ASSIGNMENT # 1
Linear Programming (LP)
Formulation, Graphical Method and Excel Solver

ADM2302 students are reminded that submitted assignments must be typed (i.e. **can NOT be hand written**), neat, readable, and well-organized. However, GRAPHS are ok to plot them by hand and SCAN/INCLUDE them within the Word document file as long as they are large, legible, and properly labeled and that their calculations are typed within the rest of the assignment. Assignment marks will be adjusted for sloppiness, poor grammar, spelling, for technical errors as well as if you submit a PDF file (i.e. Do NOT submit a PDF file).

The assignment is to be submitted electronically as a **single Word Document file** via Brightspace by Sunday September 29th prior to 23:59. Front page of the Word document has to include title of the assignment, course code and section, student name and student number. Second page is *the individual statement of integrity that must be signed.*

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.

E-mail questions related to the assignment should be sent to the Teaching Assistant or posted on the Brightspace course website "Discussion page" (viewed by all).

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Problem 1

Dwight is an elementary school teacher who also raises pigs for supplemental income. He is trying to decide what to feed his pigs. He is considering using a combination of pig feeds available from local suppliers. He would like to feed the pigs at minimum cost while also making sure each pig receives an adequate supply of calories and vitamins. Dwight has formulated the following Linear Programming (LP) model:

Let A = pounds of Feed Type A in diet
B = pounds of Feed Type B in diet

Minimize Z =	$\$0.40A + \$0.80B$	(Cost)
subject to	$800A + 1{,}000B \geq 8{,}000$	(requirement of calories per day)
	$140A + 70B \geq 700$	(requirement of units of vitamins)
	$A \leq (1/3)(A + B)$	(constraint 3)
	$A \geq 0, B \geq 0.$	

Briefly explain or define each of these parts of the model:

a. The 0.80 in the objective function.

b. The product of the 0.40 and A in the objective function (e.g. 0.40A)

c. The 8,000 calories in the calories constraint.

d. The product of 1,000 and B in the calories constraint (e.g. 1,000B)

e. The 70 units in the vitamins constraint.

f. Constraint 3 was added since Feed Type A contains an ingredient that is toxic if consumed in too large a quantity. In managerial terms (e.g. verbally explain) what does constraint 3 mean?

Solve this LP problem by using the graphical method:

g. Graph the constraints and identify the feasible region.

h. Using the Isocost line method, determine the optimal solution(s) and the minimum cost (show your work). **Include <u>"managerial statements"</u> that communicate the results of the analyses (i.e. describe verbally the results).**

i. Determine the amount of slack for each of the constraint.

Problem 2

a. Solve the following linear programming model by using the graphical method: graph the constraints and identify the feasible region then determine the optimal solution (s) (show your work).

Minimize $Z = 3x_1 + 7x_2$

Subject to

$$9x_1 + 3x_2 \geq 36$$
$$4x_1 + 5x_2 \geq 40$$
$$x_1 - x_2 \leq 0$$
$$2x_1 \leq 13$$
$$x_1, x_2 \geq 0$$

b. Are any constraints binding? If so, which one (s)?

Problem 3:

a. Solve the following linear programming model by using the graphical method: graph the constraints and identify the feasible region. Using the corner points method, determine the optimal solution (s) (show your work).

Maximize $Z = 6.5x_1 + 10x_2$

Subject to

$x_1 + x_2 \leq 15$
$2x_1 + 4x_2 \leq 40$
$x_1 \geq 8$
$x_1, x_2 \geq 0$

b. If the constraint $x_1 \geq 8$ is changed to $x_1 \leq 8$, what effect does this have on the optimal solution? Are any constraints redundant? If so, which one (s)?

Problem 4

A farmer must decide what crops to grow on a 300-hectare tract of land. He can grow oats, wheat, or barley, which yield 50, 100 and 80 kg/hectare (respectively) and sell for $1.00, $0.80, and $0.60 per kg (respectively). Production costs (fertilizer, labor, etc.) are $40, $50, and $40 per hectare for growing oats, wheat and barley, respectively. Government regulations restrict the farmer to a maximum of 150 hectares of wheat and his crop rotation schedule requires that he plants at least 50 hectares in oats and 50 hectares in barley. Because of his storage arrangements, the farmer wants the number of hectares of oats to be equal to or less than half the number of hectares of barley.

a. Formulate algebraically the linear programming model of this problem that will maximize the farmer profit (i.e. revenue – cost) and help him/her decides what crops to grow on his/her land (i.e. define the decision variables, objective function, constraints).

b. 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"). **Include "managerial statements" that communicate the results of the analyses.**