SYLLABUS

Overview
Students are introduced to deterministic and stochastic decision tools used by leading corporations and applied researchers, and apply these software packages to complex, real-world problems in engineering and finance. For each problem type covered, students learn appropriate analysis methodologies (frameworks), explore model limitations and identify sources of modeling error.

Building on a basic theoretical understanding of optimization, simulation and game theory obtained in prerequisite classes, students master commercial decision modeling programs such as *Premium Solver Professional* (linear, integer and non-linear optimization), *TreePlan* (decision-trees), *Crystal Ball* (simulation), and *OptQuest* (optimization under uncertainty). These software packages are briefly compared and contrasted to the *Matlab* programming environment. (Use of *Matlab* for course assignments is optional).

After students have mastered the course software, its limitations and the frameworks for applying it, they tackle complex case-studies of current interest to practicing engineers and applied researchers. Students also work in small teams to address (as a mid-term project) one large-scale deterministic problem and (as an end-of-semester project) one similarly-complex stochastic problem. Groups choose a deterministic project from these (example) possibilities: scheduling and plane allocation for airlines; capital budgeting; construction project scheduling; cash flow matching for defined-benefit retirement plans or municipal bond issuers; currency arbitrage; route/warehouse optimization for truckers. Example stochastic projects include: determining an ‘optimal’ currency hedge with futures contracts; portfolio “insuring” with options; determining a product development/launch path; valuing real options; financial planning; project scheduling under uncertainty; supply chain design; cash flow matching; and company valuation.

While addressing their first projects, students learn effective presentation and project reporting skills, suitable for communicating with CFOs and CEOs. Students present their project analyses to a small panel of industry experts and executives.

Prerequisites
All of the following, or instructor’s permission:
E2261: Intro to Accounting and Finance.
E3600: Introduction to Probability and Statistics.
E3608: Introduction to Mathematical Programming.

Deliverables:
- Homework assignments (individual):
  – homework assigned most weeks except during exams and project presentations.
- Project presentations and reports (completed in groups of three of four):
  – two projects.
• Final exam (individual, laptop required).

**Grades:**
- Homework: 25%
- Projects: 50% (25% per project)
- Final exam: 20%
- Class participation: 5%

**Texts and Readings**

**Required Text:**
(Fully printable eBook).

**Recommended Texts:**

**Recommended Readings (Posted on Courseworks):**
“Optimization of Production Planning at Jan de Wit Flowers.”
“Advertising Sales Optimization at NBC.”
“Optimization of a Power Generation Network.”
“Introduction to Simulation and Crystal Ball.”
“Delphi Estimating.”
“Identifying, Measuring and Hedging Currency Risk at Textron.”
“Portfolio Optimization Using Linear Programming.”
“Bush Plan shows US is not ready for deadly flu.”
“Tainted Chiron vaccine is unsalvageable, FDA says.”
“A Futures Market in Flu Vaccine.”

**Required Hardware and Software**
Laptop computer running Windows XP or Vista, and Excel 2007 or 2010.
Software (available for student-discount purchase at websites TBA):
- *TreePlan*, Decision Toolworks, Inc.
- *Crystal Ball*, Oracle Corporation.
- *OptQuest*, Oracle Corporation.
- *Matlab*, (recommended), Mathworks, Inc.
Students are strongly encouraged to bring their laptops to class.

**Topic Outline**

1. Recent History of Decision Modeling Applications
   - Examples illustrating extraordinary gains in productivity, profitability and risk mitigation achieved with decision modeling. Discussion of recent failures of some financial models.

   - Introduction to the use, capabilities and limitations of *Premium Solver Professional*. Comparison to *Matlab*. 
     - Multi-objective linear programs.
     - Multi period linear programs.
     - Mixed integer programs.
     - Non linear programs.
   - Large scale, commercial case studies:
     - Maximizing operating profit at Jan de Wit Flowers
     - Maximizing revenue through narrowcast advertising
     - Designing an optimal warehouse/ground-delivery network for an e-commerce company.

3. Optimization project.
   - Effective project reporting and presentation to CFOs and CEOs.
   - In class “crits” (critiques) of developing projects.
   - Student presentations to instructor and small panel of industry experts and executives.

4. Analysis frameworks for decision modeling under uncertainty.

5. Decision tree tools and applications
   - Evaluating real options using decision trees.
   - Introduction to the use, capabilities and limitations of *TreePlan*.

6. Simulation tools and applications
   - Introduction to the use, capabilities and limitations of *Crystal Ball*. 
     - Comparison to *Matlab*.
   - Real-world case studies:
     - Valuing Google.
     - Evaluating the probability that Rite Aide will breach a debt covenant.

8. Introduction to the use, capabilities and limitations of *OptQuest*. Comparison to *Matlab*.

9. Modeling under uncertainty project
   - In class “crits” of developing projects.
   - Student presentations to instructor and small panel of industry experts and executives.

10. Class review and preparation for final exam.