Quantitative Methods – MAT 540
Student Course Guide
Prerequisite: MAT 300

INSTRUCTIONAL MATERIAL – Required
(including all mandatory software)

Taylor, B. M. (2010). *Introduction to management science* (10th ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.

Treeplan add-on for Excel. This software is available in the Open Lab at Strayer campuses, and can also be downloaded from the textbook's companion Website. http://wps.prenhall.com/bp_taylor_introms_10/112/28870/7390752.cw/-/7390754/index.html

COURSE DESCRIPTION

Applies quantitative methods to systems management (Decision Theory), and / or methods of decision-making with respect to sampling, organizing, and analyzing empirical data.

COURSE OUTCOMES

Upon the successful completion of this course, the student will be able to:

1. Describe the role of quantitative methods in business decision making.
2. Analyze decision-making problems electronically.
3. Create statistical analysis of simulation results.
4. Apply the most appropriate forecasting method for the properties of the available data. .
5. Solve linear programming problems.
6. Create sensitivity analysis on linear programming model parameters.
7. Apply linear programming models to project management applications.
8. Solve integer-programming problems.
9. Develop solutions for transshipment problems.
10. Use technology and information resources to research issues in Management Science
11. Communicate issues in Management Science.

COURSE EXPECTATIONS

To obtain the most benefit from this class:

- Follow Strayer University's policies and procedures as well as those specific to this class.
    - Class specific information can be found within the "Class Information" section within the Student Center.

WEEKLY COURSE SCHEDULE

The weekly schedule below describes the learning activities that will help you achieve the course outcomes listed above and the assignments that will be used to measure your mastery of the outcomes. Each week is divided into sections consisting of readings, lectures, activities and assignments. For selected assignments, you will find a rubric that will be used to evaluate your performance.

Each week is divided into sections consisting of activities including readings, lectures and discussions, quizzes, and assignments.

WEEK 1

Course outcome in focus:

- Describe the role of quantitative methods in business decision making.
- Use technology and information resources to research and communicate issues in Management Science.

Supporting topics:

- Management science approach to problem solving
- Model building: break-even analysis
- Computer solution
- Management science modeling techniques
- Business usage of management science techniques
- Management science models in decision support systems
- Types of probability
- Fundamentals of probability
- Statistical independence and dependence
- Expected value
- The normal distribution

Weekly Activities:

Reading:

- Chapter 1: Management Science
- Chapter 11: Probability and Statistics
  - **Note:** Omit the sections on the Binomial Distribution (pp. 496-498) and the Chi-Square Test for Normality (pp. 511-514).
- Review Syllabus Parts I & II

Assignment:

- Complete Week 1 Homework

Course Lectures:

- **Lecture / discussion on faculty introduction, course overview ,and expectations**
- **Activity – Student introductions**

- **Lecture / discussion on: Overview of Management science; statistics and probability**

- **Activity – Review of using Microsoft's Excel Spreadsheet**

- **e-Activity** – Discuss probability in your profession
    - Do you use probability in your profession? More than likely you do. For example, in the heath field you could say that one (1) in four (4) women give birth by c-section (Parenting, May 2005). This means that the probability of giving birth by c-section is 1/4 = 0.25 = 25%. Similar probabilities could be found in other professions.

      Using your favorite search engine, find an example of probability being used in your chosen profession. Explain the example, and be sure to cite the source of the information clearly.

Assignments:
Week 1 Homework: Complete the assigned homework.

WEEK 2

Course outcome in focus:
- Analyze decision-making problems electronically.

Supporting topics:
- Components of decision making
- Decision making without probabilities
- Decision making with probabilities
- Decision analysis with additional information

Weekly Activities:

Reading:
- Chapter 12, Decision Analysis

Assignments:
- Complete Week 2 Homework
- Complete Quiz 1

Course Lectures:

- **Lecture / discussion on components of decision making through decision trees.**

- **Lecture / discussion on decision making without probabilities; decision making with probabilities.**

- **Activity – Discussion about Decision Analysis Problems**
  Discussion Topic

- In your own words, explain how to obtain the "expected value of perfect information" for any payoff table, which has probabilities associated with each state of nature. Then, provide an example, drawing from any of the payoff tables in Problems 1-17 in the back of Chapter 12. If no probabilities are given for the states of nature, then assume equal likelihood.

Assignment:
Week 2 Homework

Quiz 1

Please take the quiz in the course shell for Week 2 that covers the material in Chapters 1 and 11. This is an open book, timed quiz that can only be taken once with a time limit of four (4) hours. The quiz consists of a combination of true / false, multiple choice, and problem questions for a total of twenty questions, ten (10) from each chapter. Each question is worth two (2) points.

WEEK 3

Course outcome in focus:

- Create statistical analysis of simulation results.
- Use technology and information resources to research issues in Management Science.

Supporting topics:

- The Monte Carlo process
- Computer simulation with excel spreadsheets
- Simulation of a queuing system
- Continuous probability distributions
- Statistical analysis of simulation results
- Verification of the simulation model
- Areas of simulation application

Weekly Activities:

Reading:

- Chapter 14, Simulation

Assignments:

- Complete Week 3 Homework
- Complete Quiz 2

Course Lectures:

- **Lecture / discussion on** The Monte Carlo process; computer simulation with excel spreadsheets

Lecture / discussion on statistical analysis of simulation results; verification of the simulation model

- **Activity – Discuss Simulation**
  Select one (1) of the following topics for your primary discussion posting:
  - Identify the part of setting up a simulation in Excel that you find to be the most challenging, and explain why. Identify resources that can help you with that.
  - Explain how simulation is used in the real world. Provide a specific example from your own line of work, or a line of work that you find particularly interesting.

Assignment:

Quiz 2

Please take the quiz in the course shell for Week 3 that covers the material in Chapters 11 and 12. This is an open book, timed quiz that can only be taken once with a time limit of four (4) hours. The quiz consists of a combination of true / false, multiple choice, and problem questions for a total of twenty questions. Each question is worth two (2) points.

WEEK 4

Course outcome in focus:

- Apply the most appropriate forecasting method for the properties of the available data
- Use technology and information resources to research and communicate issues in Management Science.

Supporting topics:

- Forecasting components
- Time series methods
- Forecast accuracy
- Time series forecasting
- Regression methods

Weekly Activities:

Reading:
Chapter 15, Forecasting

Assignments:

- Complete Week 4 Homework

Course Lectures:

- **Lecture / discussion on** Forecasting components; time series methods

  There are many ways to forecast the future. In numerous firms (especially smaller ones), the entire process is subjective, involving intuition, and years of

experience. There are also many quantitative forecasting models, such as moving averages, exponential smoothing, trend projections, and least squares regression analysis. Regardless of the method that is used to make the forecast, the same eight overall procedures that follow are used.

Eight Steps to Forecasting

1. Determine the use of the forecast; what objective are we trying to obtain?
2. Select the items or quantities that are to be forecasted.
3. Determine the time horizon of the forecast; is it one (1) to 30 days (short term), 1 month to one (1) year (medium term), or more than one (1) year (long term)?
4. Select the forecasting model or models.
5. Gather the data needed to make the forecast.
6. Validate the forecasting model.
7. Make the forecast.
8. Implement the results.

These steps present a systematic way of initiating, designing, and implementing a fore-casting system. When the forecasting system is to be used to generate forecasts regularly over time, data must be collected routinely, and the actual computations or procedures used to make the forecast can be done automatically. When a computer system is used, computer forecasting files and programs are needed.

There is seldom a single superior forecasting method. One (1) organization may find regression effective, another firm may use several approaches, and a third may combine both quantitative and subjective techniques. Whatever tool works best for a firm is the one (1) that should be used.

- **Lecture / discussion on** Forecast accuracy; time series forecasting; regression methods
  Activity – Discuss Forecasting Methods
  Select one (1) of the following topics for your primary discussion posting:
  - Identify any challenges you have in setting up a time-series analysis in Excel. Explain what they are and why they are challenging. Identify resources that can help you with that.
  - Explain how forecasting is used in the real world. Provide a specific example from your own line of work, or a line of work that you find particularly interesting.

WEEK 5

Weekly Activities:

Reading:

- Midterm exam will cover contents from chapters 1, 11, 12, 14 and 15

Activity – Reflection to date

- In a paragraph, reflect on what you've learned so far in this course. Identify the most interesting, unexpected, or useful thing you've learned, and explain why.

Course Lectures: Plotting linear equations and inequalities

Assignments:

- Complete Midterm Examination

Course Lectures:

- **Lecture / discussion on** Algebra review
  - **Graphing linear equations and linear inequalities**

Assignment:

Midterm Exam

Students are to take the Midterm that covers the material in Chapters 1, 11, 12, 14 and 15. The Midterm is located in the course shell under the Week 5 tab. This is an open book, timed exam that can only be taken once with a time limit of five (5) hours. The exam consists of a combination of true / false, multiple choice, and problem questions for a total of 40 questions. Each question is worth five (5) points.

WEEK 6

Course outcome in focus:

- Solve linear programming problems.

Supporting topics:

- Model formulation
- Maximization model
- Graphical solutions of linear programming models
- A minimization model
- Irregular types of linear programming models
- Characteristics of linear programming problems

Weekly Activities:

Reading:

Chapter 2, Linear Programming: Model Formulation and Graphical Solution

Assignments:

- Complete Week 6 Homework

Course Lectures:

- **Lecture / discussion on** Model formulation; maximization model

- **Lecture / discussion on** irregular types of linear programming models; characteristics of linear programming problems

- **Lecture / discussion on** Minimization model

- **Activity** – Discuss LP Models
  Select one (1) of the following topics for your primary discussion posting:
  - The objective function always includes all of the decision variables, but that is not necessarily true of the constraints. Explain the difference between the objective function and the constraints. Then, explain why a constraint need not refer to all the variables.
  - Pick any constraint from any problem in the text, and explain how to plot the line that corresponds to that constraint.

Assignment:
Week 6 Homework

WEEK 7

Course outcome in focus:
- Create sensitivity analysis on linear programming model parameters.
- Use technology and information resources to research issues in Management Science.

Supporting topics:
- Computer solution of linear programming problems
- Sensitivity analysis

Weekly Activities:

Reading:
- Chapter 3, Linear Programming: Computer Solution and Sensitivity Analysis

Assignments:
- Complete Week 7 Homework
- Complete Quiz 3

Course Lectures:

- **Lecture / discussion on** Computer solution of linear programming problems
  Sensitivity analysis investigates how our decision might change given a change in the problem data. Sensitivity analysis is a vital part of all spreadsheet modeling. In optimization modeling, some of the most valuable insights come not from the optimal solution itself, but from a sensitivity analysis around the optimal solution. As we will see, the special structure of linear programs gives rise to certain characteristic results.

  Compared to the Solver Sensitivity output, the Sensitivity Report is more precise but less flexible. The Sensitivity Report is more precise than Solver Sensitivity with

respect to the question of where the decision variables change or where a shadow price changes.

- **Lecture / discussion on** Sensitivity analysis

  Activity –Discuss sensitivity analysis
  Select one (1) of the following topics for your primary discussion posting:
  - Identify any challenges you have in setting up a linear programming problem in Excel, and solving it with Solver. Explain exactly what the challenges are and why they are challenging. Identify resources that can help you with that.
  - Explain what the shadow price means in a maximization problem. Explain what this tells us from a management perspective.

Assignment:

Quiz 3

Please take the quiz in the course shell for Week 7 that covers the material in Chapter 2. This is an open book, timed quiz that can only be taken once with a time limit of four (4) hours. The quiz consists of a combination of true / false, multiple choice, and problem questions for a total of twenty questions. Each question is worth two (2) points.

WEEK 8

Course outcome in focus:

- Apply linear programming models to project management applications.

Supporting topics:

- Product mix
- Diet
- Investment
- Marketing
- Transportation
- Blend
- Multiperiod scheduling
- Data envelopment analysis

Weekly Activities:

Reading:

- Chapter 4, Linear Programming: Modeling Examples

Assignments:

- Complete Week 8 Homework
- Complete Assignment 1: Linear Programming Case Study

Course Lectures:

- **Lecture / discussion on how** linear programming is used to solve various types of models. The types of examples are product mix examples, diet examples, investment examples, marketing examples, transportation examples, blend examples, multiperiod scheduling examples, and data envelopment analysis examples.

- **Lecture / discussion on how we** follow the same procedure: identify the decision variables, determine the objective function, and develop the model constraints.

- **Activity** – Practice setting up linear programming models for business applications Discussion Topic:
    - Select an even-numbered LP problem from the text, excluding 14, 20, 22, 36 (which are part of your homework assignment). Formulate a linear programming model for the problem you select.

Assignment:
Week 8 Homework

Assignment 1. Linear Programming Case Study

Your instructor will assign a linear programming project for this assignment according to the following specifications.

It will be a problem with at least three (3) constraints and at least two (2) decision variables. The problem will be bounded and feasible. It will also have a single optimum solution (in other words, it won't have alternate optimal solutions). The problem will also include a component that involves sensitivity analysis and the use of the shadow price.

You will be turning in two (2) deliverables, a short writeup of the project and the spreadsheet showing your work.

Writeup.

Your writeup should introduce your solution to the project by describing the problem. Correctly identify what type of problem this is. For example, you should note if the problem is a maximization or minimization problem, as well as identify the resources that constrain the solution. Identify each variable and explain the criteria involved in setting up the model. This should be encapsulated in one (1) or two (2) succinct paragraphs.

After the introductory paragraph, write out the L.P. model for the problem. Include the objective function and all constraints, including any non-negativity constraints. Then, you should present the optimal solution, based on your work in Excel. Explain what the results mean.

Finally, write a paragraph addressing the part of the problem pertaining to sensitivity analysis and shadow price.

Excel.

As previously noted, please set up your problem in Excel and find the solution using Solver. Clearly label the cells in your spreadsheet. You will turn in the entire spreadsheet, showing the setup of the model, and the results.

Your work will be graded according to the following rubric.

Points: 110	**Assignment 1: Linear Programming Case Study**				
Criteria	**Unacceptable Below 60% F**	**Meets Minimum Expectations 60-69% D**	**Fair 70-79% C**	**Proficient 80-89% B**	**Exemplary 90-100% A**
Explain what type of problem this is and the approach you are taking (20%)	Did not explain what type of problem this is and the approach taken, or did so insufficiently.	Insufficiently explained what type of problem this is and the approach taken	Partially explained what type of problem this is and the approach taken	Satisfactorily explained what type of problem this is and the approach taken	Thoroughly explained what type of problem this is and the approach taken
Objective function specified correctly in writeup (10%)	Objective function is specified incorrectly, with both coefficients incorrect or missing.	Objective function is specified, but one (1) coefficient is incorrect.	Coefficients for objective function are correct, but whether this is a max or min problem is incorrect.		Objective function is specified correctly.
Constraints are specified correctly in writeup (10%)	Constraints are specified incorrectly or missing.	Some constraints are correctly specified.	Most constraints are correctly specified.	All constraints are correctly specified, buy applicable nonnegativity constraints are omitted.	All constraints are correctly specified, including nonnegativity constraints, if applicable.
Specified L.P. Model is correctly translated to Excel (10%)	Specified L.P. Model is incorrectly translated into Excel	Specified model is translated to Excel in a partially correct manner	Specified model is translated to Excel in a mostly correct manner		Specified model is correctly translated to Excel
Correct Answer is Obtained (10%)	Correct optimum is not obtained				Correct optimum is obtained
Correctly answer the sensitivity analysis part of the problem. (15%)	Did not attempt the sensitivity analysis part of the problem or did so with less than 60% accuracy and completeness	Insufficiently explained and/or provided a partially correct answer to the sensitivity analysis part of the problem	Partially explained and/or provided a partially correct answer to the sensitivity analysis part of the problem	Satisfactorily explained and correctly answered the sensitivity analysis part of the problem	Thoroughly explained and correctly answered the sensitivity analysis part of the problem

Correctly answer the shadow price part of the problem. (15%)	Did not attempt the sensitivity analysis part of the problem or did so with less than 60% accuracy and completeness	Insufficiently explained and/or provided a partially correct answer to the sensitivity analysis part of the problem	Partially explained and/or provided a partially correct answer to the sensitivity analysis part of the problem	Satisfactorily explained and correctly answered the sensitivity analysis part of the problem	Thoroughly explained and correctly answered the sensitivity analysis part of the problem
5. Writing / Grammar and mechanics (10%)	Serious and persistent errors in grammar, spelling, and punctuation.	Numerous errors in grammar, spelling, and punctuation.	Partially free of errors in grammar, spelling, and punctuation.	Mostly free of errors in grammar, spelling, and punctuation.	Free of errors in grammar, spelling, and punctuation.

WEEK 9

Course outcome in focus:

- Solve integer programming problems.

Supporting topics:

- Integer programming (ip) models
- Integer programming graphical solution
- Computer solution of integer programming problems

Weekly Activities:

Reading:

- Chapter 5, Integer Programming.

Assignments:

- Complete Week 9 Homework
- Complete Quiz 4

Course Lectures:

- **Lecture / discussion on** the three (3) basic types of integer linear programming models. In a total integer model, all of the decision variables are required to have integer solution values. In a zero-one integer model, all the decision variables must have values of zero (0) or one (1). In a mixed integer model, some, but not all, of the decision variables are required to have integer solutions.

- **Lecture / discussion on** how to solve these different models, certain constraints must be specified as part of the model. For a total integer model, all decision variables must be designated as integer. For a zero-one integer model, the decision variables must be designated as integers, with the only possible values being zero (0) and one (1). Finally, for a mixed integer model, only those decision variables that must be integers are designated as integer values. The other decision variables can be designated as real, or non-integer, values.

- **Activity** – Discuss characteristics of integer programming problems

Select one (1) of the following topics for your primary discussion posting:

- Explain how the applications of Integer programming differ from those of linear programming. Give specific instances in which you would use an integer programming model rather than an LP model. Provide real-world examples.
- Identify any challenges you have in setting up an integer programming problem in Excel, and solving it with Solver. Explain exactly what the challenges are and why they are challenging. Identify resources that can help you with that.

Assignment: Week 9 Homework

Quiz 4

Students are to take the quiz in the course shell for Week 9 that covers the material in Chapter 4. This is an open book, timed quiz that can only be taken once with a time limit of four (4) hours. The quiz consists of a combination of true / false, multiple choice, and problem questions for a total of twenty questions. Each question is worth two (2) points.

WEEK 10

Course outcome in focus:

- Develop solutions for transshipment problems.
- Use technology and information resources to research issues in Management Science.

Supporting topics:

- The transportation model
- Computer solution of a transportation problem
- The transshipment model
- Computer solution of a transshipment problem
- The assignment model

Weekly Activities:

Reading:

- Chapter 6, Transportation, Transshipment, and Assignment Problems

Assignments:

- Complete Week 10 Homework
- Complete Quiz 5

Course Lectures:

- **Lecture / discussion on** transshipment models being an extension of the transportation model where intermediate points, known as transshipment points, are added between sources and destinations.

- **Lecture / discussion on** assignment problem being a special form of a linear programming model in which all supply and demand values equal one (1).

- **Activity** – Discussion assignment and transshipment problems

  Select one (1) of the following topics for your primary discussion posting:
  - Explain the assignment model and how it facilitates in solving transportation problems. Determine the benefits to be gained from using this model.
  - Identify any challenges you have in setting up an transshipment model in Excel, and solving it with Solver. Explain exactly what the challenges are and why they are challenging. Identify resources that can help you with that.

Assignment: Week 10 Homework

Quiz 5

Students are to take the quiz in the course shell for Week 10 that covers the material in Chapter 5. This is an open book, timed quiz that can only be taken once with a time limit of four (4) hours. The quiz consists of a combination of true / false, multiple choice, and problem questions for a total of twenty questions. Each question is worth two (2) points.

WEEK 11

Weekly Activities:

Reading:
- Final exam will cover contents from chapters 1, 2, 3, 4, 5, 6, 11, 12, 14 and 15

Activity – Reflection to date
- In a paragraph, reflect on what you've learned in this course. Identify the most interesting, unexpected, or useful thing you've learned, and explain how it can be applied to your work or daily life in some manner.

Assignment:
- Complete Final Examination

Final Exam

Students are to take the Final Exam that covers the material in Chapters 1, 2, 3, 4, 5, 6, 11, 12, 14 and 15. The Final exam is located in the course shell under the Week 11 tab. This is an open book, timed exam that can only be taken once with a time limit of five (5) hours. The exam consists of a combination of true / false, multiple choice, and problem questions for a total of 40 questions. Each question is worth five (5) points.

ASSIGNMENT OUTLINE AND GRADING

Assignment Type	Value
Discussions = 11 x 10 points = 110 points	**11%**
Case Assignments = 1 x 110 = 110 points	**11%**
Homework = 9 x 20 = 180 points	**18%**
Quizzes = 5 x 40 = 200 points	**20%**
Midterm Exam = 1 x 200 = 200 points	**20%**
Final Exam = 1 x 200 = 200 points	**20%**

Grading Scale

90-100	A
80-89	B
70-79	C
Below 70	F