

# Rodrigo Investigación Operativa

## FORMULACION Y RESOLUCION GRAFICA

1.1 A y B

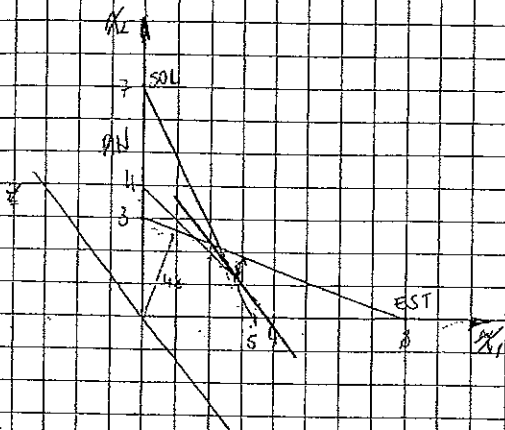
$$Z = 4x_1 + 3x_2$$

EST	$6x_1 + 16x_2 \leq 48000$
SOL	$12x_1 + 6x_2 \leq 42000$
PIM	$9x_1 + 9x_2 \leq 36000$

$6x_1 + 16x_2 + x_3 = 48000$
$12x_1 + 6x_2 + x_4 = 42000$
$9x_1 + 9x_2 + x_5 = 36000$

$$x_4 = x_5 = 0$$

14cu	—	48000
0.3cu	—	$x = 10285,7$



1.2 A y B

A ← 300 gr LICOR  
500 gr NUEZ \$120  
200 gr BOMBONES DE FRUTA

B ← 400 gr L  
200 gr N \$90  
100 gr F

L = 100kg      N = 120kg      F = 100kg

$$Z = 120x_1 + 90x_2 \rightarrow \text{MAX}$$

$$0,3x_1 + 0,4x_2 \leq 100$$

$$0,5x_1 + 0,2x_2 \leq 120$$

$$0,2x_1 + 0,1x_2 \leq 100$$

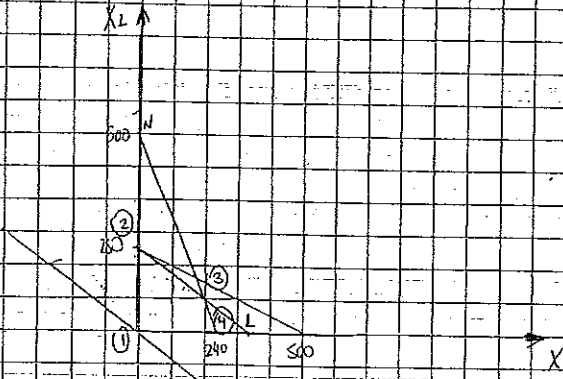
①  $Z = 0$

②  $Z = 90 \cdot 250 = 22500$

④  $Z = 240 \cdot 120 = 28800$

⑤  $0,3x_1 + 0,4x_2 = 100 \Rightarrow x_1 = 100 - 0,4x_2$   
 $0,5x_1 + 0,2x_2 = 120 \Rightarrow x_1 = 200 - 0,2x_2$

$$Z = 33000$$



A y B

A  $\begin{cases} 4 \text{ Fina} \\ 3 \text{ galleta} \\ 5 \text{ Piedrecillas} \end{cases} \quad \$60$

X LO MENOS  
12 F  
12 G  
10 P

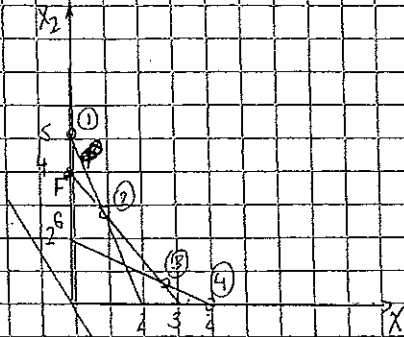
B  $\begin{cases} 3 \text{ Fina} \\ 6 \text{ Galleta} \\ 2 \text{ Piedrecillas} \end{cases} \quad \$100$

$$Z = 60X_1 + 100X_2 \rightarrow \text{MAX}$$

$$F \quad 4X_1 + 3X_2 \geq 12$$

$$G \quad 3X_1 + 6X_2 \geq 12$$

$$P \quad 5X_1 + 2X_2 \geq 10$$



$$1) Z = 500$$

$$2) Z \rightarrow \begin{cases} 4X_1 + 3X_2 = 12 \\ 3X_1 + 2X_2 = 10 \end{cases} \Rightarrow X_2 = \frac{2-4X_1}{3}$$

$$5X_1 + 8 - \frac{8}{3}X_1 = 10 \quad X_1 = 0,375 \quad X_2 = 3,5$$

$$Z = 372,5$$

$$3) Z \Rightarrow \begin{cases} 4X_1 + 3X_2 = 12 \\ 3X_1 + 6X_2 = 12 \end{cases} \Rightarrow X_2 = \frac{2-4X_1}{3} \quad 3X_1 + 2(2-4X_1) = 12 \quad X_1 = 2,4 \quad X_2 = 0,8$$

$$Z = 224$$

$$4) Z = 240$$

5) X LO MENOS 300 LUMENES

MIN 150 LUXES

ALUX  $\begin{cases} 2 \text{ LUM} \\ 3 \text{ LUX} \end{cases} \quad \text{Kg: } \$450$

BLUX  $\begin{cases} 4 \text{ LUM} \\ 1 \text{ LUX} \end{cases} \quad \text{Kg: } \$120$

$$2X_1 + 4X_2 \geq 300$$

$$3X_1 \geq 150$$

$$Z = 450X_1 + 120X_2 \rightarrow \text{MIN}$$

$$6) Z = 12X_1 + 8X_2 \rightarrow \text{MAX}$$

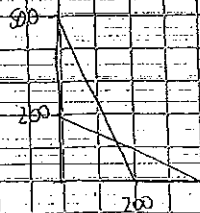
$$X_1 + 0,4X_2 \leq 200$$

$$0,5X_1 + X_2 \leq 100$$

$$X_1 = 200 - 0,4X_2$$

$$100 - 0,4X_2 + X_2 = 100$$

$$X_2 = 166,67 \quad X_1 = 133,33 \quad Z = 2933,36$$



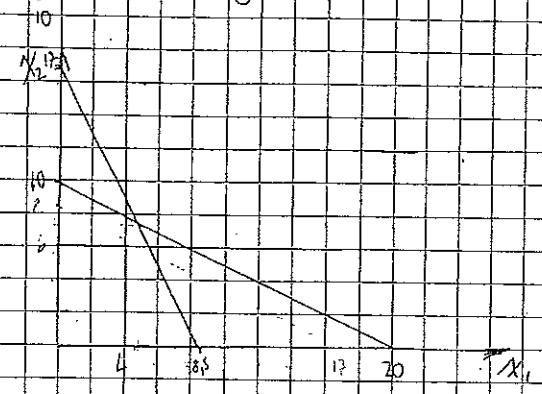
1.6

M < 100g A, 100g C, 200g D \$10 Kg  
 N < 100 B, 200c, 100D \$4 Kg

MIN → 400g A, 600g B, 2000g C, 700g D

$Z = 10 \cdot X_1 + 4 \cdot X_2 \rightarrow \text{MIN}$

$0,1X_1 \geq 0,4$   
 $0,1X_2 \geq 0,6$   
 $0,1X_1 + 0,2X_2 \geq 2$   
 $0,2X_1 + 0,1X_2 \geq 1,7$   
 siendo  $x_1, x_2 \geq 0$   
 $X_1 = \frac{2 - 0,2X_2}{0,1}$



$4 - 0,4X_2 + 0,1X_2 = 1,7$

$X_2 = \frac{2,3}{0,1} = 23$        $X_1 = \frac{0,8}{0,1} = 8$       MAX DIRECTAMENTE

$Z = 10(4,66) + 4(7,67) = 77,28$

MONTAÑA

1.7

EST < 25000 A, 40000 C  
 MONT < 33333 A, 16667 C

Como MIN 12000A y 8000C  
 MAX 18000 A  
 A → \$5000      C → \$25000

$X_1 = \text{cant. de autos producidos}$   
 $X_2 = \text{cant. de camionetas producidos}$

- MONT A → 22500  
 - MONT C → 15000

- $X_1 \leq 22500$
- $X_2 \leq 5000$
- $X_1 \geq 12000$
- $X_2 \geq 8000$
- $X_1 \geq 18000$

$\frac{X_1}{25000} + \frac{X_2}{40000} \leq 1$   
 $\frac{X_1}{33333} + \frac{X_2}{16667} \leq 1$

$Z = 15000 X_1 + 25000 X_2 = \text{MAX}$

$$\text{con } X_1 = 18000 \rightarrow X_2 = 7666,7 \quad \text{NO } (18000 \times 2)$$

$$X_1 = 8000 \rightarrow X_2 = 17333,5$$

# FORMULACION CON VARIAS VARIABLES

2.1)  $Z = 2X_1 + 2.5X_2 + 1.5X_3 + 2X_4 \rightarrow \text{MIN}$

$$6500X_1 + 5800X_2 + 6200X_3 + 5900X_4 \geq 5950$$

$$6500X_1 + 5800X_2 + 6200X_3 + 5900X_4 \leq 6050$$

$$0.2X_1 + 0.35X_2 + 0.15X_3 + 0.11X_4 \geq 0.1$$

$$0.2X_1 + 0.35X_2 + 0.15X_3 + 0.11X_4 \leq 0.3$$

$$0.05X_1 + 0.015X_2 + 0.065X_3 + 0.1X_4 > 0.045$$

$$0.05X_1 + 0.015X_2 + 0.065X_3 + 0.1X_4 \leq 0.055$$

$X_1$ : Kg usados del mat A  
 $X_2$ : " " " " B  
 $X_3$ : " " " " C  
 $X_4$ : " " " " D

2.2)  $Z = 6.8X_E + 5.7X_K + 4.5X_T + 7X_{A1} + 5X_{B1} + 4X_{C1} \rightarrow \text{MAX}$

$$0.6X_E \leq X_{A1}$$

$$X_{A1} = X_{A1} + X_{A2} + X_{A3}$$

$$0.2X_E \geq X_{C1}$$

$$X_E = X_{A1} + X_{B1} + X_{C1}$$

$$0.15X_K \leq X_{A2}$$

$$0.6X_K \geq X_{C2}$$

$$0.15X_T \geq X_{C3}$$

$$X_{A1} + X_{A2} + X_{A3} \leq 2000$$

$$X_{A1} + X_{A2} + X_{A3} - 2000 \leq 0$$

$$X_{B1} + X_{B2} + X_{B3} \leq 2500$$

$$X_{B1} + X_{B2} + X_{B3} - 2500 \leq 0$$

$$X_{C1} + X_{C2} + X_{C3} \leq 1200$$

$$X_{C1} + X_{C2} + X_{C3} - 1200 \leq 0$$

$X_{A1}$  = litros, mat prima A con el E y sigue...

2.3)  $5V_1 - 10V_2 + 2V_3 + 15V_4 + 3V_5 - 1V_6 + 2V_7 = 100 = 0$

$$3V_2 + 1V_2 + 5V_3 + 10V_4 + 2V_5 + 0V_6 + 1V_7 = 80 = 0$$

$$1V_3 + 1V_3 - 3V_3 + 1V_3 + 2V_3 + 0V_3 + 6V_3 \geq 120 \geq 0$$

$$1V_3 + 1V_3 - 3V_3 + 1V_3 + 2V_3 + 0V_3 + 6V_3 \leq 160 \leq 0$$

$$Z = 1P_1 + 1P_2 + 5P_3 + 0.16P_4 + 3.5P_5 + 0.7P_6 + 4P_7 \quad \text{MINI}$$

$$P_1 = V_1 + V_2 + V_3$$

creando  $P_1, V_2, P_3, P_4, P_5, P_6, P_7, V_1, V_2, \dots, V_6, V_7 \geq 0$

A → (I) M (20kg) (I) 2 turnos 8hs

B → (I) (II) N (34kg) (II) 2 turnos, 8hs

C → (I) M  
ns x sm = 168

10 b. x sm

$$Z = 1000X_A + 1500X_B + 1800X_C = 80I - 80II$$

$$5A_I + 6B_{II} - 80 \leq 0$$

$$X_A = A_I - B_{II}$$

$$4B_{II} + 4C_{II} - 80 \leq 0$$

$$X_B = B_{II} + C_{II}$$

$$X_C = C_{II}$$

$$1,6X_A + 1,2X_B - 20 \leq 0$$

$$1,8X_A - 30 \leq 0$$

$$X_C \leq 10$$

$X_A$  = PULLOVERS DE TIPO A

$X_B$  = PULLOVERS DE TIPO B

$X_C$  = PULLOVERS DE TIPO C

I = PULLOVERS Q' SE HACEN EN LA MAQ 1

II = " " " " " " " " 2

$$I = A_I + B_{II}$$

$$II = B_{II} + C_{II}$$

$$X_A, X_B, X_C, B_I, B_{II}, A_I, C_{II} \geq 0$$

f

5)  $Z = 500A_p + 600B_p + 1200C_p + 1000D_p + 800A_c + 750B_c + 1500C_c + 800D_c$   
MIN

$$0,05(A_p + B_p + C_p + D_p) \leq 200$$

$$0,1A_p + 0,12B_p + 0,14C_p + 0,18D_p \leq 3600$$

$$0,2A_p + 0,25B_p + 0,3C_p + 0,25D_p \leq 5000$$

$$0,9(0,08A_p + 0,10B_p + 0,06C_p + 0,10D_p) \leq 3000$$

$$0,9(0,02A_p + 0,03B_p + 0,03C_p + 0,03D_p) + 0,8(0,3A_c + 0,05B_c + 0,04C_c + 0,04D_c)$$

$$\leq 3000$$

$$A_p + A_c = 4000$$

$$B_p + B_c = 3000$$

$$C_p + C_c = 8000$$

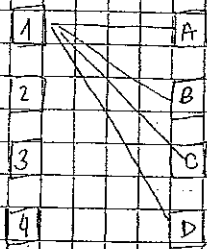
$$D_p + D_c = 5000$$

siendo  $A_p, B_p, C_p, D_p, A_c, B_c, C_c, D_c \geq 0$

$A_0$  = cant. de tableros producidos tipo A  
 $B_0$  = " " " " " " B  
 $C_0$  = " " " " " " C  
 $D_0$  = " " " " " " D

$A_c$  = cant. de tableros comprados tipo A  
 $B_c$  = " " " " " " B  
 $C_c$  = " " " " " " C  
 $D_c$  = " " " " " " D

2.6



$$F_1 = X_{1A} + X_{1B} + X_{1C} + X_{1D} \leq 140 \leq 140$$

$$F_2 = X_{2A} + X_{2B} + X_{2C} + X_{2D} \leq 260$$

$$F_3 = X_{3A} + X_{3B} + X_{3C} + X_{3D} \leq 340$$

$$F_4 = X_{4A} + X_{4B} + X_{4C} + X_{4D} \leq 220$$

$$Z = 60F_1 + 72F_2 + 48F_3 + 60F_4 + X_{1A} \cdot 28 + X_{1B} \cdot 40 + \dots \text{ MIN}$$

$$X_{1A} + X_{2A} + X_{3A} + X_{4A} \geq 80$$

$$X_{1B} + X_{2B} + X_{3B} + X_{4B} \geq 280$$

$$X_{1C} + X_{2C} + X_{3C} + X_{4C} \geq 150$$

$$X_{1D} + X_{2D} + X_{3D} + X_{4D} \geq 200$$

$$X_{1A}, \dots, X_{4D} \geq 0$$

2.7

A y B = cant. de productos (A, B) litros

$A_1, A_2$  = cant. de productos A según el método 1, 2

$A(i)$  = canno

$A(i)1$  = cant. de veces q' paso

$H_{1A}, H_{1B}, H_{2A}, H_{2B}, H_{3A}, H_{3B}, H_{4A}, H_{4B}$  = horas en dentro del prod j

$$\text{MAX} \rightarrow Z = 60A - 30A + 80B - 60B - 1500H_{1A} - 2000H_{2A} - 1800H_{3A} - 220H_{4A}$$

$$300 H_1 A = A(1) \\ 450 H_2 A = A(2) \quad (\text{y siguen})$$

$$0,9 A(1) = A(2) \\ 0,95 A(2) = A(4) \\ 0,85 A(4) = A(2) \\ 0,8 A(2) = A(1) \quad \dots (\text{y los de B}) \\ 0,75 A(3) = A(4)$$

$$H_1 A + H_1 B \leq 16 \\ H_2 A + H_2 B \leq 16 \\ H_3 A + H_3 B \leq 12 \\ H_4 A + H_4 B \leq 12$$

$$A = A_1 + A_2 \quad \Rightarrow \quad A + B \leq 2500 \quad A \leq 1750 \\ A \geq 600 \quad B \leq 1500$$

100 ACRES DE CAMPO  $\begin{cases} \rightarrow T & 60/\text{año} \\ \rightarrow M & 95/\text{año} \end{cases}$

4 hrs <sup>propias</sup> / acre  $\rightarrow$  T 0,15 h/b 0,2 \$/b y costo 1,75 \$/b vende  
 M 0,17 h/b 0,12 \$/b 0,95 \$/b

cerdos \$40/año  $\rightarrow$  25 b T 25 hrs de M 250 pies  $\begin{cases} 0,80 $/b \\ 1,50 $/b \end{cases}$  y comida

vacas \$40/año  $\rightarrow$  25 b T 40 hrs de M 150 pies  $\begin{cases} 0,80 $/b \\ 1,50 $/b \end{cases}$

DISPONE DE 10000 pies<sup>2</sup> 1000 hrs/annales propias 2000 hrs/annales Alca

PERSONAL 150 \$/hr x c/hr  $\rightarrow$  0,5 hrs tareas de supervisión x c/hr contratada.

ACRES DE TRIGO (AT) Y ACRES DE MAÍZ (AM)

...

# METODO SIMPLEX

$$\begin{aligned} x_1 &\leq 3 \\ x_2 &\leq 6 \\ 6x_1 + 4x_2 &\leq 36 \end{aligned} \quad \text{MAX: } z = 8x_1 + 3x_2$$

$$\begin{aligned} x_1 + x_3 &= 3 \\ x_2 + x_4 &= 6 \\ 6x_1 + 4x_2 + x_5 &= 36 \end{aligned}$$

Ck	Xk	B	x <sub>1</sub>	x <sub>2</sub>	x <sub>3</sub>	x <sub>4</sub>	x <sub>5</sub>	θ
0	x <sub>3</sub>	3	(1)	0	1	0	0	3 ←
0	x <sub>4</sub>	6	0	1	0	1	0	6 ←
0	x <sub>5</sub>	36	6	4	0	0	1	6
	z = 0		-8	-3	0	0	0	

8	x <sub>1</sub>	3	1	0	1	0	0	-
0	x <sub>4</sub>	6	0	1	0	1	0	6
← 0	x <sub>5</sub>	18	0	(4)	-6	0	1	4.5 ←
			0	-3	8	0	0	

8	x <sub>1</sub>	3	1	0	(1)	0	0	→ 1 - (6/0) = 1
0	x <sub>4</sub>	1.5	0	0	6/4	1	(-1/4)	→ 1/4
3	x <sub>2</sub>	1.5	0	1	-5/4	0	1/4	→ 0 - 1/4 = -1/4
			0	0	3/8	0	0.75	

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(4.2) 
$$\begin{aligned} x_1 + 2x_2 + x_3 &\leq 430 \\ 3x_1 + 2x_3 &\leq 460 \\ x_1 + 4x_2 &\leq 420 \end{aligned}$$

$$\begin{aligned} x_1 + 2x_2 + x_3 + x_4 &= 430 \\ 3x_1 + 2x_3 + x_5 &= 460 \\ x_1 + 4x_2 + x_6 &= 420 \end{aligned}$$

MAX:  $z = 3x_1 + 2x_2 + 5x_3$

Ck	Xk	B	x <sub>1</sub>	x <sub>2</sub>	x <sub>3</sub>	x <sub>4</sub>	x <sub>5</sub>	x <sub>6</sub>	θ
0	x <sub>4</sub>	430	1	2	1	1	0	0	430
0	x <sub>5</sub>	460	3	0	(2)	0	1	0	230 ←
0	x <sub>6</sub>	420	1	4	0	0	0	1	105
	z = 0		-3	-2	-5	0	0	0	

0	x <sub>4</sub>	200	-0.5	(2)	0	1	-0.5	0	100 ←
5	x <sub>3</sub>	230	3/2	0	1	0	1/2	0	-
0	x <sub>6</sub>	420	1	4	0	0	0	1	105
	z = 1150		4.5	-2	0	0	2.5	0	

$$\frac{430 - 460}{2} = -15$$

2	x <sub>2</sub>	100	-0.5	1	0	1/2	-0.5	0	
5	x <sub>3</sub>	230	1.5	0	1	0	0.5	0	
0	x <sub>6</sub>	20	2	0	0	2	1	1	
			4	0	0	1	2	0	

$x_1 = x_4 = x_5 = 0$

(4.4)  $3x_1 + x_2 + x_3 = 3$   
 $4x_1 + 8x_2 - x_4 = 6$   
 $x_1 + 2x_2 - x_5 = 2$   
 $Z = 2x_1 + x_2$  (MAX)

C <sub>k</sub>	X <sub>b</sub>	B	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	
M	M <sub>1</sub>	3	(3)	1	-1	0	0	1	0	0	1 ←
M	M <sub>2</sub>	6	4	3	0	-1	0	0	1	0	1,5
M	M <sub>3</sub>	2	1	2	0	0	-1	0	0	1	2
Z = 11M		8M-2	6M-1	-M	-M	-M	0	0	0	0	
2	X <sub>1</sub>	1	1	1/3	-1/3	0	0	1/3	0	0	3
M	M <sub>2</sub>	2	0	1/6	1/3	-1	0	-1/3	1	0	1,2
M	M <sub>3</sub>	1	0	(1/2)	0,33	0	-1	-0,33	0	1	0,6
Z = 3M		0	3,33M	0,33	-M	-M	-2,66M	1/6	0	0	

2	X <sub>1</sub>	0,18	1	0	-0,4	0	0,2	0,4	0	-0,2	-
M	M <sub>2</sub>	1	0	0	(1)	-1	1	-1	1	-1	1 ←
1	X <sub>2</sub>	0,6	0	1	0,2	0	0,4	0,2	0	-0,6	3
Z = M + 2,2		0	0	M-0,6	-M	1	-2M+0,6	0	-2M+1		

2	X <sub>1</sub>	1/3	1	0	0	-0,1	0,6	0	0,4	-0,6	2
0	X <sub>2</sub>	1	0	0	1	-1	(1)	-1	1	-1	1
1	X <sub>2</sub>	0,4	0	1	0	0,2	0,4	0	-0,2	-0,4	1
Z = 2,8		0	0	0	-0,6	1,6	0	0,6	-1,6		

2	X <sub>1</sub>	1/6	1	0	-0,2	-1	0	0,6	1	0	
0	X <sub>4</sub>	1	0	0	1	-1	1	-1	1	-1	X <sub>3</sub> , X <sub>4</sub> , X <sub>6</sub> = 0
1	X <sub>2</sub>	1/8	0	1	-0,4	0,4	0	0,4	-0,6	0	
		0	0	-1,6	-1,4	0	1,4-M	1,4-M	-M		

(4.5)  $x_1 + x_2 \leq 300$   
 $25x_1 + 4x_2 + 5x_3 \leq 1000$   
 $x_2 + x_3 = 200$   
 $x_1 \leq 200$   
 $x_1 + x_2 + x_4 = 300$   
 $25x_1 + 4x_2 + 5x_3 + x_5 = 1000$   
 $x_2 + x_3 + \lambda_1 = 200$   
 $x_1 + x_6 = 200$

$Z = 6x_1 + 2x_2 + 3x_3 + 0x_4 + 0x_5 + 0x_6 - M\lambda_1$

C <sub>k</sub>	X <sub>b</sub>	B	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	λ <sub>1</sub>
0	X <sub>4</sub>	300	1	1	0	1	0	0	-
0	X <sub>5</sub>	1000	25	4	5	0	1	0	200
-M	λ <sub>1</sub>	200	0	1	(1)	0	0	0	1 ←
-10	X <sub>6</sub>	200	1	0	0	0	0	1	0
Z = -200M		-6	-M-2	-M-3	0	0	0	0	
0	X <sub>4</sub>	300	1	1	0	-1	0	0	300
0	X <sub>5</sub>	70	(2)	-1	0	0	1	0	0 ←
0	X <sub>3</sub>	200	0	1	1	0	0	-1	-
0	X <sub>6</sub>	200	1	0	0	0	0	1	200
Z = 600		0	-6	1	0	0	0	M-6	
0	X <sub>4</sub>	300	0	1/4	0	1	-0,4	0	214,3
0	X <sub>1</sub>	20	1	0,4	0	0	0,4	0	-
3	X <sub>3</sub>	200	0	(1)	1	0	0	0	1 ←
0	X <sub>6</sub>	200	0	0,4	0	0	-0,4	1	500
Z = 600		0	-1,4	0	0	2,4	0	M-9	

# EJERCITACIÓN EN CLASE

Materia prima  
Demanda mínima  
Eficacia

(4.5)  $MP) 6X_1 + 5X_2 \leq 30$

DM)  $X_2 \geq 1$

MAX:  $Z = 5X_1 + 8X_2 + M$

EF)  $-2X_1 + 2X_2 \leq 6$

$X_3, X_4, X_5$  var. slacks

$6X_1 + 5X_2 + X_3 = 30$

$X_2 - X_4 + M_1 = 1$

$-2X_1 + 2X_2 + X_5 = 6$

$X_1 =$  Producto 1

$X_2 =$  Producto 2

$X_3 =$  sobrante de MP.

$X_4 =$  Excedente D, V, o P.

$X_5 =$  Demanda insatisfecha.

$X_1$	$X_2$	$X_3$	$X_4$	$X_5$	$M$
6	5	1	0	0	0
0	1	0	-1	0	1
-2	2	0	0	1	0

Vectores canonicos = a la cantidad de vectores de cvl. de filas

crec. tecnológicas  
aspiradas a los  
reales.

FACTIBLE  
BASICA  
OPTIMA

Demanda

$C_k$	$X_k$	B	$X_1$	$X_2$	$X_3$	$X_4$	$X_5$	$M$	$\theta$
0	$X_3$	30	6	5	1	0	0	0	6
$-M$	$M$	1	0	1	0	-1	0	1	1
0	$X_5$	6	-2	2	0	0	1	0	3
			-5	-M-8	0	M	0	0	

$m - n$   
Real Slacks artificiales  
 $6 - 3$

0	$X_3$	25	6	0	1	5	0	5
8	$X_2$	1	0	1	0	-1	0	-
0	$X_5$	4	-2	0	0	2	1	2
$Z = 8$			-5	0	0	-8	0	

$\theta \geq 0$   $X_3$  representa

## CONTINUACION DEL (4.5)

0	$X_1$	20	0	0	1	1	0	0,6
6	$X_1$	80	1	0	0	0	0	-1,6
2	$X_2$	200	0	1	1	0	0	1
0	$X_4$	120	0	0	0	0	1	1,6
$Z = 880$			0	0	1,4	0	2,4	$M - 7,6$

116) MAX  $Z = 6x_1 + 4x_2$

$2x_1 + x_2 \leq 600$

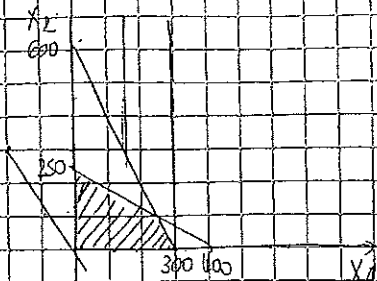
$2 \leq x_1 + 4x_2 \leq 1000$

$x_1 \leq 300$

$2x_1 + x_2 + x_3 = 600$

$2x_1 + x_2 + 4x_4 + x_5 = 1000$

$x_1 + x_6 = 300$



Cx	Xk	B	X1	X2	X3	X4	X5	
0	X3	600	2	1	↑	0	0	300
0	X4	1000	2,5	4	0	1	0	400
-0	X5	300	(1)	0	0	0	1	300
	Z=0		-6	-4	0	0	0	
			↑					
0	X3	0	0	(1)	1	0	-2	0
0	X4	250	0	4	0	1	-2,5	62,5
6	X1	300	1	0	0	0	1	-
	Z=1800		0	-4	0	0	6	
			↑					
4	X2	0	0	1	1	0	-2	-
0	X4	250	0	0	-4	1	(5,5)	45,45
6	X1	300	1	0	0	0	1	300
	Z=1800		0	0	4	0	-2	
			↑					
4	X2	190,90	0	1	-0,45	0,36	0	-
0	X5	45,45	0	0	-0,73	0,18	1	-
6	X1	254,34	1	0	0,73	-0,18	0	-
	Z=1890,84		0	0	2,54	0,36	0	

→ SOL. DEGENERADA

117) MAX  $Z = -2x_1 - 4x_2$

$x_2 \leq 3$

$4x_1 + 5x_2 \leq 24$

$2x_1 + 2x_2 \geq 0$

siendo  $x_i \geq 0$

$Z = -2x_1 + 4x_2 - M M_1$

$x_2 + x_3 = 3$

$4x_1 + 5x_2 + x_4 = 24$

$2x_1 + 2x_2 - x_5 + M_1 = 0$

siendo  $x_i, M \geq 0$

Cx	Xk	b	X1	X2	X3	X4	X5	M1
0	X3	3	0	1	-1	0	0	0
0	X4	24	4	5	0	1	0	0
m	M1	0	2	(2)	0	0	-1	1
	Z=0		-2m	-2m	0	0	m	0
			↑					
0	X5	3	-1	0	1	0	(1/2)	-1/2
0	X4	24	-1	0	0	1	2,5	-2,5
4	X2	0	-1	1	0	0	-1/2	1/2
	Z=0		-6	0	0	0	-2	2+m

	$C_k$	$X_k$	B	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$	-M
que pasa cuando $C_1 = C_2 = ?$	0	$x_3$	6	-2	0	2	0	1	-1
	0	$x_4$	9	4	0	-3	1	0	0
	4	$x_2$	3	0	1	1	0	0	0
	$Z = 2$			2	0	4	0	0	0M

$\downarrow$   
 costo de oportunidad       $\downarrow$  valor marginal

4.8) MAX  $Z = 4x_1 + 4x_2$

sujeto a:  $x_1 + x_3 = 6$        $x_1 + x_2 + x_3 + x_4 = 8$   
 $x_1 + x_2 \leq 8$        $x_1 + 2x_2 + x_5 = 12$   
 $x_1 + 2x_2 \leq 12$

Siendo  $x_i \geq 0$

$C_k$	$X_k$	B	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$	
0	$x_3$	6	①	0	1	0	0	6 ←
0	$x_4$	8	1	1	0	1	0	8
0	$x_5$	12	1	2	0	0	1	12
	$Z = 0$		-4	-4	0	0	0	
			↑					
4	$x_1$	6	1	0	1	0	0	6 ←
0	$x_4$	2	0	①	-1	1	0	2 ←
0	$x_5$	6	0	-4	-1	0	1	6
	$Z =$		0	-4	4	0	0	
			↑					
4	$x_1$	6	1	0	1	0	0	6
4	$x_2$	2	0	1	-1	1	0	2 ←
0	$x_5$	2	0	0	①	-2	1	2 ←
	$Z = 24$		0	0	0*	4	0	
					1			
4	$x_1$	4	1	0	0	2	-1	
4	$x_2$	4	0	1	0	-1	1	
0	$x_3$	2	0	0	1	-2	1	
	$Z = 24$		0	0	0	4	0*	

→ RANGO DE SOLUCIONES.

→ soluciones alternativas

Operaciones

4.9) MAX  $Z = 6x_1 + 4x_2$

$2x_1 + 4x_2 \leq 48$        $2x_1 + 4x_2 + x_3 = 48$   
 $4x_1 + 2x_2 \leq 60$        $4x_1 + 2x_2 + x_4 = 60$   
 $3x_1 \leq 45$        $3x_1 + x_5 = 45$

Siendo  $x_i \geq 0$

$C_k$	$X_k$	B	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$	
0	$x_3$	48	2	4	1	0	0	24
0	$x_4$	60	④	2	0	1	0	15
0	$x_5$	45	③	0	0	0	1	15
	$Z = 0$		-6	-4	0	0	0	
			↑					
		15	1	0.5	0	1/4	0	
	$x_5 \leftarrow$	15	1	0	0	0	1/3	

→ solución degenerada

C <sub>k</sub>	X <sub>k</sub>	B	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	θ
0	X <sub>3</sub>	18	0	4	1	0	-0,67	4,5 ←
0	X <sub>4</sub>	0	0	2	0	1	-1,33	0 ←
6	X <sub>1</sub>	15	1	0	0	0	0,33	-
	Z = 90		0	-4	0	0	2	
				↑				
0	X <sub>3</sub>	18	0	0	1	-2	(1,99)	9,05 ←
4	X <sub>2</sub>	0	0	1	0	1	-0,67	-
6	X <sub>1</sub>	15	1	0	0	0	0,33	4,545
	Z = 90		0	0	0	2	-0,66	
				↑				
0	X <sub>2</sub>	9,05	0	0	0,5	-1	1	
4	X <sub>2</sub>	6,05	0	1	0,34	-0,7	0	
6	X <sub>1</sub>	12,02	1	0	-0,17	0,33	0	
	Z = 94,36		0	0	0,33	1,34	0	

1.10) MAX = Z = 2X<sub>1</sub> + X<sub>2</sub>

Substansia:  $-3X_1 + 3X_2 \geq 5$        $-3X_1 + 3X_2 - X_3 + M_1 = 5$   
 $X_1 + X_2 \leq 4$                                $X_1 + X_2 + X_4 = 4$   
 $2X_1 + X_2 \geq 10$                                $2X_1 + X_2 - X_5 + M_2 = 10$

shunda X<sub>i</sub> ≥ 0

C <sub>k</sub>	X <sub>k</sub>	B	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	M <sub>1</sub>	M <sub>2</sub>	
-M	M <sub>1</sub>	5	-3	3	0	0	0	1	0	5/3 ←
0	X <sub>4</sub>	4	1	1	0	1	0	0	0	4
-M	M <sub>2</sub>	10	2	1	0	0	-1	0	1	10
	Z = -15M		3M-9	M-1	M	0	M	0	0	
			↑	↑						
1	X <sub>2</sub>	5/3	-5/3	1	-1/3	0	0	1/3	0	-
←	0	2,33	2,67	0	1/2	-1	0	-1/2	0	0,87
-M	M <sub>1</sub>	3,33	3,67	0	1/3	0	-1	-1/3	1	2,27
	Z = -8,33M + 1,67		3,67(M+1)	0	-1/3(M+1)	0	0	1/3M + 1/3	0	
			↑							

1	X <sub>2</sub>	3/5	0	1	-0,12	0,63	0	0,12	0
2	X <sub>1</sub>	0,87	1	0	0,12	0,37	0	-0,12	0
-M	M <sub>2</sub>	6	0	0	-0,12	-1,37	-1	0,12	1
	Z = -8,33M + 1,67		0	0	0,2(M+1)	1,37(M+1)	M	0,88M - 0,12	0