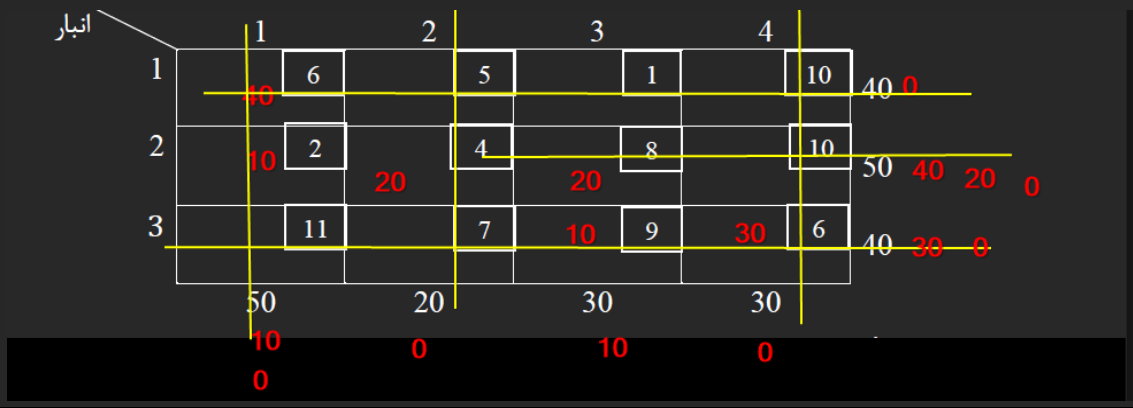
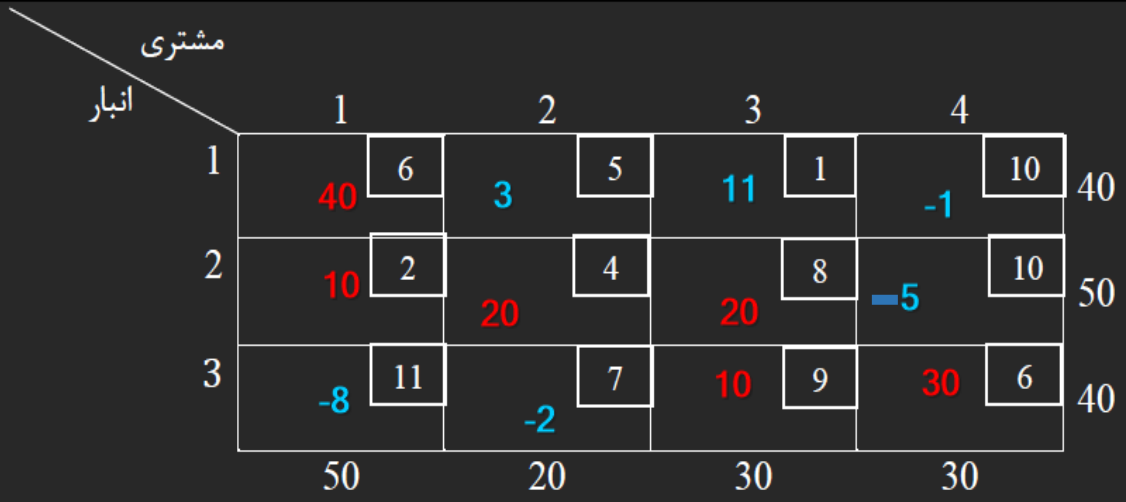
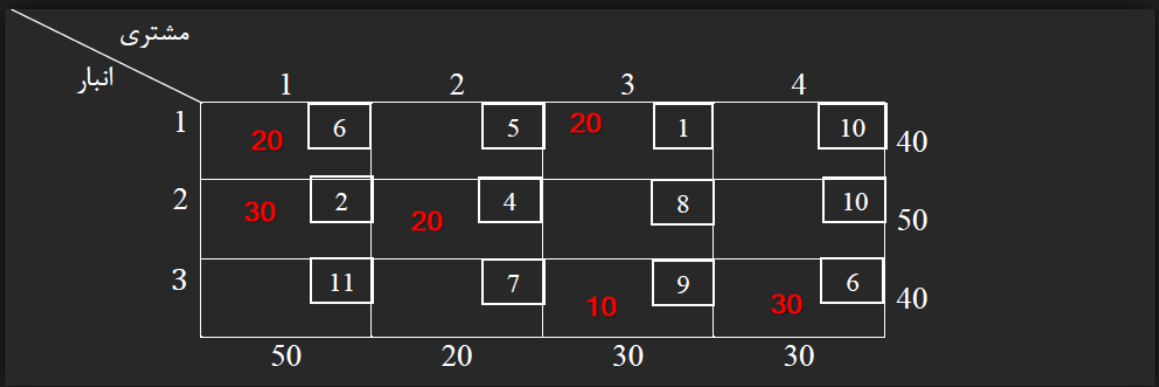
Q1)



reducing cost of x_ij is written with Blue color

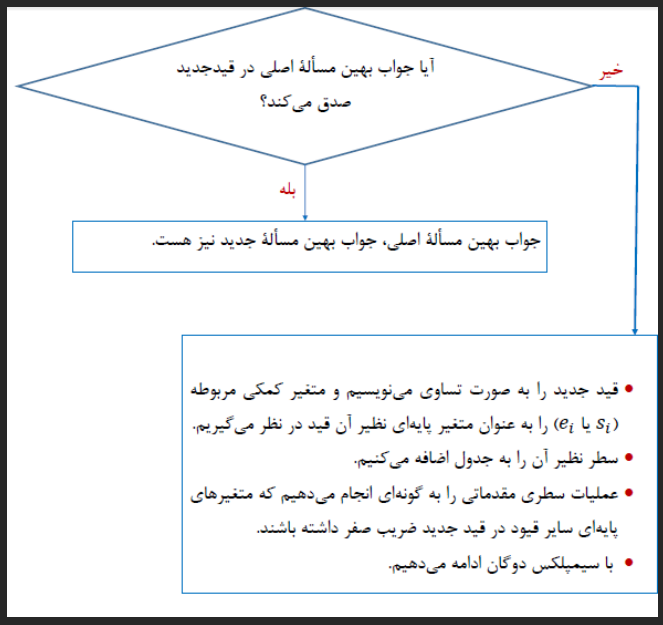


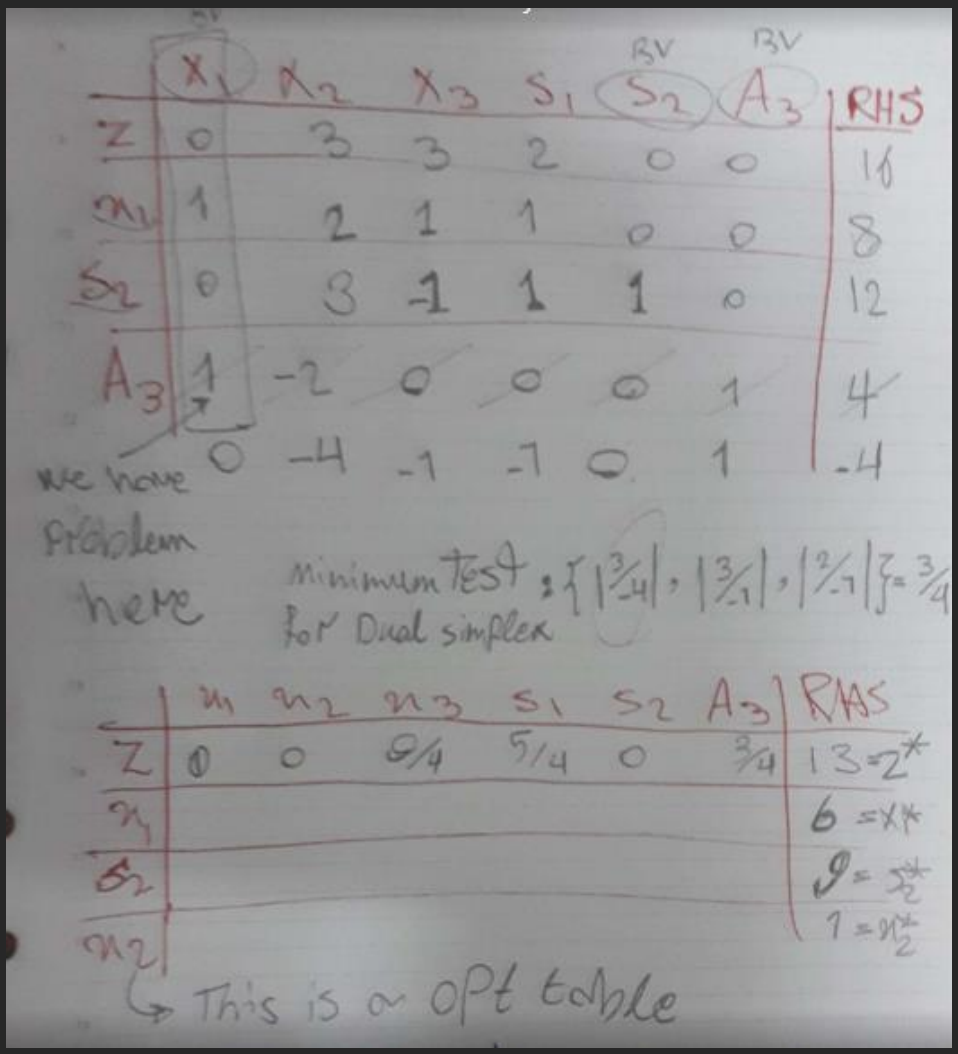
Based one last picture interring variable is X13 and leaving var is X23



Q2)

We should follow this algorithm.
Because our old optimal solution does not satisfy new constraint that we've added we should add Artificial variable and then solve it by Dual simplex method as follows :





Q2) Part 2 :

جدول بهین:

Dual price

کل متغیرها/BV	x_1	x_2	x_3	s_1	s_2	RHS
z	0	3	3	2	0	16
x_1	1	2	1	1	0	8
s_2	0	3	-1	1	1	12

الف) فرض کنید قید جدید $x_1 - 2x_2 = 4$ به مسأله اضافه شود، با استفاده از تحلیل حساسیت جواب بهین مسألهٔ جدید را پیدا کنید.

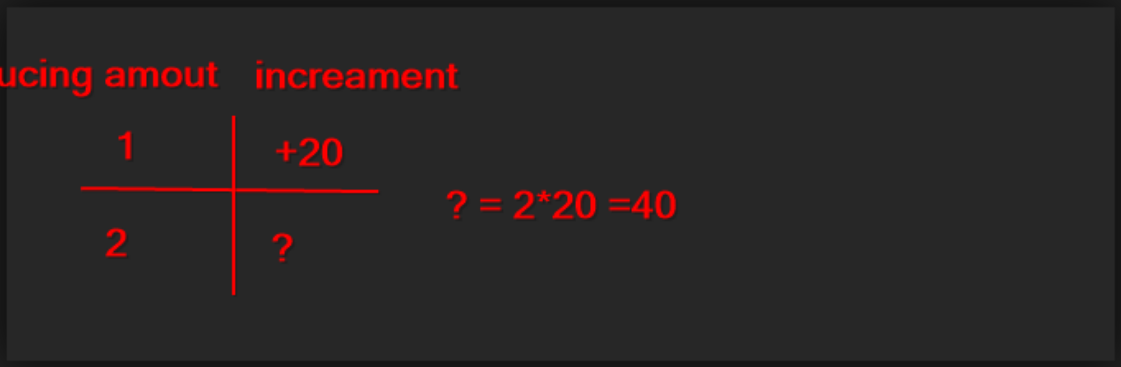
ب) اگر قرار بود بین یک واحد افزایش در سمت راست اولین و دومین قید یکی را انتخاب کنید، کدام را انتخاب می‌کردید؟ چرا؟ اثر این افزایش روی مقدار بهینهٔ تابع هدف چیست؟

we can answer second part with help of Dual price
becuase dual price of first slack variabel is grater than second slack var (I mean 2 > 0) we should increase RHS of First constraint
in other hand if we increase 8 to 9 opt value of objective function will be 16+2 = 18

Q3)

Part 1) One way for solving this problem is by using “Sensitivity analysis “ and “” shadow price” theorems.

Since the Dual price for X1 is Y5 and equal to -20 and we are in a Maximization problem and since 86 is in valid interval of change(85<= 86<=90)then it means if we reduce one unit of X1 it can increase –(-20) of objective function and we will have “ 32580 “ for the new optimal value of objective function due to the following calculation :



Part 2) In this part we are adding new activity (variable) :

After introducing slack,surplus,artificial variables and BEFORE ADDING NEW VAR

Max Z = 300 X_1 + 400 X_2 - 50 M_1 + 0 S_1 + 0 S_2 + 0 S_3 + 0 S_4 + 0 S_5 + 0 S_6 - M A_1 - M A_2

subject to

0.8 X_1 + X_2 - M_1 + S_1 = 0
M_1 + S_2 = 98
0.6 X_1 + 0.7 X_2 + S_3 = 73
2 X_1 + 3 X_2 + S_4 = 260
X_1 - S_5 + A_1 = 88
X_2 - S_6 + A_2 = 26

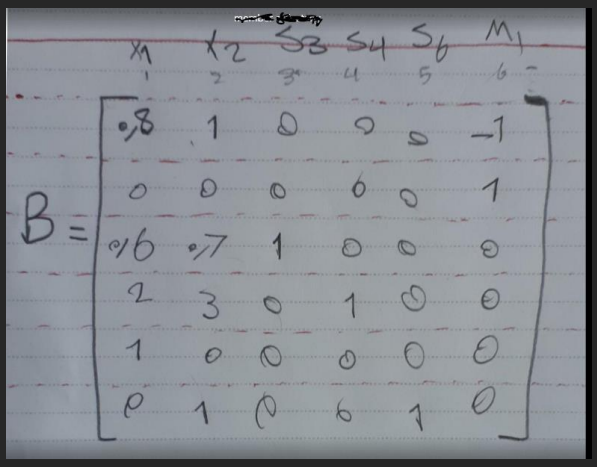
and X_1,X_2,M_1,S_1,S_2,S_3,S_4,S_5,S_6,A_1,A_2 >= 0

First table BEFORE ADDING NEW VAR:

BV	X1	X2	M1	S1	S2	S3	S4	S5	S6	A1	A2	RHS
S1	0.8	**(1)**	-1	1	0	0	0	0	0	0	0	0
S2	0	0	1	0	1	0	0	0	0	0	0	98
S3	0.6	0.7	0	0	0	1	0	0	0	0	0	73
S4	2	3	0	0	0	0	1	0	0	0	0	260
A1	1	0	0	0	0	0	0	-1	0	1	0	88
A2	0	1	0	0	0	0	0	0	-1	0	1	26
Z=-114M	-M-300	-M-400	50	0	0	0	0	M	M	0	0	**-114M**

Opt table BEFORE ADDING NEW VARIABLE (I mean Jeep machine)

Opt table											
BV		**X_1**	**X_2**	**M_1**	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**	**S_6**	**RHS**
X_2		0	1	0	1	1	0	0	0.8	0	27.6
S_6		0	0	0	1	1	0	0	0.8	1	1.6
S_3		0	0	0	-0.7	-0.7	1	0	0.04	0	0.88
S_4		0	0	0	-3	-3	0	1	-0.4	0	1.2
X_1		1	0	0	0	0	0	0	-1	0	88
M_1		0	0	1	0	1	0	0	0	0	98
Z=		0	0	0	400	350	0	0	20	0	**32540**



0	0	0	0	1	0
1	1	0	0	-0.8	0
-0.7	-0.7	1	0	-0.04	0
-3	-3	0	1	0.4	0
-1	-1	0	0	0.8	1
0	1	0	0	0	0

$= B^{-1}$

$$\bar{a}_{x_3} = B^{-1} a_{x_3}$$

$$B \cdot \begin{bmatrix} 1.2 \\ 0 \\ 2 \\ 4 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1.2 \\ 1.16 \\ 0.4 \\ -1.2 \\ 0 \end{bmatrix} = \bar{a}_{x_3}$$

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$$\bar{C}_{X_3} = \begin{bmatrix} X_1 & X_2 & S_3 & S_4 & S_6 & M_1 \\ 300 & 400 & 0 & 0 & 0 & -50 \end{bmatrix} \begin{bmatrix} 0 \\ 1,2 \\ 1,6 \\ 0,4 \\ -1,2 \\ 0 \end{bmatrix} - 600 = -120$$

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We have used $C_{BV}^{T} \cdot (B^{-1} \cdot \bar{a}_{X_3}) - C_{X_3}$ Formula

AFTER ADDING NEW VARIABLE :

Opt table												
BV		**X_1**	**X_2**	**M_1**	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**	**S_6**	**X_3**	**RHS**
X_2		0	1	0	1	1	0	0	0.8	0	0	27.6
S_6		0	0	0	1	1	0	0	0.8	1	1.2	1.6
S_3		0	0	0	-0.7	-0.7	1	0	0.04	0	1.16	0.88
S_4		0	0	0	-3	-3	0	1	-0.4	0	0.4	1.2
X_1		1	0	0	0	0	0	0	-1	0	-1.2	88
M_1		0	0	1	0	1	0	0	0	0	0	98
Z=		0	0	0	400	350	0	0	20	0	**-120**	**32540**

Now since X_3 has a negative reduce cost, we are not in a OPT table. After elementary row operation and Minimum test we will have next table as follows :

BV	**X1**	**X2**	**M1**	**X3**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**RHS**
X2	0	1	0	0	1.7241	1.7241	-1.0345	0	0.7586	0	26.6897
S6	0	0	0	0	1.7241	1.7241	-1.0345	0	0.7586	1	0.6897
X3	0	0	0	1	-0.6034	-0.6034	0.8621	0	0.0345	0	0.7586
S4	0	0	0	0	-2.7586	-2.7586	-0.3448	1	-0.4138	0	0.8966
X1	1	0	0	0	0	0	0	0	-1	0	88
M1	0	0	1	0	0	1	0	0	0	0	98
Z=32631	0	0	0	0	327.5862	277.5862	103.4483	0	24.1379	0	**32631.03**

32631 is > than 32540 So we should Produce new variable.

Thanks for all of your time that you have spent for teaching us .I really appreciate it. 9513004