Assignment #1
Linear Programming
Formulation, Graphical Method and Excel Solver

ADM2302 students are reminded that submitted assignments must be neat, readable, and well-organized. Assignment marks will be adjusted for sloppiness, poor grammar and spelling, as well as for technical errors. While working together is encouraged, plagiarism on assignments will not be accepted. *Each student must sign the individual statement of integrity to be included with the submission.* This assignment can be hand written.

Note: *Each student must provide an individual original submission of completed Assignment #1*. Please also note: Assignment #1 copies that are submitted jointly (i.e., by more than one author) will not be graded.

Problem 1:
Gillian's Restaurant has an ice-cream counter where it sells two main products, ice cream and frozen yogurt, each in a variety of flavors. The restaurant makes one order for ice cream and yogurt each week. The store has enough freezer space for 115 gallons of both products. A gallon of frozen yogurt costs $0.75 and a gallon of ice cream costs $0.93. The restaurants budgets $90 each week for these products. The manager estimates that each week the restaurant sells at least twice as much ice cream as frozen yogurt. Profit per gallon of ice cream is $4.15 and profit per gallon of yogurt is $3.60.

1. Formulate algebraically a linear programming model for this problem. Define the decision variables, objective function, and constraints.
2. Use the graphical method by hand to solve this model.
3. Describe clearly and completely the optimal solution to this problem using a managerial statement.
4. How much additional profit would the restaurant realize each week if it increased its freezer capacity to accommodate 20 extra gallons total of ice cream and yogurt? Justify.

Problem 2:
Consider the following four LP formulations. Using a graphical approach, determine

1. Which formulation has more than one optimal solution
2. Which formulation is unbounded
3. Which formulation is infeasible
4. Which formulation has a unique optimal solution

Formulation 1

Maximize: 10X + 10Y
Subject to: 2X <= 10
2X + 4Y <= 16
4Y <= 8
X >= 6
X, Y >= 0

Formulation 2

Maximize: X + 2Y
Subject to: X <= 1
X + 2Y <= 2
2Y <= 2
X, Y >= 0

Formulation 3

Maximize: 3X + 2Y
Subject to: X >= 2
X + Y >= 5
2Y >= 8
X, Y >= 0

Formulation 4

Minimize: 3X + 3Y
Subject to: 4X + 6Y <= 48
4X + 2Y <= 12
3Y >= 3
2X >= 2
X, Y >= 0

Problem 3:

Mt. Sinai Hospital in New Orleans is a large, private 600-bed facility complete with laboratories, operating rooms, and x-ray equipment. In seeking to increase revenues, Mt. Sinai's administration has decided to make a 90-bed addition on a portion of adjacent land currently used for staff parking. The administrations feel that the labs, operating rooms, and x-ray department are not being fully utilized at present and do not need to be expanded to handle additional patients. The addition of 90 beds, however, involves deciding how many beds should be allocated to the medical staff for medical patients and how many to the surgical staff for surgical patients.

The hospital's accounting and medical records departments have provided the following pertinent information. The average hospital stay for a medical patient is 8 days, and the average medical patient generates $2,280 in revenues. The average surgical patient is in the hospital for 5 days and receives a $1,515 bill. The laboratory is capable of handling 15,000 tests per year more than it was handling. The average medical patient requires 3.1 lab tests and the average surgical patient takes 2.6 lab tests. Furthermore, the average medical patient uses one x-ray, whereas the average surgical patient requires two x-rays. If the hospital was expanded by 90 beds, the x-ray department could handle up to 7,000 x-rays without significant additional cost. Finally, the administration estimates that up to 2,800 operations could be performed in existing operating room facilities. Medical patients, of course, require no surgery, whereas each surgical patient generally has one surgery performed. Finally, **assume that the hospital is open 365 days a year**.

1. Formulate algebraically a linear programming model for this problem in order to determine how many medical beds and how many surgical beds should be added to maximize revenues. Define the decision variables, objective function, and constraints.
2. Formulate this same linear programming problem on a spreadsheet and SOLVE using Excel solver (Provide a printout of the corresponding "Excel Spreadsheet" and the "Answer Report").
3. Describe clearly and completely the optimal solution to this problem using a managerial statement.

Problem 4:

RJCK Inc. produces two steak sauces, Spicy Diablo and Mild Red Baron. These sauces are both made by blending two ingredients, A and B. A certain level of flexibility is permitted in the formulas for these products. The allowable percentages, along with the revenue and cost data, are given the table below.

	INGREDIENT		**SALES PRICE PER LITER**
SAUCE	**A**	**B**	**$**
Spicy Diablo	a least 25%	at least 50%	5.35
Mild Red Baron	at most 75%	*	4.85
Cost per liter	$1.60	$2.59	

*No explicit maximum or minimum percentage.

Up to 40 liters of A and 30 liters of B could be purchased. RJCK can sell as much of these sauces as it produces. The objective is to maximize the net revenue from the sale of the sauces.

1. Formulate algebraically a linear programming model for this problem. Define the decision variables, objective function, and constraints.
2. Formulate this same linear programming problem on a spreadsheet and SOLVE using Excel solver (Provide a printout of the corresponding "Excel Spreadsheet" and the "Answer Report").
3. Describe clearly and completely the optimal solution to this problem using a managerial statement.

Source:

Problem 1: Taylor, B.W. III 2007. *Introduction to Management Science*. (9th ed.) Prentice-Hall, Upper Saddle River, New Jersey. 771p. + appendices.

Problem 2 and Problem 3: Render, B., and R.M. Stair, Jr., N. Balakrishnan 2003. *Managerial Decision Modeling*. Prentice-Hall, Inc.: Upper Saddle River, New Jersey. 616p.