

ARE YOU READY?



Amandla Clothing Company manufactures clothing to sell to supporters at political rallies. Amandla is capable of manufacturing three types of clothing: shirts, shorts, and pants. The manufacture of each type of clothing requires that Amandla have the appropriate type of machinery available. The machinery needed to manufacture each type of clothing must be rented at the following rates: shirt machinery, R200 per week; shorts machinery, R150 per week; pants machinery, R100 per week.

Resource requirements for Amandla					
Clothing type	Labour (hours)	Cloth (m^2)			
Shirts	3	4			
Shorts	2	3			
Pants	6	4			



The manufacture of each type of clothing also requires the amounts of cloth and labour shown in the first table. Each week, 150 hours of labour and 160 m^2 of cloth are available. The variable unit cost and selling price for each type of clothing are shown in the second table below.

Revenue and cost information for Amandla					
Clothing type	Sales Price (R)	Variable cost (R)			
Shirts	12	6			
Shorts	8	4			
Pants	15	8			

Formulate an IP whose solution will maximize Amandla's weekly profits.

- Declaring decision variables:
 - $x_i = number\ of\ item\ i\ manufactured\ i = 1 = shirts, 2 = shorts, 3 = pants$
 - $y_j = machine j$ rented or not j = 1 = shirt machine, 2 = short machine, 3 = pants machine



Objective function:

•
$$\max z = 6x_1 + 4x_2 + 7x_3 - 200y_1 - 150y_2 - 100y_3$$

Labour constraint:

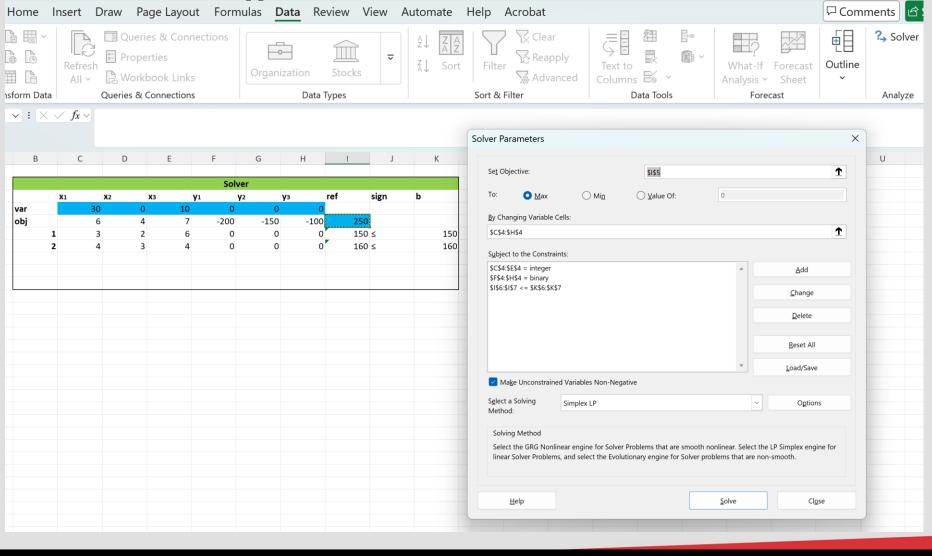
•
$$s.t.3x_1 + 2x_2 + 6x_3 \le 150$$

Cloth constraint:

•
$$4x_1 + 3x_2 + 4x_3 \le 160$$

- Sign restrictions:
 - $x_1, x_2, x_3 \ge 0$
 - x_1, x_2, x_3 integers
 - $y_1, y_2, y_3 = 0 \text{ or } 1$

Fixed Charge - Solver





Check 1st year slides if you don't remember how to add Solver or how to do the Sumproduct to have the correct cell referencing in cells 15 to 17

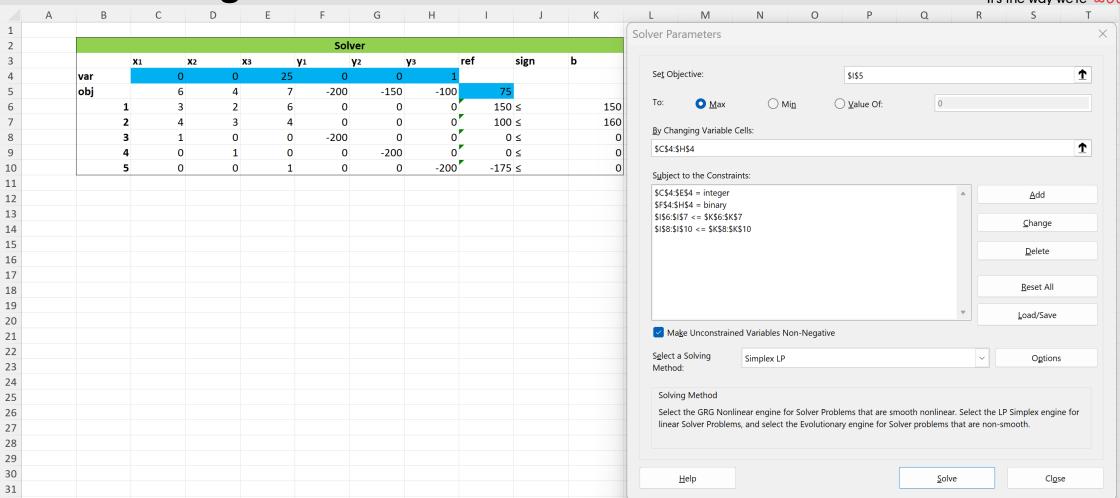


- Y constraints:
 - $x_1 \le 40y_1 \longrightarrow x_1 40y_1 \le 0$ If shirts are made, then shirt machine is rented
 - $x_2 \le 53{,}33y_2 \longrightarrow x_2 53{,}33y_2 \le 0$ If shorts are made, then shorts machine is rented
 - $x_3 \le 25y_3 \longrightarrow x_3 25y_3 \le 0$ If pants are made, then pants machine is rented

x1	<=	40y1				
If 0 shirts are made						
0<= 40(0)	TRUE If 0 shirts are made, the machine is not rented					
		If 20 shirts are ma	ide			
20<= 40(0)) FALSE will change y1=0 to y1=1					
20<= 40(1)	TRUE if 20 shirts are made, a shirt machine is rented					
If 50 shirts are made						
50<= 40(0)	FALSE	will change y1=0 to y1=1				
50<= 40(1)	FALSE	Also false, will not allow t	his value			



Fixed Charge - Solver





Fixed Charge - Either or constraints

- If pants are made (if x_3 has a values), more than or exactly 20 must be made.
- M = 25, 25 pants can be made at most.
- $x_3 \le 0$ or $x_3 \ge 20$, but we cannot just add these two constraints
- d3 = dummy variable 0 or 1
- use the following for an either-or constraint:

$$x - (U \times 2)d \le L$$
 and $-x + (U \times 2)d \le U$

x_3	_	$40d_3$	<u> </u>	0				
$-x_3$	+	$40d_3$	<u> </u>	20				
If $x_3 = 0$								
(0)	_	40(0)	≤	0	Т	TRUE	Takes $d_3 = 0$	
-(0)	+	40(0)	≤	20	Т	INOL		
If $x_3 = 10$								
(10)	_	40(0)	≤	0	F	FALS	Changes	
-(10)	+	40(0)	≤	20	Т	E	$d_3 = 1$	
(10)	_	40(1)	≤	0	Т	FALS	10 is not accepted	
-(10)	+	40(1)	≤	20	F	Е		
If $x_3 = 30$								
(30)	_	40(0)	≤	0	F	FALS	Changes	
-(30)	+	40(0)	≤	20	Т	E	$d_3 = 1$	
(30)	_	40(1)	≤	0	Т	TRUE	30 is accepted	
-(30)	+	40(1)	≤	20	Т			



Fixed Charge — It's the way we're wired. Either or constraints

Change the previous formulae to fit the example L = 0, U = 20

$$x_3 - 40d_3 \le 0$$
 and $-x + 40d_3 \le 20$



Exercises

A manufacturer can sell product 1 at a profit of \$2/unit and product 2 at a profit of \$5/unit. Three units of raw material are needed to manufacture one unit of product 1, and six units of raw material are needed to manufacture one unit of product 2. A total of 120 units of raw material are available. If any of product 1 is produced, a setup cost of \$10 is incurred, and if any of product 2 is produced, a setup cost of \$20 is incurred.

- Formulate an Integer Programming Model that will solve the requirements of the Manufacturer.
- Solve the formulated Integer Programming Model using Solver.
- Add the following to the IP: If product 1 is produced, more than 20 should be produced or less than 5.
- Solve the formulated Integer Programming Model using Solver.
- Change the IP so that product 1 and product 2 uses the same setup cost of \$40 once off for any of the two or both.
- Solve using Branch & Bound Simplex Algorithm.



Exercises

In the document 'Fixed-Charge Problems (Exercises)





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