OPERATIONAL RESEARCH

Section2

Problem 3 in sheet 2:

Universal Mines Inc. operates three mines in West Virginia. The ore from each mine is separated into two grades before it is shipped; the daily production capacities of the mines, as well as their daily operating costs, are as follows:

	High-Grade Ore, tons/day	Low-Grade Ore, tons/day	Operating Cost, $1000/day
Mine I	4	4	20
Mine II	6	4	22
Mine III	1	6	18

Universal has committed itself to deliver 54 tons of high-grade ore and 65 tons of low-grade ore by the end of the week. It also has labor contracts that guarantee employees in each mine a full day's pay for each day or fraction of a day the mine is open. Determine the number of days each mine should be operated during the upcoming week if Universal Mines is to fulfill its commitment at minimum total cost.

	High Grade (ton/day)	low Grade (ton/day)	Operating Cost ($1000/day)
Mine 1	4	4	20
Mine 2	6	4	22
Mine 3	1	6	18
Demande	54 ton/week	65 ton/week	

*Has labor Contracts that guarantee employees in each mine a full day's pay for each day or fraction of a day the mine is open

Determine # of days should be operated to fulfill its Commitment during upcoming week cut min Cost?

Solution:

Decision Variables:

x_1 → # of days for mine1/week
x_2 → # of days for mine2/week
x_3 → # of days for mine3/week

Objective: Minimize $Z = 20x_1 + 22x_2 + 18x_3$

Subject to:

$4x_1 + 6x_2 + x_3 \geq 54$ tons

$4x_1 + 4x_2 + 6x_3 \geq 65$ tons

$x_1, x_2, x_3 \geq 0$ and $x_1, x_2, x_3 \leq 7$

x_1, x_2, x_3 are integers

Full days pay for each day or fraction of day the mine is open

علشان قال في المسألة

Problem 4 in Sheet 2.

A town has budgeted $250000 for the development of new rubbish disposal areas. Seven sites are available whose projected capacities and development costs are given below. Which sites should the town develop?

Site	A	B	C	D	E	F	G
Capacity, tons/wk	20	17	15	15	10	8	5
Cost, $1000	145	92	70	70	84	14	47

- Budget : $ 250,000

Sites	A	B	C	D	E	F	G
Capacity (ton/week)	20	17	15	15	10	8	5
Cost (1000$)	145	92	70	70	84	14	47

- Which sites should the down develop?

أنا مش محتاج أقل التكلفة لأن هو كده كده هيدفعهم، المهم
ابن ازود عدد الـ tons

- Decision Variables:

x_i ; $1 \le i \le 7$

- 1 : Site should be developed
- 0 : Otherwise

يا هاخد الـ site ، يا مش هاخده

- objective:

Maximize Capacity $Z: 20x_1 + 17x_2 + 15x_3 + 15x_4 + 10x_5 + 8x_6 + 5x_7$

- Subject to:

$145x_1 + 92x_2 + 70x_3 + 70x_4 + 84x_5 + 14x_6 + 47x_7 \le 250$

where: $x_i \ge 0$ → Binary, Integers.
1

Problem 6 in Sheet 2:

A certain farming organization operates three farms of comparable productivity. The output of each farm is limited both by the usable acreage and by the amount of water available for irrigation. Following are the data for the upcoming season:

Farm	Usable acreage	Water available in acre feet
1	400	1,500
2	600	2,000
3	300	900

The organization is considering three crops for planting which differ primarily in their expected profit per acre and in their consumption of water. Furthermore, the total acreage that can be devoted to each of the crops is limited by the amount of appropriate harvesting equipment available.

Crop	Minimum acreage	Water consumption in acre feet per acre	Expected profit per acre
A	700	5	Rs. 400
B	800	4	Rs. 300
C	300	3	Rs. 100

In order to maintain a uniform work load among the farms, it is the policy of the organization that the percentage of the usable acreage planted must be the same at each farm. However, any combination of the crops may be grown at any of the farms. The organization wishes to know how much of each crop should be planted at the respective farms in order to maximize expected profit Formulate this as a linear programming problem

Farm	Usable acreage	water available in acre feet
1	400	1,500
2	600	2,000
3	300	900

Crop	min acreage	water Cons. per acr.	Profit per acr.
A	700	5	400
B	800	4	300
C	300	3	100

* Percentage of usable acreage planted must be the same at any of farms.
* Any combination of the crops may be form at any farm
*
- How much of each crop should be planted as the respected farms to maximize the profit.

Solution:

Decision Variables:

$X_{1A}, X_{1B}, X_{1C}, X_{2A}, X_{2B}, X_{2C}, X_{3A}, X_{3B}, X_{3C}$

X_{ij} : $1 \le i \le 3$ → Farm.

$A \le j \le C$ → Crop

↳ Area planted from j in farm i

objective:

Maximize Profit:

$$Z = 400(X_{1A} + X_{2A} + X_{3A}) + 300(X_{1B} + X_{2B} + X_{3B}) + 100(X_{1C} + X_{2C} + X_{3C})$$

Subject to:

$X_{1A} + X_{1B} + X_{1C} \le 400$ * No. of area. in each farm.

$X_{2A} + X_{2B} + X_{2C} \le 600$

$X_{3A} + X_{3B} + X_{3C} \le 300$

$5X_{1A} + 4X_{1B} + 3X_{1C} \le 1500$ * water availble in each farm.

$5X_{2A} + 4X_{2B} + 3X_{2C} \le 2000$

$5X_{3A} + 4X_{3B} + 3X_{3C} \le 900$

$X_{1A} + X_{2A} + X_{3A} \ge 700$ * Min acr. for each Crop

$X_{1B} + X_{2B} + X_{3B} \ge 800$

$X_{1C} + X_{2C} + X_{3C} \ge 300$

Percentage:

$$\frac{X_{1A} + X_{1B} + X_{1C}}{400} = \frac{X_{2A} + X_{2B} + X_{2C}}{600} = \frac{X_{3A} + X_{3B} + X_{3C}}{300}$$

$X_{ij} \ge 0$