The goal of this course is to provide the student with the methods and analytical tools to formulate and solve managerial decision making problems. A sophisticated analyst must cultivate (1) the ability to translate a verbal or graphical description of a real-world business problem into a precise quantitative formulation, (2) the ability to analyze data in order to develop a better understanding of the problem and to generate actionable insights, and (3) the ability to clearly convey the justification and practicality of the final solution to others, often in the form of visual evidence. In addition, (4) the ability to develop tools that can be repeatedly used by the analyst or their co-workers and clients allows the tasks to be completed rapidly, while reducing the likelihood of errors.

This course is designed to equip students with competencies in each of the above skill sets – the intended product being an individual capable of developing analytically rigorous decision support tools, which can be easily handed off for robust application by a range of intended users in a range of managerial environments.

Excel Spreadsheet will be the platform on which we build models, solve, and analyze the various problems. The primary structure of the course is as follows:

- Translate a verbal or graphical description of a business problem into an optimization or simulation model
- Set up the optimization or simulation model in Excel and generate a solution
- Interpret the results and perform sensitivity analyses to examine the feasibility of the solution
- Analyze data to aid in decision making, and to present the data visually
- Develop decision support systems (DSS) to help facilitate decision making

**Required Course Material**


Additional materials will be made available (usually handed out in class).
Grading Policy and Class Design

The course grade will be determined as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Project</td>
<td>35%</td>
</tr>
<tr>
<td>In-class Participation/Citizenship</td>
<td>20%</td>
</tr>
<tr>
<td>Assignments</td>
<td>20%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>25%</td>
</tr>
</tbody>
</table>

Course Technology

We will be doing most of our work on the Microsoft Excel environment. This design is based on at least three motivating forces: 1) Unlike other possible platforms Excel has become a commodity among business firms and students are more likely to find it available for use in the workplace than any other foundation for DSS development, 2) Excel has a number of simple yet effective built-in functions (e.g. Solver, interactive graphics, macros, etc.) which make it a flexible and robust platform for DSS development, and 3) The extensive capability for integration built in across Microsoft products provide the potential for wide-spread ubiquitous Excel based decision tools in the workplace (i.e. it can be catered to assist co-workers who use packages like Word or PowerPoint regularly but don’t know the first thing about Excel).

Students enrolled in this course (as well as other ISOM electives) are provided free-access to a host of Microsoft products through the school’s participation in the Microsoft Academic Alliance Program (http://www.bus.emory.edu/software/msdn.html). These products include packages that aren’t otherwise available at GBS terminals, such as MapPoint, Project Professional, Access and Visio Professional. Students are encouraged to make use of any of the additional packages as they apply to course projects in this or other class settings.

In particular we will be making use of Excel2010/Excel2013 in class demonstrations (and in the text readings); however Excel2003 and all later versions are also compatible for use with the course. We will also be making use of will be RiskOptimizer. GBS has made arrangements to have these packages available in the 4th floor student lab. However student versions of the Palisades Suite (e.g. RiskOptimizer) are available at discounts – http://www.palisade.com/academic/students.asp

We will also make use of screen capturing technology for the development of project videos (part of the project requirements). Camtasia is available on specific computers in the 4th floor lab; however there may be alternate available packages for free download:

eg. Jing: http://www.techsmith.com/jing.html?gclid=CI2wxACGhrQCFQixnQodDQkABw
Tipcam: http://download.cnet.com/TipCam/3000-13633_4-10796452.html

Details of Course Grading

Homework

There will be up to 3 homework assignments (due by 5pm on the due date; 5% penalties are automatically incurred for submissions missing that deadline + 1.5% additional penalties per hour late). So please manage your time, and start these as soon as they are distributed. These assignments will come in multiple parts and cover several days’ worth of material. Although I am comfortable with peer-to-peer discussion of the questions, students should NOT share advice on approaches to
solution. I expect final work to be independent. I don’t want to see work that looks suspiciously like someone else’s, and I certainly don’t want to see work simply copied from one student and dressed-up differently in another student’s submission; such submissions will be deemed violations of the Honor Code.

*On occasion, when I feel students have had sufficient in-class time to complete work, I will request submissions (e.g. via e-mail) of work developed in class [such requests will be made very infrequently but will not be announced prior to the in-class work period]. This can help ensure checks on the originality of work and serious participation during these in-class periods.*

**Intermediate and End-of-term Quizzes**

We will have 3 intermediate semester quizzes (about 20 minutes each) and a final quiz (30 minutes). The 3 intermediate quizzes will serve as a check to student preparation for class and absorption of prior material (i.e. having done readings, followed along on in-class examples, etc.). The final quiz is designed to check on whether students can identify what tools and techniques in general (from among those taught) may be most appropriate for specific managerial decision support tasks. Quiz dates are found on the course schedule attached. All students must take all 3 intermediate quizzes as well as the final quiz. Make-ups are rarely granted, with rationale filed and supported by the program office.

**Group Projects**

Each student will be required to contribute to one group project spanning the duration of the semester. **In contrast to homeworks and quizzes, students are expected to collaborate; ideally groups of 3-4 students per group project.**

These group projects can either focus on providing guidance in terms of **(Route-1)** specific solutions (e.g. as possible through optimization, simulation, etc.) or **(Route-2)** enhanced data navigation and visualization (e.g. as possible through sophisticated used of dynamic tables, graphics, live feeds, etc.). Students will also have the choice of focusing on the development of either **(Format-A)** a traditional workbook-based dashboard (w/ embedded tables and graphs), or **(Format-B)** a workbook-independent Excel add-in (see *Expectations on User Interface Development* for examples of each). Group projects that are able to professionally display a combination of these features may of course be the most impressive, but at the same time will likely require more effort (and room for greater error). Ultimately “planned scope” by itself should not be automatically equated with, or lead to an expectation of a “higher score”.

Regardless of focus, all groups must demonstrate the role of ‘variability’ in their support system. For projects with a focus on **Route-1**, this might mean incorporating variance/uncertainty in either an optimization search mechanism, a post-analysis robustness comparison or in terms of general descriptive statistics both with numbers and graphics. The latter could also be used in projects focusing on **Route-2**, as can a demonstration of robust fool-proofing against tool misuse, and built-in customizability of data depicted and graphics displayed.

**Project grades are broken into four key deliverables:**

(a) Project Outline, (b) Working Application, (c) In-class Presentation, (d) YouTube Videos
Project Outlines

Decisions on the specific format of the project (workbook or add-in) won’t likely be possible until students gain sufficient exposure to course material. However, I want groups to think about the general theme of their projects early on. As such, all groups will first develop a project outline. To get groups started, it will be useful for students to select a specific management problem “class” for study (e.g. human resource management, facility location/supply network modification, order/customer scheduling, strategic/tactical opportunity/threat identification, performance and performance-trajectory monitoring etc. – whatever students find appealing). In selecting a project, I encourage students to leverage work experiences and/or Emory club experience, where available. I also encourage students to build on GBS course work and other class projects they have been involved with.

For that “class” of problems, your group will be expected to provide a document with the following elements:

1) OVERVIEW: Briefly describe your intended tool (a few sentences), including your intended focus on either Route-1 or -2, and intended Format-A or -B. Make sure to pinpoint what you see as the primary difficulty(ies) associated with developing decisions for this ‘class’ of problem, and hence the value of the proposed tool.

2) INTENDED USE: Provide a “story” of how you envision you tool being used (paragraph).

3) KEY FACTORS & DEPENDENCIES: Provide a conceptual sketch of the various relationships assumed between the intended key outputs of your tool, and the factors that might be subject to change by users (or solution search engines).

4) LIMITATIONS: Provide some thoughts on what limitations exist with regards to the extent to which these factors can be reasonably modified by users (or as part of searches).

To further demonstrate that your group understands the issues you’ll be facing in development, provide at least one of the following items:

5a) DRAFT OF ANALYTICS: A concrete ‘model’ for optimizing some key decision, or summarizing data, in their context (outlining any applicable mathematical notation is strongly encouraged here).

5b) DRAFT OF VISUALIZATION: A concrete outline for how you intend to better organize/visualize data/results (a computer-drawn sketch of a draft interface is encouraged here).

The outline should be no more than 6 pages single-spaced in length (no less than 2 pages), not counting any data or diagram appendices deemed relevant. It should include a tentative TITLE for their proposed application (3 words max). The format of the outline should be 5 sections outlined descriptions of each of the elements (1-6) listed above.

This outline will be due on March 5th

*** Projects that are OFF LIMITS *** (i.e. DON’T do these):

1) Projects that involve any of the following genres: Dietary/meal planning, Sports team or Fantasy league management, Personal finance management, personal trip or event/dining planning, College search.
2) The development of one-shot consulting solutions – These are intended to be ‘repeated use’ tools, not one-point-in-time solutions to an existing problem. Make sure your design is for multiple practical uses.

3) The development of nothing more than a forecast – Forecasts can help form the basis of decision support but I do not want forecasting to be the main part of the deliverable (take a forecasting class).

**Working Applications**

The primary project deliverable (the decision support tool submitted on a CD (or via email IF < 5 MB) - please make sure it runs as expected off of another computer!) will be due near the end of the semester (April 14th). The evaluation criteria listed on the next page should be taken into consideration when designing and developing your tool. In terms of general content and functionality, the tools must make use of at least two data manipulations (e.g. optimization, simulation, query, data cleaning, drill down, etc.). Data used in analysis should be appropriate to the context – some significant portion must have been acquired either through available archives/databases, on-line sources, surveys or real-time observations of activities conducted by the group. The tool should also demonstrate a robustness to use such that variants of the problem dealt with could also be specified by other users for subsequent comparative analysis. Outputs (e.g. descriptive summaries, notable constraints to decision making and prescriptions for policy) should be clearly depicted – implied is the leveraging of visualization technique covered in the course.

With your submission, please feel free to include soft-copies of any additional documentation you feel would be helpful in clarifying your application’s use. The quantity and form of such paperwork is up to your own discretion. If you don’t feel any documentation is needed aside from what is embedded in your system, i.e. that your tool is sufficiently straightforward for a user, that’s great – ultimately it’s your call.

**In-Class Presentation**

Teams will present their applications in-class during one of the two last weeks of the course. Once feedback on project outlines have been returned to students, I’ll post a sign-up so that teams can specify their preferred final presentation dates. Since these presentations will involve both a justification of the work and a demonstration of functionality (15 minutes), as well as a Q&A period to follow (5-8 minutes), we will limit the number of presentations per each class session to three. You should plan ahead for preferred presentation dates.

**Video Walkthroughs and Pitches**

Teams will also be expected to create 2 YouTube videos. The 1st will be a walk-through of their tool. This should predominantly be a screen capture presentation of how their application is intended to be used (between 4 and 8 minutes in length). These should not replicate your entire presentation; they are designed to only showcase the application, not describe the context for which it was designed, and not describe limitations/future prospects). The 2nd video should be an elevator pitch for the application (20-40 seconds). It should quickly introduce the application, state its purpose and functionality.

**In the 4th floor lab, Camtasia software is available on select computers.** Possible alternatives:

Jing: [http://www.techsmith.com/jing.html?gclid=CI2wxaCGhrQCFQixnQodDQkABw](http://www.techsmith.com/jing.html?gclid=CI2wxaCGhrQCFQixnQodDQkABw)
Tipcam: [http://download.cnet.com/TipCam/3000-13633_4-10796452.html](http://download.cnet.com/TipCam/3000-13633_4-10796452.html)

Such software allows for continuous screen capture capabilities with voice-over recording, as well as editing to create video files that can be posted to YouTube for my viewing (if you wish to share with others, that’s your option). These videos serve several purposes: 1) Creating them gives you practice for your in-class presentations; 2) They serve as back-up presentations to me (and others perhaps) in case of technical difficulties during your “live” presentations; 3) They can be used as a virtual component of your personal vitae.

**YouTube links** should be e-mailed to me *NO LATER than 5pm on the Friday of the first in-class presentation week.*

**How your group’s working application and presentation will be evaluated:**

Both your final tool and presentation will be evaluated by the following criteria, which you should use as a check-list when developing your tool and presentation:

**Problem Characteristics**

- Is the problem a difficult one to deal with in the absence of a computerized tool?
- Is the problem realistically depicted (w.r.t. what is specified in the functionality of the tool)?

**Output Characteristics**

- Can the outputs provided be generally viewed as applicable in practice?
- Are the outputs provided likely to encourage repeated subsequent use by the target user(s)?
- Is any uncertainty/variability regarding the data/assumptions taken into account by the tool?
- Is any error/robustness/sensitivity associated with potential outputs described?

**System Components**

- Are at least 2 separate graphical displays (e.g. charts and graphs) of data used? (*Note: Pivot tables don’t count here, though graphs based on their summary contents do count*)
- Are at least 2 types of data manipulations used (e.g. Solver, query, data clean, data redux via pivot-table filters, simulation comparisons, other optimization methods, etc.)?
- Is there a direct (and clear) way for users to change specifics/parameters/constants assumed in the problem’s depiction?
- Are at least 2 types of controls/forms present to assist users in the main interface (e.g. pull-downs, click boxes, etc.)?

**Organization Issues**

- Is there a clear presentation of recommendations or data summaries made by the system?
- Does the use of any controls, pop-ups and dialogue windows appear intuitive from a user’s perspective?
- Is there a clear effort to make use of cell labels, object labels, graph axis titles, activation buttons and controls, macro and VB variable labels (if such are obviously used)?

**Group Knowledge**

- Understanding of the Problem targeted
- Understanding of the Outputs generated
- Understanding of the System “components” (e.g. how the components work together)
- Understanding of the Limitations of the system

**Expectations on interface development:**

The interface should be user-friendly and to that extent will require some conscious effort on the part of the group to ensure that controls and results are easy to locate and view in a logical and easily interpretable manner. *On the following pages* are some screen shots of past projects that were able to provide both the level of rigor in back-end data-management, calculations and automation while still providing what would be expected of a professional front-end interface.

**Route-1 Examples: Workbook-based Applications** *(others at [http://experimental-instruments.com/Gallery.htm](http://experimental-instruments.com/Gallery.htm))*

- Patient Support (Walkthrough)
- Channel Management Support (walkthrough)
- Career Search Support (walkthrough)
- Production Planning Support (pitch)
- Facility Location Support (walkthrough)
- Exercise Routine Support (pitch)

**Route-2 Examples: Workbook-independent Add-ins** *(others at [https://sites.google.com/site/exceladdinsdirectory/home/main-directory](https://sites.google.com/site/exceladdinsdirectory/home/main-directory))
Participation & Citizenship

The course is designed to incorporate significant portions of in-class lab-time during which students will be able to work on examples and later on their own projects. While attendance in class is voluntary, participation in lab exercises is expected (a unique issue to lab courses). Furthermore there are benefits to what I refer to as "positive" versus "negative" participation even during non-lab discussions/lectures. Positive participation involves consistently providing insightful contributions to classroom discussion, enthusiasm in class learning activities and a willingness to take responsibility and add-value to student-group projects. This is assessed at the end of the semester based on my classroom observations as well as peer (e.g. project group member and audience) evaluations. Highly positive participation can push students above the boundary of two grades. Similarly, negative participation can have the opposite effect.

Negative participation involves things like talking about non-class issues during class discussion, doing homework in class, not participating in activities, not contributing to group project work, consistently arriving late or leaving early (without informing me ahead of time), etc. Consistent negative participation (again measured by my own observations and reports of your peers) can bring a student's grade down.

To that end, all students are required to sign the class’s Ethics Contract (provided by blackboard) and submit a signed copy to me by the end of the first week of class. Without a signed contract I will not be able to assign any points to assignments (i.e. scores on quizzes and homeworks will be “0”). Signing of the ethics contract is also part of the total participation grade in this course.

Q: Why is this so important?

A: This is not a class of "I" - What you do effects the learning environment of those around you. I want to give everyone the best opportunity to take lessons away from the time they spend in class, and anything that detracts from those opportunities needs to be discouraged. Having said that, again, you will not be penalized for not attending class. If you feel that on certain days you have other priorities or will have a hard time avoiding negative participation of some kind... just don't come in (That's ok). But if you do come to class, come prepared to listen and work.
A final note on in-class demos with Excel: In class I’ll often ask students to open up files I’ve made available (either on-line access from the Cambridge site or the course Blackboard site). **BEFORE opening a new file, unless instructed otherwise, PLEASE close down the Excel application first (if already open).** The entire application, not just a given workbook. In class we will alternate between different Excel settings, some of which will not work well with certain examples. Closing down Excel prior to opening new examples will help avoid functionality errors.

**Course Content in Depth:**

The course is a mix of decision analysis / management science and information systems content. We will be interweaving a host of topics from these fields as we pursue the course objectives.

From a decision analysis perspective we will cover various approaches to framing complex management problems, conducting analysis and deriving multi-faceted recommendations for decision makers. The approaches can be roughly divided into three categories:

[1] **Statistical Data Analysis**

Developing effective solutions to management problems often starts with uncovering insights gleaned through data analysis. For example, a simple Pareto analysis might reveal that critical resources are being consumed by non-lucrative activities. Similarly, a regression analysis might reveal that a specific customer segment is more likely to respond to marketing campaigns. Likewise, a pivot table based on retail sales data from a set of geographically distributed stores might allow the analyst to have a better understanding of the distribution of sales volume by geography.

[2] **Math-Programming and Optimization**

Given the existence and complex interplay of constraints to decision making, realistic policy prescriptions derived from automated support systems must incorporate any limitations or requirements. This begins with spelling out specific requirements for decision making and translating them into mathematical forms that can be used in analysis. Once such limitations are specified, along with the critical decisions that need to be made towards an objective, various tools can be applied to automate a search for intelligent solutions. We will discuss the processes by which to structure such decision making methods as well as interpret areas for potential outside-the-box approaches to improving them.

[3] **Scenario and System Simulation**

The ability to model uncertainty in managerial problem solving is a crucial skillset. We will cover Monte Carlo-type scenario analysis, and also learn to construct and apply "system simulations" wherein the evolution of a simulated business scenario requires multiple iterations to provide managers with an understanding of the underlying risk. Some of the examples discussed involved simulations of inventory decisions as well as overbooking policies in revenue management contexts. Various approaches to developing, conducting and considering the results of iterative system simulations are discussed.

From an information systems perspective, it informs on various approaches to acquiring, managing and visualizing data.
[1] Data Cleaning and Organization

Discussion relative to a variety of data sets/sources encountered in raw forms from legacy archives or on-line. Tactics for handling and obtaining data sets, consolidation and grouping/clustering as well as other generalized weighted aggregation approaches.

[2] Graphic vs. Tabular Visualization

An appreciation of the utility of graphical visualization, as well as approaches to effectively develop visualizations of data that showcase relationships, managerial options and limitations (constraints) more effectively than that purely tabular formats.

[3] Interface Design and Development

Input and output interface structuring to assist in facilitating decision making processes. Object oriented approaches to interface development. Translating functional and decision policy logic into user-friendly system capabilities. Caveats to overly complex interface development and the art of dash-boarding.

DISCLAIMERS:

1) This is not a Finance class. So don’t expect us to spend much time with specific financial models (that’s the job of other courses). However, if you do have specific interests in better automating and leveraging those models for practical purposes (e.g. for work), I’m in complete support of that and will welcome projects developed to that end or any questions regarding tactics for doing so.

2) If you already have extensive Excel or VB development experience, this class might not be right for you. I’ll be spending a bit of time ramping people up to a skill base at which development can take place. Please consult with me personally if you feel you have considerable experience and are unsure whether to participate in the elective.

3) If you are not willing to dive a little into computer programming (which we will do lightly with Macros at the very end of the semester), this course might not be for you. I want to emphasize that NO past programming experience is expected, and that those students who have learned the few key tricks we’ll cover in class on Macros have truly appreciated the power these have given them. Please consult with me personally if you feel uncomfortable with the idea of learning a little about these very powerful tactics.
<table>
<thead>
<tr>
<th>Session</th>
<th>Date</th>
<th>Topics and Readings</th>
<th>Handed out / Due</th>
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<tr>
<td>1</td>
<td>Tue, 01/13</td>
<td><strong>Course Introduction.</strong> Introduction to Spreadsheet Engineering. “What-if” Analyses: <em>Advertising Budget Problem</em> Excel Functionality for course Ch. 2</td>
<td></td>
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<tr>
<td>2</td>
<td>Thurs, 01/15</td>
<td><strong>Navigating the Excel Environment</strong> Key functions Working with Data Formatting / Displaying Data Ch. 2, Ch. 3</td>
<td></td>
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<tr>
<td>3</td>
<td>Tue, 01/20</td>
<td><strong>Exploratory Data Analysis I</strong> Cover tools used in analyzing and describing data <em>Pivot Tables, Pivot Charts, Regressions</em> Ch. 4</td>
<td></td>
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<tr>
<td>4</td>
<td>Thurs, 01/22</td>
<td><strong>Exploratory Data Analysis II</strong> Cover tools used in analyzing and describing data <em>More Regressions, Categorical Data Analysis</em> Ch. 4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Tue, 01/27</td>
<td><strong>Linear Programming</strong> Introduction to Linear Optimization Introduction to Solver <strong>Allocation Models</strong>: <em>Cost accounting / Product Mix</em> Ch. 6</td>
<td>HW # 1 due at start of class</td>
</tr>
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<td>6</td>
<td>Thurs, 01/29</td>
<td><strong>Covering Models:</strong> <em>The diet problem Workforce Scheduling</em> Ch. 6</td>
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<td>7</td>
<td>Tue, 02/3</td>
<td><strong>Sensitivity Analysis:</strong> <em>Product Mix, Bond Selection, Green Grass</em> Sensitivity Analysis, How Solver Works, Solver Tables Ch. 7</td>
<td>Quiz 1</td>
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<td>8</td>
<td>Thurs, 02/5</td>
<td><strong>Network Models</strong> Supply Chain Management: <em>Shipping Assignment Problem: Selecting Individuals for Tasks</em></td>
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<td>9</td>
<td>Tue, 02/10</td>
<td><strong>Binary Choice Models:</strong> <em>Capital Budgeting, Set Covering</em></td>
<td>HW # 2 Due at start of class</td>
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<td>10</td>
<td>Thurs, 02/12</td>
<td><strong>Integer Programming:</strong> <em>Linking Constraints and Fixed Costs Incorporating Logic into Models</em></td>
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<td>11</td>
<td>Tue, 02/17</td>
<td><strong>Overcoming LP Limitations</strong> <em>Traveling Salesperson, Currency Arbitrage Evolutionary Solver</em></td>
<td>Quiz 2</td>
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<td>12</td>
<td>Thurs, 02/19</td>
<td><strong>Non-Linear Optimization I:</strong> <em>Revenue Management, Facility Location</em></td>
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<td>Week</td>
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<tr>
<td>13</td>
<td>Tue, 02/24</td>
<td>Advanced / Non-Linear Optimization II: Inventory Management, Portfolio Optimization</td>
<td></td>
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| 14   | Thurs, 02/26 | Simulation I Basics of Simulation  
Simulation as a form of “what-if” analysis  
Ch. 8 |                                                                  |
| 15   | Tue, 03/3  | Guest Speaker Charlie Thompson, Principal, Axtria  
Lecture on data analytics |                                                                 |
| 16   | Thurs, 03/5 | Work on Outlines Outlines due by Midnight  
Due midnight on blackboard |                                                                 |
| 17   | Tue, 03/17 | Simulation II Advertising Budget, Managing Cash Balances |                                                                 |
| 18   | Thurs, 03/19 | Simulation III Option Pricing, Newsvendor Model  
HW # 3 Due at start of class |                                                                 |
| 19   | Tue, 03/24 | Simulation IV / Advanced Topics Simulation Optimization |                                                                 |
| 20   | Thurs, 03/26 | Visual Basic I Introduction to VBA, Syntax  
Ch. 11 | Quiz 3 |
| 21   | Tue, 03/31 | Visual Basic II Programming Structures, Integration with Excel  
Ch. 11 |                                                                 |
| 22   | Thurs, 04/2 | Decision Support Systems Tying everything together  
Ch. 12, Ch. 13 |                                                                 |
| 23   | Tue, 04/7  | Project Lab Intensives Project Labs |                                                                 |
| 24   | Thurs, 04/9 | Project Lab Intensives Project Labs |                                                                 |
| 25   | Tue, 04/14 | Final Group Presentations: Group A  
Final projects due Start of Class  
Final Videos (Links due via Friday April 17)  
Projects due by start of class |                                                                 |
| 26   | Thurs, 04/16 | Final Group Presentations: Group B |                                                                 |
| 27   | Tue, 04/21 | Final Group Presentations: Group C |                                                                 |
| 28   | Thurs, 04/23 | Final Group Presentations: Group D |                                                                 |

**Note1:** Schedule is tentative. Even though we will cover all of the topics, the pace of learning/discovery will dictate the actual schedule.

**Note2:** Some of the content, specifically in classes 8-13 is not included in the textbook, and will be made available via handouts.