter 4 (Sections 4.1-4.6))

Required Course Material

- **Textbook:**
  Title: Management Science: The Art of Modeling with Spreadsheets
  Authors: Stephen G. Powell, Kenneth R. Baker

Edition: 4th Edition
ISBN: 978-1-118-58269-5
Publisher: John Wiley and Sons Inc.
(Note: For our purposes, Edition 3 (ISBN: 978-0-470-39376-5) is sufficient. The major change in Edition 4 is a slightly expanded treatment of data mining algorithms for classification and prediction. These will not be a major focus in the course.)

- **Course Packet**
  Through Chalk

- **Software**

  1. Microsoft Excel 2010/2013 (Excel 2007 is also acceptable) - read the note below
  2. Excel Solver (included with Excel)
  3. Some freely available Excel add-ins (e.g., Sensitivity Toolkit, SolverTable) - announced as needed
  4. DecisionTools Suite Industrial 6 by Palisade Corporation (includes Precision Tree, @RISK, and RiskOptimizer)
     Note: Booth has purchased student licenses for 36106. Download the installer and the license file from Chalk under "Palisade Installer/License." This software may prove useful in other Booth courses.
     Note: We will not use the Risk Solver platform associated with the Powell and Baker textbook.

Important: Since the DecisionTools Suite is not compatible with Mac version of Excel, you must be Windows compatible. If you own a Mac, you can get Excel 2010 running under a Windows emulator, e.g. Parallels Desktop or VirtualBox. Excel 2010 and 2007 are significantly different from previous versions of Excel, and therefore I must require all students to use Excel 2010 or newer (less preferably, 2007) on their laptops. The primary difference between 2010 and 2007 for the purposes of this course is the Solver interface.

Supplemental Texts/Readings

- *Microsoft Office Excel 2010: Data Analysis and Business Modeling.* **OR** *Microsoft Office Excel 2013: Data Analysis and Business Modeling.*
  Wayne L. Winston. Microsoft Press.
  An excellent reference for learning relevant Excel 2010/2013 functions and contains numerous examples on using Excel for modeling business decision problems.

- *Practical Management Science (4th Edition).* Wayne L. Winston, S. Christian Albright. South-Western.
  A nice collection of decision modeling problems from different areas in business. This book uses the DecisionTools Suite as the platform. A **free** academic version of DecisionTools Suite is also available with new copies of the fourth edition.

- *Competing on Analytics: The New Science of Winning.* Thomas H. Davenport, Jeanne G. Harris. Harvard Business School Press.

- *The Flaw of Averages: Why we underestimate risk in the face of uncertainty*. Sam L. Savage. Wiley.

Grades

- Based on exams, 8 weekly assignments (2 individual, 6 group assignments), which include spreadsheet model building and case analyses, and class participation:

Homework	40%
Midterm (Week 6, in-class)	20%
Final (Week 11, take home)	30%
Class participation	10%

- Midterm is in-class, open book/open notes. Computer will be needed.

- Final is take home, open book/open notes. Computer will be needed.

- **This class can not be taken pass/fail or audited.**

- If you expect a **provisional grade** for graduation before the quarter ends, you MUST take the midterm, submit the first 4 assignments and commit in writing (or email) to submitting a completed final exam.

- The midterm is optional. That is, the 20% of the course grade allocated to the midterm exam will be determined as the better of midterm and final exam grades.

- Final exam will be comprehensive, and include material from week 1 through 5 as well.

- All grade disputes must be submitted in writing (or email) within two weeks of an assignment/exam being returned. You must indicate which questions you feel were graded incorrectly and clearly explain why you feel your answer is correct. Your entire assigment/exam may be regraded, possibly lowering your grade, if I find something that was misgraded.

Homework Assigments

- Homework assigments will be posted on the Chalk website one week before the due date.

- A hard copy of the homework is **due at the start** of the lecture on the homework due date.

- An electronic copy of the homework must be submitted to the Chalk site by the time indicated on the assigment.

- **No late homework will be accepted**. If you can not attend the lecture for some reason, you can scan/email or submit the homework in person to me prior to the lecture.

- On all group assigments, you may work in groups of size 3 or 4. You may form a group across sections. However, assignments must be turned in before the full-time session (Section 02/03), if any group member is in the respective section. You need to submit only a single piece of work. The first assignment will be individual to give you time to form groups.

- You **may not** discuss the homework assignment with anyone not in your group. You cannot share or transmit written or electronic answers or analysis to any other student who is not a member of your group.

Other Issues

- Students are required to adhere to the standards of conduct in the Booth *Honor Code* and the Booth Standards of Scholarship. The Booth *Honor Code* also requires students to sign the following Booth Honor Code pledge, "I pledge my honor that I have not violated the *Honor Code* during this examination," on every examination and homework.

- You must attend the section for which you are registered. If an important conflict arises such as a job interview, I will make an exception, but you must notify me ahead of time.

- Class Participation: Please use your name card during every class. You are expected to complete the reading assignments, come prepared, and contribute to class discussions.

- Absolutely no cell/smartphone use, or social networking during lectures! I will cold call if I sense you are distracted.

- While beverages are ok, I prefer that you do not eat during lectures. If you must, please be considerate of classroom environment and opt for something discreet.

TENTATIVE SCHEDULE - Subject to change

Week 1 (April 1,2) : Administrivia. Course overview. Introduction to Spreadsheet Modeling. Introduction to Linear Optimization Models.
Topics:

- **Assignment 0 (nothing to submit):** Go over Excel tutorial
- Spreadsheet engineering
- Net Present Value (NPV) analysis
- Breakeven analysis: *Goal Seek, Data Table, Scenario Manager*
- Optimal resource allocation
- Excel add-in: *Sensitivity Toolkit (Tornado Charts)*, Solver, *SolverTable*

Readings:

- Powell and Baker

    - Appendix 1 – Excel overview (Ed. 3: Chapters 3, 4 (Sections 4.1-4,.6))
    - Sections 1.1-1.3 (Eds 3 and 4)
    - Sections 2.1-2.2 (Eds 3 and 4)
    - Sections 4.3.2, 4.3.4, 4.4-4.6 (Ed. 3: Sections 6.3.2, 6.3.4, 6.4-6.6)
    - Sections 9.1-9.2 (Ed. 3: Sections 11.1-11.2)

- "Competing on analytics" by T.H. Davenport, Harvard Business Review 2006.

Week 2 (April 8,9) : Linear Optimization Models. Sensitivity Analysis.
Topics:

- Optimal resource allocation
- Blending in Oil and Gas
- Capital Rationing
- Investment portfolio planning
- Cash Flow Matching
- Finding arbitrage opportunities
- Homework: Production planning

Readings:

- Sections 9.3-9.6, 9.8 (Ed. 3: Sections 11.3-11.6, 11.8)

Week 3 (April 15,16) : Network Optimization Models.
Topics:

- Optimizing Shipping Decisions
- Optimal assignment/matching
- Cash Flow Matching
- Homework: Airline revenue management

Readings:

- Chapter 10 (Ed. 3: Chapter 12)

Week 4 (April 22,23) : Integer Programming Models.
Topics:

- Employee Staffing
- Capital budgeting, project selection
- Facility location
- Homework: Bundle pricing models (combinatorial auctions), optimizing production network

Readings:

- Chapter 11 (Ed. 3: Chapter 13)

Week 5 (April 29,30) : Integer Models (contd.). Nonlinear Models.
Topics:

- Awarding contracts

- Inventory management: Economic Order Quantity (EOQ) model
- Location models
- Rating sports teams
- Portfolio optimization
- Project selection
- Homework: Predicting house prices, CAFÉ compliance in the auto industry

Readings:

- Chapter 8 (Ed. 3: Chapter 10)

Week 6 (May 6,7) : MIDTERM

Week 7 (May 13,14) : Sequential Decision Making under Uncertainty.
Topics:

- Install Excel add-in: DecisionTools Suite by Palisade Corporation
- Payoff tables, decision criteria
- Decision tree models
- Expected value of information
- Bayes' rule for computing conditional probabilities
- Excel add-in: *PrecisionTree (DecisionTools Suite)*

Readings:

- Sections 13.1-13.6 (Ed. 3: Sections 15.1-15.6)
- "Decision Analysis" by George Wu (See CoursePack)

Week 8 (May 20,21) : Monte Carlo Simulation.
Topics:

- Introduction to Monte Carlo simulation
- Review of basic probability and statistics: random variables, probability distributions, expected value, variance, confidence intervals
- New product introduction
- Airline overbooking
- Setting reserve price for auctions
- Excel add-in: *@RISK (DecisionTools Suite)*

Readings:

- Chapter 14 (Ed. 3: Chapter 16)

Week 9 (May 27,28) : More Monte Carlo Simulation.
Topics:

- Optimal stopping

- Corporate valuation

- Option pricing

Week 10 (June 3,4) : Monte Carlo Simulation with Optimization.
Topics:

- Inventory planning: A newsvendor model

- Hedging commodity price risk

- Portfolio optimization via simulation

- Excel add-in: *RiskOptimizer (DecisionTools Suite)*

Readings:

- Chapter 15 (Ed. 3: Chapter 17)

Week 11 : TAKE HOME FINAL

Now in its fifth edition, Powell and BakersBusiness Analytics: The Art of Modeling with Spreadsheetsprovides students and business analysts with the technical knowledge and skill needed to develop real expertise in business modeling. In this book, the authors cover spreadsheet engineering, management science, and the modeling craft. The briefness accessibility of this title offers opportunities to integrate other materials such as cases -into the course. In this book, the authors cover spreadsheet engineering, management science, and the modeling craft. The briefness & accessibility of this title offers opportunities to integrate other materials â€"such as cases -into the course. It can be used in any number of courses or departments where modeling is a key skill. Related Resources. Spreadsheet Modeling and Decision Analysis : A Practical Introduction to Business Analytics. Cliff Ragsdale. Paperback. The book does talk somewhat about the theory of Management Science and decision modeling, but relies much too heavily on a $1000 Excel add-on to do the work. Much of the basic things can be done in Excel's built in Solver add-on, but the more sophisticated optimization, distribution and sensitivity analysis requires the more expensive add-on.