UNIVERSITÉ D'OTTAWA
UNIVERSITY OF OTTAWA

FACULTÉ D'ADMINISTRATION
FACULTY OF ADMINISTRATION

MIDTERM EXAM

ADM 2302

INTRODUCTIION TO MANAGEMENT SCIENCE

Duration: 90 minutes

Question # 1

Find the complete optimal solution to this Linear Programming problem.

Min Z = 3x1 + 3x2

Subject to

12x1 + 4x2 >= 48
10x1 + 5x2 >= 50
4x1 + 8x2 >= 32
x1, x2 >= 0

Question # 2

A company produces tools at two plants and sells them to three customers. The cost of producing 1000 tools at a plant and shipping them to a customer is given in Table below:

	Customer1	**Customer2**	**Customer3**
Plant 1	$60	$30	$160
Plant 2	$130	$70	$170

Customers 1 and 3 pay $200 per thousand tools; customer 2 pays $150 per thousand tools. To produce 1000 tools at plant 1, 200 hours of labour are needed, while 300 hours are needed at plant 2. A total of 5500 hours of labour are available for use at the two plants. Additional labour hours can be purchased at $20 per labour hour. Plant 1 can produce up to 10,000 tools and plant 2, up to 12,000 tools. Demand by each customer is assumed unlimited.

If we let Xij = number of tools (**in thousands**) produced at plant i and shipped to customer j, and L = number of additional hour purchased.

The problem when formulated as an LP and solved is as follows:

Max. Z = 140 X11 + 120 X12 + 40 X13 + 70 X21 + 80 X22 + 30 X23 - 20 L

Subject to

C1 1 X11 + 1 X12 + 1 X13 <= 10

C2 1 X21 + 1 X22 + 1 X23 <= 12

C3 200 X11 + 200 X12 + 200 X13 + 300 X21 + 300 X22 + 300 X23 - 1 L <= 5500

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		X11	X12	X13	X21	X22	X23	L					
2													
3	Solution	10.00	0.00	0.00	0.00	11.67	0.00	0.00					
4									Total				
5	Profit	$140	$120	$40	$70	$80	$30	-$20	$2,333.33				
6													
7									RHS				
8	C1	1	1	1	0	0	0	0	10.00	<=	10		
9	C2	0	0	0	1	1	1	0	11.67	<=	12		
10	C3	200	200	200	300	300	300	-1	5500.00	<=	5500		
11													

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B3	Solution X11	10	0	140	1E+30	20
C3	Solution X12	0	-20	120	20	1E+30
D3	Solution X13	0	-100	40	100	1E+30
E3	Solution X21	0	-10	70	10	1E+30
F3	Solution X22	11.67	0	80	130	10
G3	Solution X23	0	-50	30	50	1E+30
H3	Solution L	0	-19.73	-20	19.73	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
I8	C1 RHS	10	86.67	10	17.5	0.50
I9	C2 RHS	11.67	0.00	12	1E+30	0.33
I10	C3 RHS	5500	0.27	5500	100	3500.00

a) If it costs $70 to produce 1000 tools at plant 1 and ship them to customer 1, what would be the new solution to the problem and the profit? (6 points)

b) If the price of an additional hour of labor were *reduced to* $4, would the company purchase any additional labor? (6 points)

c) A consultant offers to increase plant 1's production capacity by 5000 tools for a cost of $400. Should the company take the offer? (6 points)

d) If the company were given 5 extra hours of labor, what would the profit become? (6 points)

Question # 3

Margaret Young's family owns five panels of farmland broken into a southwest sector, north sector, west sector, and southwest sector. Young is involved primarily in growing wheat, alfalfa, and barley crops and is currently preparing her production plan for next year. The Pennsylvania Water Authority has just announced its yearly water allotment, with the Young farm receiving 7,400 acre-feet. Each parcel can only tolerate a specified amount of irrigation per growing season, as specified below:

Parcel	Area (acre)	Water Irrigation Limit (acre-feet)
Southeast	2000	3200
North	2300	3400
Northwest	600	800
West	1100	500
Southwest	500	600

Each of Young's crops needs a minimum amount of water per acre and there is a projected limit of each crop. Crop data follow:

Crop	Maximum Sales	Water Needed per Acre (acre-feet)
Wheat	110,000 bushels	1.6
Alfalfa	1,800 tons	2.9
Barley	2,200 tons	3.5

Young's best estimate is that she can sell wheat at a net profit of $2 per bushel, alfalfa at $40 per ton, and barley at $50 per ton. One acre of land yields an average of 1.5 tons of alfalfa and 2.2 tons of barley. The wheat yield is approximately 50 bushels per acre.

Formulate Young's production plan. (Define the decision variables, objective function and the constraints).