Homework 2

Due Date: Friday, 3/31, at noon 12pm on Blackboard

General Requirements

You should submit one Excel file including your answers, your model formulation, and excel output. Your answers must be in the order of the questions, and should be neat, clearly written, and concise. Highlight your answers to the questions in yellow. No credit will be given if GA or I cannot easily find your answers.

You will be graded on readability and flexibility of Excel setup. **The Excel files must be executable**. I have seen output in answer submissions that were clearly not generated by the submitted Excel file. If GA runs your Excel file, it should give the same results you submit. That means the spreadsheet has correct embedded formulae and Solver dialog boxes have all the inputs. **If 'Solve' is clicked and your spreadsheet does not produce the reported results, a minimum 50% penalty will be applied.**

There are **four** problems. Must put each problem in a different worksheet.

(i) Name each model worksheet by the problem #, for example, "Problem1", "Problem2".

(ii) Name your file by last name and homework number, for example, LastName _Homework2.xlsx.

Problem 1

MSA Computer Corporation manufactures two models of smartphones, the Alpha 4 and the Beta 5. The firm employs five technicians, working 160 hours each per month, on its assembly line. Management insists that full employment (i.e., *all* 160 hours of time) be maintained for each worker during next month's operations. It requires 20 labor hours to assemble each Alpha 4 computer and 25 labor hours to assemble each Beta 5 model. MSA wants to see at least 10 Alpha 4s and at least 15 Beta 5s produced during the production period. Alpha 4s generate $1,200 profit per unit, and Beta 5s yield $1,800 each. Determine the most profitable number of each model of smartphone to produce during the coming month.

Detailed requirement:

Define the decision variables necessary for the LP formulation as follows:

X = number of Alpha 4 manufactured

Y = number of Beta 5 manufactured

(a) Formulate appropriately as a profit maximization LP. Provide the **algebraic model formulation** in your submission. Must be neatly presented. (Hint: All available labor hours **must** be used up.)

(b) Input and solve the formulation using Excel. **All constraints must be presented in the spreadsheet (i.e., not only in Solver).**

After running Solver, **report how many of each model of smartphones will be manufactured, and what is the maximum profit the firm can obtain**.

Problem 2

Working with chemists at Virginia Tech and George Washington Universities, landscape contractor Kenneth Golding blended his own fertilizer, called "Golding-Grow." It consists of four chemical compounds: C-30, C-92, D-21, and E-11. The cost per pound for each compound is indicated as follows:

CHEMICAL COMPOUND	COST PER POUND ($)
C-30	0.12
C-92	0.09
D-21	0.11
E-11	0.04

The specifications for Golding-Grow are as follows: (1) E-11 must constitute at least 15% of the blend; (2) C-92 and C-30 must together constitute at least 45% of the blend; (3) D-21 and C-92 can together constitute no more than 30% of the blend; and (4) Golding-Grow is packaged and sold in 50-pound bags.

Formulate an LP problem to determine what blend of the four chemicals will allow Golding to minimize the cost of a 50-pound bag of the fertilizer.

Detailed requirement:

Define the decision variables necessary for the LP formulation as follows:

W = Pounds of C-30 used in the blend

X = Pounds of C-92 used in the blend

Y = Pounds of D-21 used in the blend

Z = Pounds of E-11 used in the blend

(a) Formulate appropriately as an LP to minimize total cost. Provide the **algebraic model formulation** in your submission. Must be neatly presented.

(b) Input and solve the formulation using Excel. **All constraints must be presented in the spreadsheet (i.e., not only in Solver).**

After running Solver, **report the total cost, and the resulting usage of each type of chemical compound.**

Problem 3

The Feed 'N Ship Ranch fattens cattle for local farmers and ships them to meat markets in Kansas City and Omaha. The owners of the ranch seek to determine the amounts of cattle feed to buy so that minimum nutritional standards are satisfied and at the same time total feed costs are minimized. The feed mix can be made up of the three grains that contain the following ingredients per pound of feed:

	FEED (OZ.)		
INGREDIENT	**STOCK X**	**STOCK Y**	**STOCK Z**
A	3	2	4
B	2	3	1
C	1	0	2
D	6	8	4

The cost per pound of stocks X, Y, and Z is $2, $4, and $2.50, respectively. The minimum requirement per cow per month is 4 pounds of ingredient A, 5 pounds of ingredient B, 1 pound of ingredient C, and 8 pounds of ingredient D.

The ranch faces one additional restriction: it can obtain only 500 pounds of stock Z per month from the feed supplier, regardless of its need. Because there are usually 100 cows at the Feed 'N Ship Ranch at any given time, this means that no more than 5 pounds of stock Z can be counted on for use in the feed of each cow per month.

Detailed requirement:

Define the decision variables necessary for the LP formulation as follows:

X = pounds of stock X used

Y = pounds of stock Y used

Z = pounds of stock Z used

(Hint: The numbers in the table are the ounces of each ingredient contained by 1 pound of each type of feed. For example, the first number 3 means that every pound of stock *X* contains 3 ounces of ingredient A. Therefore, the minimum requirements for each ingredient should be converted to ounces. For example, total ingredient A must be at least 4lb * (16oz/lb) = 64oz.)

(a) Formulate appropriately as an LP to minimize the cost. Provide the **algebraic formulation in your submission**. Must be neatly presented.

(b) Input and solve the formulation using Excel. **All constraints must be presented in the spreadsheet (i.e., not only in Solver).** After running Solver, generate sensitivity report.

(c) Answer the following questions in the Sensitivity Report worksheet. **DO NOT** modify or rerun the model. **You must explain all the steps on how you answered the question based on the output of the one standard LP output which can include Excel's sensitivity report.** If you feel that it is not possible to answer the question with the single output, explain why this is the case.

i) In the optimal strategy, how many pounds of stock X, Y, Z will be purchased, respectively? What is the minimum cost for the ranch?

ii) What would be the optimal solution if the cost of stock X increases to $2.5? What would be the minimum total cost with such an increase? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication**.

iii) What would be the optimal solution if the cost of stock Z decreases to 80 cents? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication**.

iv) What will be the total cost if only 80 ounces of ingredient A are required? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication.**

v) What will be the total cost if 90 ounces of ingredient B are required? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication.**

Problem 4

The Weinberger Electronics Corporation manufactures four highly technical products that it supplies to aerospace firms that hold NASA contracts. Each of the products must pass through the following departments before being shipped: wiring, drilling, assembly, and inspection. The time requirement in hours for each unit produced and its corresponding profit value are summarized in the following table:

	DEPARTMENT				
PRODUCT	**WIRING**	**DRILLING**	**ASSEMBLY**	**INSPECTION**	**UNIT PROFIT ($)**
XJ201	0.5	0.3	0.2	0.5	9
XM897	1.5	1	4	1	12
TR29	1.5	2	1	0.5	10
BR788	1	3	2	0.5	8

The production available in each department each month and the minimum monthly production requirement to fulfill contracts are as follows:

DEPARTMENT	**CAPACITY (HOURS)**	**PRODUCT**	**MINIMUM PRODUCTION LEVEL**
Wiring	15,000	**XJ201**	150
Drilling	17,000	**XM897**	100
Assembly	26,000	**TR29**	300
Inspection	12,000	**BR788**	400

The production manager has the responsibility of specifying production levels for each product for the coming month. HelP him by formulating Weinberger's problem using LP.

Define the decision variables necessary for the LP formulation as follows:

W = number of XJ201 manufactured

X = number of XM897 manufactured

Y = number of TR29 manufactured

Z = number of BR788 manufactured

(a) Formulate this problem as an LP to maximize the profit. **Show the algebraic formulation in your submission**.

(b) Input and solve this formulation using Excel. **All constraints must be presented in the spreadsheet (i.e., not only in Solver).** After running Solver, generate sensitivity report.

(c) Based on the sensitivity report, answer the following questions. **Again, I do NOT want you to rerun more linear programs.** You must answer the questions based on the **one** linear program solution/sensitivity report. You must explain all the steps on how you answered the question based on the one output for the linear program. If you feel that it is not possible to answer the question with the single output, explain why this is the case.

i) How many of each type of product will the company manufacture? How much profit will the company receive from the optimal production strategy?

ii) What happens to the optimal solution if the unit profit of XM897 increases by 20%? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication.**

iii) What happens to the optimal solution if the unit profit of XJ201 decreases by 10%? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication.**

iv) What happens to the optimal profit if the company obtains another 1000 wiring hours? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication.**

v) What happens to the optimal profit if the company loses 4000 drilling hours? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication.**

vi) What happens to the optimal profit if the company loses 2000 assembly hours? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication.**

vii) What happens to the optimal profit if the company decides to manufacture at least 550 units of BR788? Must explain how you arrived to your answer based on the given output. **Do not reformulate the LP to find out the implication.**