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Q1:

① Variables: let x = number of units of product X to produce.

let y = number of units of product y to produce.

② Objective function:

⇒ Maximize revenue $\text{Max } Z = 20x + 30y$

③ Constraints:

$40 * 60 = 2400$ hours

Machine A → $50x + 24y \leq 2400$

Machine B → $30x + 33y \leq 2100$

طرح

Demand constraints $x + 30 \geq 75 \rightarrow x \geq 45$

$y + 90 \geq 95 \rightarrow y \geq 5$

Non-negativity constraints : $x \geq 0$, $y \geq 0$.

Q_2:

RHs	S_3	S_2	S_1	X_1	X_2	basic veriable
6	0	0	1	2	1	S_1
4	0	1	0	1	-2	S_2
15	1	0	0	3	5	S_3
0	0	0	0	-4	-5	z - c

→ Convert the inequalities to equations by adding slack veriabels S_3, S_2, S_1:

$$\begin{cases} x_1 + 2x_2 + s_1 = 6 \\ -2x_1 + x_2 + s_2 = 4 \\ 5x_1 + 3x_2 + s_3 = 15 \end{cases}$$

→ Set up the initial simplex tableau and perform iterations until the optimal solution is reached.

→ optim solution $x_1 = 3$, $x_2 = 0$, $Z_3 = 15$

Q_3: Max $Z = 3x_1 + 2x_2$

subject to →

$$\begin{cases} x_1 + 2x_2 \leq 6 \\ 2x_1 + x_2 \leq 8 \\ x_2 - x_1 \leq 1 \\ x_2 \leq 2 \\ x_1, x_2 \geq 0 \end{cases}$$

Basic Solution	x_1	x_2	s_1	s_2	s_3	s_4	RHS
obj	0	0	1/3	4/3	0	0	12.6
x_2	0	1	2/3	-1/3	0	0	4/3
x_1	1	0	-1/3	2/3	0	0	10/3
s_3	0	0	-1	1	1	0	3
s_4	0	0	-2/3	1/3	0	1	2/3

⇒ Part "a": change the return value of x_1 to 2.

- the new objective function is $Z = 2x_1 + 2x_2$
- the current solution remains feasible, but its optimality needs to be verified.

⇒ Part "b": Add a new constraint $2x_1 + x_2 \geq 10$.

- the current solution $x_1 = 10/3$, $x_2 = 4/3$ doesn't satisfy the new constaint.
- the problem must be re-solved with the new constraint.

Q4:

⇒ The dual: Min $W = 4y_1 + 8y_2$

subject to:

$$\begin{cases} y_1 + y_2 \geq 2 \\ y_1 + 4y_2 \geq 4 \\ y_1 \geq 4 \\ y_2 \geq -3 \end{cases}$$

$y_1, y_2 \geq 0$

⇒ The optimal solution stisfies the primal constraints and maximizes Z.

- without the tabelu, the exact values of $x_1 \to 0$, $x_2 \to 2$, $x_3 \to 2$, $x_4 \to 0$ cannot be determined.

optimal value $Z^* = 16$.