hw

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IE 407 - HOMEWORK 1

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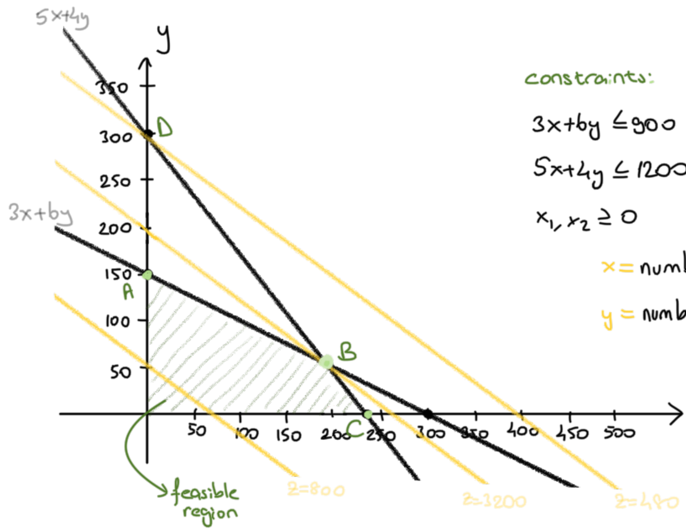
(a)



constraints:

$3x+6y \leq 900$ $\qquad z = 12x+16y$

$5x+4y \leq 1200$

$x_1, x_2 \geq 0$

x = number of t-shirts to be produced

y = number of sweatshirts to be produced

The last isoprofit intersecting the feasible region B is the optimal solution.

$B = (200, 50)$ $\qquad$ maximum profit $z = 12.200 + 16.50 = 3200$ \$

(b) let p_1 = profit for a sweatshirt

$-\frac{5}{4} \leq -\frac{12}{p_1} \leq -\frac{3}{6}$ $\qquad 24 \geq p_1 \geq 9{,}6$ $\qquad$ when $p_1 = 17$ it is inside this range, so optimum solution will not change.

new maximum profit $z_{new} = 12.200 + 17.50 = 3250$ \$

(c) let p_2 = profit for a thirt

$-\frac{5}{4} \leq -\frac{p_2}{16} \leq -\frac{3}{6}$ $\qquad 8 \leq p_2 \leq 20$

when $p_2 = 20$, since it is in the range, the optimum solution would be same, the new maximum profit value $20.200 + 16.50 = 4800$

If it changed more than 20\$, the optimum solution would change to point A, new maximum profit would be greater than 4800 $\rightarrow z_{new} \geq 4800$

(d)

$$\left.\begin{aligned} 3x+6y &\leq 900+\Delta_1 \\ 5x+4y &\leq 1200 \\ x &= 200 - \frac{2}{9}\Delta_1 \\ y &= 50 + \frac{5\Delta_1}{18} \end{aligned}\right\}$$

$z = 12(200 - \frac{2}{9}\Delta_1) + 16(50 + \frac{5\Delta_1}{18}) = 3250 + \frac{16}{9}\Delta_1$

the shadow price for wool constraints is $\frac{16}{9}$

wool constraint's upper bound (for B point to be the optimum solution) is when constraints intersection point is A.(0,300) $\Rightarrow 3.0 + 6.300 = 1800$. So when 300 additional is obtained $900 + 300 = 1200$ the point B (with new values) is still optimum solution. Since shadow price is $\frac{16}{9}$ new maximum profit would be $3200 + \frac{16}{9}.300 = 3733.33$

decision variables (number of products to be produced)

	handmade	machine 1	machine 2	machine 3	total product		requirement
cheesecake	0	0	3000	0	3000	>	3000
muffin	3000	0	0	2000	5000	>	5000
cake	0	0	0	2000	2000	>	2000

production cost per unit

	handmade	machine 1	machine 2	machine 3
cheesecake	5	5	3	4
muffin	3	4	4	3
cake	8	6	5	4

cost to minimize
32000

processing time per unit

	handmade	machine 1	machine 2	machine 3
cheesecake	0,9	0,25	0,2	0,2
muffin	0,5	0,3	0,2	0,25
cake	1,2	0,6	0,6	0,5
total time processed	1500	0	600	1500
	<=	<=	<=	<=
available time	1500	1200	1500	2000

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Microsoft Excel 16.16 Answer Report
Worksheet: [q2.xlsx]Sheet1
Report Created: 30.10.2022 19:47:12
Result: Solver found a solution. All constraints and optimality conditions are satisfied.
Solver Engine

Engine: Simplex LP
Solution Time: 42950394,933 Seconds.
Iterations: 11 Subproblems: 0

Solver Options

Max Time Unlimited, Iterations Unlimited, Precision 0,000001
Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Solve Without Integer Constraints, Assume NonNegative

Objective Cell (Min)

Cell	Name	Original Value	Final Value
$G$9	cheesecake cost to minimize	32000	32000

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$3	cheesecake handmade	0	0	Integer
$C$3	cheesecake machine 1	0	0	Integer
$D$3	cheesecake machine 2	3000	3000	Integer
$E$3	cheesecake machine 3	0	0	Integer
$B$4	muffin handmade	3000	3000	Integer
$C$4	muffin machine 1	0	0	Integer
$D$4	muffin machine 2	0	0	Integer
$E$4	muffin machine 3	2000	2000	Integer
$B$5	cake handmade	0	0	Integer
$C$5	cake machine 1	0	0	Integer
$D$5	cake machine 2	0	0	Integer
$E$5	cake machine 3	2000	2000	Integer

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$B$18	total time processed handmade	1500	$B$18<=$B$20	Binding	0
$C$18	total time processed machine 1	0	$C$18<=$C$20	Not Binding	1200
$D$18	total time processed machine 2	600	$D$18<=$D$20	Not Binding	900
$E$18	total time processed machine 3	1500	$E$18<=$E$20	Not Binding	500
$F$3	cheesecake total product	3000	$F$3>=$H$3	Binding	0
$F$4	muffin total product	5000	$F$4>=$H$4	Binding	0
$F$5	cake total product	2000	$F$5>=$H$5	Binding	0
$B$3:$E$5=Integer					

Microsoft Excel 16.16 Sensitivity Report
Worksheet: [q2.xlsx]Sheet1
Report Created: 30.10.2022 19:47:12

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$3	cheesecake handmade	0	2	5	1E+30	2
$C$3	cheesecake machine 1	0	2	5	1E+30	2
$D$3	cheesecake machine 2	3000	0	3	1	3
$E$3	cheesecake machine 3	0	1	4	1E+30	1
$B$4	muffin handmade	3000	0	3	2,22045E-16	1E+30
$C$4	muffin machine 1	0	1	4	1E+30	1
$D$4	muffin machine 2	0	1	4	1E+30	1
$E$4	muffin machine 3	2000	0	3	1	2,22045E-16
$B$5	cake handmade	0	4	8	1E+30	4
$C$5	cake machine 1	0	2	6	1E+30	2
$D$5	cake machine 2	0	1	5	1E+30	1
$E$5	cake machine 3	2000	0	4	1	4

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$B$18	total time processed handmade	1500	-4,44089E-16	1500	1000	1000
$C$18	total time processed machine 1	0	0	1200	1E+30	1200
$D$18	total time processed machine 2	600	0	1500	1E+30	900
$E$18	total time processed machine 3	1500	0	2000	1E+30	500
$F$3	cheesecake total product	3000	3	3000	4500	3000
$F$4	muffin total product	5000	3	5000	2000	2000
$F$5	cake total product	2000	4	2000	1000	2000

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b)

From the variable cells table in the sensitivity report sheet, the allowable increase in cost of producing cheesecake, in machine 2 is 1, allowable decrease is 3. For values between 0 and 4, the current basis remains optimal.

Since 1 is allowable increase, the optimum solution will remain same. Therefore, the new objective function value will be:

z_new = z_old + 1*(number of cheesecake produced in machine 2)
z_new = 32000 + 3000 = 35000

c)

From the variable cells table in the sensitivity report sheet, the allowable increase in cost of producing cake in machine 2 is up to infinite, allowable decrease is 1. For values greater that 4, the current basis remains optimal.

If we increase the cost by 1 unit to 6, since it is in the allowable range, the current optimum solution will still be the optimum solution. The new objective function value will be:

z_new = z_old + 1*(number of cake produced in machine 2)
z_new = 32000 + 1*(0) = 32000 (Since we do not produce any cake in the machine 2, it also stays the same)

If we decrease the cost by 2 units to 3, since it is not in the allowable range, the current optimum solution won't remain same. We have to solve the problem again to find the exact new z value, but we can conclude that (since allowable decrease is 1):

z_new <= z_old - 1(number of cake produced in machine 2)
z_new <= 32000

d)

From the constraints table in the sensitivity report sheet, the allowable increase in production requirement of muffin is 2000, allowable decrease is 2000, so that the current solution remains. Between (3000, 7000)

Shadow price for this constraint is 3, so if we the production requirement is increased by 1 the optimal objective function value will increase by 3, then will be 32003. We have to solve the problem again to find the exact values of the production of other products.

e)

From the constraints table in the sensitivity report sheet, the allowable increase in the time availability of the Machine 3 is up to infinite, allowable decrease is 500, so that the current solution remains. (For values greater that 1500, the current basis remains optimal.) Since it is not a binding constraint from the answer report, and increasing it by one will remain in the allowable range the current optimum solution and optimal objective function value will be same. Its shadow price is 0 from the constraints table (since it is not binding, shadow price must be 0 too).

f)

Since there is no handmade cheesecake in the optimum solution, if we forced to be, the cost will increase by 2, because its reduced cost is 2. The new optimal objective value would be: 32002, we have to solve the problem again to find the exact values of production.

Since allowable decrease is 2 and increase is up to infinity, for cost values greater than or equal to 3, the current basis remains optimum.

Since the reduced cost value of handmade cheesecake is 2, it will be part of the solution if the cost would decrease more than 2 unit. So, it will take positive values for cost values less than 3.