

Title: DIET and MIXING Model

1-What is the meaning of Operations Research? What are the different phases for operations research?

Operations Research in the USA , south Africa and Australia and Operations Research in Europe and Canda.

It is interdisciplinary branch of applied mathematics and formal sciences that uses methods such as mathematical modeling,statistics and algorithms to arrive at optimal or near optimal solutions to complex problem .it is typically concerned with optimizing the maxima or minima of some objective function Operations Research helps management achieve its goals using scientific methods. The first formal activities of OR were initiated in England warII when a team of British scientists set out to make scientifically based decisions regarding the best utilization of war material After the war the ideas advanced in military operation were adapted to improve effecience and productivity in the civilian sector .

The different phases for operations research is :

1-Problem Definition (1-Decision variable .2-objective .3constrains)==(Formulate the problem).

2-Model Constrains (translate the problem definition into mathematical relationships .if the resulling model fits one of standard mathematical model such as LP .we can usually reach a solution by using available algorithm)==Develop a model.

3-Select appropriate data input.

4-Model Solution (it is far the simplest of all OR phase).

5-Model Validity (checks whether or not the proposed model does what it purport to do).

6-Implemention (the translation of the result into understandable operation instructions to be issued to the people who will administer the recommended system).

2- Formulate the Mathematical Linear Programming for this problem

1Decision Variable : x_1 :The number of units of food of type 1.

x_2 :The number of units of food of type 2. x_3 :The number of units of food of type 3. x_4 :The number of units of food of type 4. 2Objective :

Min : $z = 45x_1 + 40x_2 + 85x_3 + 65x_4$.

3-Constraint:

$3x_1 + 4x_2 + 8x_3 + 6x_4 \geq 800$, for proteins

$2x_1 + 2x_2 + 7x_3 + 5x_4 \geq 200$, for fats

$6x_1 + 4x_2 + 7x_3 + 4x_4 \geq 700$, for carbohydrates

where $x_1, x_2, x_3, x_4 \geq 0$ hidden.

3-Define the meaning of basic feasible solution of a general Linear Programming Problem.

In the theory of linear programming, a basic feasible solution (BFS) is a solution with a minimal set of non-zero variables. Geometrically, each BFS corresponds to a corner of the polyhedron of feasible solutions. If there exists an optimal solution, then there exists an optimal BFS.

4- Solve the problem using Regular Simplex method.

Modeling : $z = 45x_1 + 40x_2 + 85x_3 + 65x_4$.

Subject to

$3x_1 + 4x_2 + 8x_3 + 6x_4 \geq 800$, for proteins

$2x_1 + 2x_2 + 7x_3 + 5x_4 \geq 200$, for fats

$6x_1 + 4x_2 + 7x_3 + 4x_4 \geq 700$, for carbohydrates

where $x_1, x_2, x_3, x_4 \geq 0$ hidden. Add 3 surplus

and 3 artificial.

1. As the constraint-1 is of type ' \geq ' we should subtract surplus variable S_1 and add artificial variable A_1

2. As the constraint-2 is of type ' \geq ' we should subtract surplus variable S_2 and add artificial variable A_2

3. As the constraint-3 is of type ' \geq ' we should subtract surplus variable S_3 and add artificial variable A_3

After adding

Min $Z = 45x_1 + 40x_2 + 85x_3 + 65x_4 + 0S_1 + 0S_2 + 0S_3 + MA_1 +$

$MA_2 + MA_3$ subject to

$$\begin{aligned}
 3x_1 + 4x_2 + 8x_3 + 6x_4 - S_1 &+ A_1 = 800 \\
 2x_1 + 2x_2 + 7x_3 + 5x_4 - S_2 &+ A_2 = 200 \\
 6x_1 + 4x_2 + 7x_3 + 4x_4 - S_3 &+ A_3 = 700
 \end{aligned}$$

1-tablon or table

Iteratio n-1		C_j	45	40	85	65	0	0	0	M	M	M	
B	C B	XB	x_1	x_2	x_3	x_4	S 1	S 2	S 3	A 1	A 2	A 3	MinRatio XBx_3
A1	M	80 0	3	4	8	6	-1	0	0	1	0	0	8008=100
A2	M	20 0	2	2	(7)	5	0	-1	0	0	1	0	2007=28.57 14→
A3	M	70 0	6	4	7	4	0	0	-1	0	0	1	7007=100
Z=1700 M		Z	11M	10M	22M	15M	- M	- M	- M	M	M	M	
		Z- C_j	11M- 45	10M- 40	22M85↑	15M- 65	- M	- M	- M	0	0	0	

Enter =x3, Drop =A2.

R2=R2/7, R1=R1-8*R2, R3=R3-7R.

2-tablon or table

Iteration2		C_j	45	40	8 5	65	0	0	0	M	M	M	
B	C_B	X_B	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XBx1
A1	M	57 1.4 28 6	0.7143	1.7143	0	0.2857	- 1	1.142 9	0	1	- 1.1429	0	571.428 60.7143 =800
x_3	8 5	28. 57 14	(0.285 7)	0.2857	1	0.7143	0	- 0.142 9	0	0	0.1429	0	28.5714 0.2857= 100→
A3	M 0	50 4	4	2	0	-1	0	1	- 1	0	-1	1	5004=1 25
$Z=1071.4$ $286M+24$ 28.5714		Z_j	4.7143 $M+24.$ 2857	3.7143 $M+24.$ 2857	8 5	- 0.7143 $M+60.$ 7143	- M	2.142 9 $M-$ 12.14 29	- M	M	- 2.1429 $M+12.$ M 1429	M	
		$Z_j - C_j$	4.7143 $M-$ 20.714 3↑	3.7143 $M-$ 15.714 3	0	- 0.7143 $M-$ 4.2857	- M	2.142 9 $M-$ 12.14 29	- M 0	0	- 3.1429 $M+12.$ 1429	0	

Enter $=x_1$, Drop $=x_3$.

$R_2 = R_2 / 0.2857$, $R_1 = R_1 - 0.7143R_2$, $R_3 = R_3 - 4R_2$.

3-tablon or table

Iteratio n-3		C_j	$\begin{matrix} 4 \\ 5 \end{matrix}$	40	85	65	0	0	0	M	M	M	
B	C_B	X_B	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XBS_2
A_1	M	$\begin{matrix} 50 \\ 0 \end{matrix}$	0	1	-2.5	-1.5	$\begin{matrix} - \\ 1 \end{matrix}$	1.5	0	1	-1.5	0	$5001.5=33.3333$
x_1	$\begin{matrix} 4 \\ 5 \end{matrix}$	$\begin{matrix} 10 \\ 0 \end{matrix}$	1	1	3.5	2.5	0	-0.5	0	0	0.5	0	---
A_3	M	$\begin{matrix} 10 \\ 0 \end{matrix}$	0	-2	-14	-11	0	(3)	$\begin{matrix} - \\ 1 \end{matrix}$	0	-3	1	$1003=33.3333 \rightarrow$
$Z=600$ $M+4500$		Z_j	$\begin{matrix} 4 \\ 5 \end{matrix}$	$\begin{matrix} - \\ M+45 \end{matrix}$	$\begin{matrix} - \\ 16.5M+157.5 \end{matrix}$	$\begin{matrix} - \\ 12.5M+112.5 \end{matrix}$	$\begin{matrix} - \\ M \end{matrix}$	$\begin{matrix} 4.5M-22.5 \end{matrix}$	$\begin{matrix} - \\ M \end{matrix}$	M	$\begin{matrix} - \\ 4.5M+22.5 \end{matrix}$	M	
		Z_j C_j	0	$\begin{matrix} - \\ M+5 \end{matrix}$	$\begin{matrix} - \\ 16.5M+72.5 \end{matrix}$	$\begin{matrix} - \\ 12.5M+47.5 \end{matrix}$	$\begin{matrix} - \\ M \end{matrix}$	$\begin{matrix} 4.5M-22.5 \end{matrix}$ \uparrow	$\begin{matrix} - \\ M \end{matrix}$	0	$\begin{matrix} - \\ 5.5M+22.5 \end{matrix}$	0	

Enter =S2, Drop =A3.

$R_3=R_3/3$, $R_1=R_1-1.5R_3$, $R_2=R_2+.5R_3$. 4-tablon
or table

Iteratio n-4		C_j	$\begin{matrix} 4 \\ 5 \end{matrix}$	40	85	65	0	0	0	M	M	M	
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B	C_B	XB	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XBx_3
A1	M	450	0	2	(4.5)	4	-1	0	0.5	1	0	-0.5	450/4.5=100 →
x_1	45	116.6667	1	0.6667	1.1667	0.6667	0	0	-0.1667	0	0	0.1667	116.6667/1.1667=100
S_2	0	33.3333	0	-0.6667	-4.6667	-3.6667	0	1	-0.3333	0	-1	0.3333	---
$Z=450M+5250$		Z_j	45	$2M+30$	$4.5M+52.5$	$4M+30$	$-M$	0	$0.5M-7.5$	M	0	$-0.5M+7.5$	
		Z_j-C_j	0	$2M-10$	$4.5M-32.5$ ↑	$4M-35$	$-M$	0	$0.5M-7.5$	0	$-M$	$-1.5M+7.5$	

Enter =x3, Drop =A1

$R_1=R_1/4.5$, $R_2=R_2-1.1667R_1$, $R_3=R_3-4.6667R_1$. 5-tablon
or table

Iterati on-5		C_j	4 5	40	8 5	65	0	0	0	M	M	M	
B	C_B	X_B	x_1 1	x_2	x_3 3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XBx_2

x_3	8 5	10 0	0	0.44 44	1	0.88 89	- 0.22 22	0	0.11 11	0.2222	0	- 0.1111	1000.4444= 225
x_1	4 5	0	1	(0.14 81)	0	- 0.37 04	0.25 93	0	- 0.29 63	- 0.2593	0	0.2963	00.1481=0 →
S_2	0	50 0	0	1.40 74	0	0.48 15	- 1.03 7	1	0.18 52	1.037	- 1	- 0.1852	5001.4074= 355.2632
$Z=850$ 0		Z_j	4 5	44.4 444	8 5	58.8 889	- 7.22 22	0	- 3.88 89	7.2222	0	3.8889	
		$Z_j - C_j$	0	4.44 44↑	0	- 6.11 11	- 7.22 22	0	- 3.88 89	- $M+7.2$ 222	- M	- $M+3.8$ 889	

Enter = x_2 , Drop = x_1 .

$R_2 = R_2 / .01481$.

$R_1 = R_1 - .4444R_2$.

$R_3 = R_3 - 1.4074R_2$.

6-tablon or table

Iteration6		C_j	45	40	85	65	0	0	0	M	M	M	
B	$C B$	XB	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XBx_4
x_3	85	100	-3	0	1	(2)	-1	0	1	1	0	-1	1002=50 →
x_2	40	0	6.7 5	1	0	- 2.5	1.7 5	0	-2	-1.75	0	2	---

S2	0	500	-9.5	0	0	4	-3.5	1	3	3.5	-1	-3	5004=125
Z=8500		Zj	15	4 0	8 5	70	-15	0	5	15	0	-5	
		Zj- Cj	-30	0	0	5 ↑	-15	0	5	- M+15	- M	-M- 5	

Enter =x4, Drop =x3.

R1=R1/2.

R2=R2+2.5R1.

R3=R3-4R1.

7-tablon or table

Iteration n-7		Cj	45	4 0	85	6 5	0	0	0	M	M	M	
B	C B	XB	x1	x 2	x3	x 4	S1	S 2	S3	A1	A 2	A3	MinRatio XBS3
x4	65	50	-1.5	0	0.5	1	-0.5	0	(0.5)	0.5	0	-0.5	500.5=100 →
x2	40	125	3	1	1.2 5	0	0.5	0	0.7 5	-0.5	0	0.75	---
S2	0	300	-3.5	0	-2	0	-1.5	1	1	1.5	-1	-1	3001=300

$Z=8250$		Z_j	22. 5	4 0	82. 5	6 5	12. 5	0	2.5	12.5	0	-2.5	
		$Z_j - C_j$	22. 5	0	- 2.5	0	12. 5	0	2.5 ↑	- $M+12.5$	- M	- M - 2.5	

Enter=S3, Drop =x4.

$R1=R1/0.5$

$R2=R2-.75R1$.

$R3=R3-R1$.

8-tablon or table

Iteration8		C_j	45	4 0	8 5	65	0	0	0	M	M	M	
B	C_B	XB	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio
S3	0	100	-3	0	1	2	-1	0	1	1	0	-1	
x_2	40	200	0.7 5	1	2	1. 5	- 0.25	0	0	0.25	0	0	
S2	0	200	-0.5	0	-3	-2	-0.5	1	0	0.5	-1	0	
$Z=8000$		Z_j	30	4 0	8 0	60	-10	0	0	10	0	0	
		$Z_j - C_j$	-15	0	-5	-5	-10	0	0	- $M+10$	- M	- M	

$X_2=200, x_1=0, x_3=0, x_4=0$ then $z=40*200=8000$.

Final tablon .

5- Find the Dual Problem, and determine which is computationally advantageous to solve either the Primal or the Dual, then solve both problems

1-Dual problem :

$$\text{Max} = \mathbf{b}^T \mathbf{y}$$

$$\mathbf{A}^T \mathbf{y} \leq \mathbf{c} \quad \mathbf{y} \geq 0$$

$$\text{max } z = 800 y_1 + 200 y_2 + 700 y_3.$$

Subject to

$$3 y_1 + 2 y_2 + 6 y_3 \leq 45,$$

$$4 y_1 + 2 y_2 + 4 y_3 \leq 40,$$

$$8 y_1 + 7 y_2 + 7 y_3 \leq 85, \quad 6$$

$$y_1 + 5 y_2 + 4 y_3 \leq 65.$$

2-Determine

$$\text{CE} = (\text{constraints} + 1)(\text{no of variable} + \text{constraints} + \text{artificial} + 1)(\text{artificial} + 1).$$

$$\text{CEP} = (3 + 1)(4 + 3 + 3 + 1)(3 + 1) = 176.$$

$$\text{CED} = (4 + 1)(3 + 4 + 0 + 1)(0 + 1) = 40$$

Dual problem is better than primal problem . 3- solve Dual problem

$$z = 800 y_1 + 200 y_2 + 700 y_3 + 0s_1 + 0s_2 + 0s_3 + 0s_4.$$

$$3 y_1 + 2 y_2 + 6 y_3 + s_1 = 45,$$

$$4 y_1 + 2 y_2 + 4 y_3 + s_2 = 40,$$

$$8 y_1 + 7 y_2 + 7 y_3 + s_3 = 85, \quad 6$$

$$y_1 + 5 y_2 + 4 y_3 + s_4 = 65.$$

		Y1 800	Y2 200	Y3 700	S1 0	S2 0	S3 0	S4 0	
S1	0	3	2	6	1	0	0	0	45
S2	0	4	2	4	0	1	0	0	40
S3	0	8	7	7	0	0	1	0	85
S4	0	6	5	4	0	0	0	1	68
		-800	-200	-700	0	0	0	0	

Enter y1, Drop s2. R2=R2/4

$$R1=R1-3R2$$

$$R3=R3-8R2$$

$$R4=R4-6R2$$

		Y1 800	Y2 200	Y3 700	S1 0	S2 0	S3 0	S4 0	
S1	0	0	1/2	3	1	-3/4	0	0	15
Y1	800	1	1/2	1	0	1/4	0	0	10
S3	0	0	3	-1	0	-2	1	0	5
S4	0	0	2	2	0	-3/2	0	1	5
		0	200	100	0	200	0	0	

So

$$S1=x1=0, s2=x2=200, s3=x3=0, s4=x4=0; Z=200*40=8000.$$

4-solve primal with regular simplex methods (in number 4)

Modeling : $z=45 x1+40 x2+85 x3+65 x4$.

Subject to

$$3x1+4x2+8x3+6x4 \geq 800, \text{ for proteins}$$

$$2x1+2x2+7x3+5x4 \geq 200, \text{ for fats}$$

$$6x1+4x2+7x3+4x4 \geq 700, \text{ for carbohydrates where } x1, x2, x3, x4 \geq 0 \text{ hidden.}$$

Add 3 surplus and 3 artificial.

1. As the constraint-1 is of type ' \geq ' we should subtract surplus variable $S1$ and add artificial variable $A1$

2. As the constraint-2 is of type ' \geq ' we should subtract surplus variable $S2$ add artificial variable $A2$ and

3. As the constraint-3 is of type ' \geq ' we should subtract surplus variable $S3$ add artificial variable $A3$ and

After adding

$$\text{Min } Z = 45 x1 + 40 x2 + 85 x3 + 65 x4 + 0 S1 + 0 S2 + 0 S3 + M A1 + M A2 + M A3$$

subject to

$$3x_1 + 4x_2 + 8x_3 + 6x_4 - S_1 + A_1 = 800$$

$$2x_1 + 2x_2 + 7x_3 + 5x_4 - S_2 + A_2 = 200$$

$$6x_1 + 4x_2 + 7x_3 + 4x_4 - S_3 + A_3 = 700$$

1-tablon or table

Iteration n-1		C_j	45	40	85	65	0	0	0	M	M	M	
B	C B	XB	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XBx_3
A1	M	80 0	3	4	8	6	-1	0	0	1	0	0	8008=100
A2	M	20 0	2	2	(7)	5	0	-1	0	0	1	0	2007=28.57 14→
A3	M	70 0	6	4	7	4	0	0	-1	0	0	1	7007=100
Z=1700 M		Z	11M	10M	22M	15M	-M	-M	-M	M	M		
		Z- C_j	11M- 45	10M- 40	22M85↑	15M- 65	-M	-M	-M	0	0		

Enter =x3, Drop =A2.

R2=R2/7, R1=R1-8*R2, R3=R3-7R.

2-tablon or table

Iteration2		C_j	45	40	85	65	0	0	0	M	M	M	
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B	C_B	X_B	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio $X_B x_1$
A1	M	57 1.4 28 6	0.7143	1.7143	0	0.2857	- 1	1.142 9	0	1	- 1.1429	0	571.428 60.7143 =800
x_3	8 5	28. 57 14	(0.285 7)	0.2857	1	0.7143	0	- 0.142 9	0	0	0.1429	0	28.5714 0.2857= 100→
A3	M 0	50 4	4	2	0	-1	0	1	- 1	0	-1	1	5004=1 25
Z=1071.4 286M+24 28.5714		Zj	4.7143 M+24. 2857	3.7143 M+24. 2857	8 5	- 0.7143 M+60. 7143	- M	2.142 9M- 12.14 29	- M	M	- 2.1429 M+12. 1429	M	
		Zj- Cj	4.7143 M- 20.714 3↑	3.7143 M- 15.714 3	0	- 0.7143 M- 4.2857	- M	2.142 9M- 12.14 29	- M	0	- 3.1429 M+12. 1429	0	

Enter =x1, Drop =x3.

R2=R2/0,2857, R1=R1-0,7143R2 , R3=R3-4R2.

3-tablon or table

Iteration n-3	C_j	4 5	40	85	65	0	0	0	M	M	M	
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B	C_B	X_B	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XBS2
A_1	M	50 0	0	1	-2.5	-1.5	-1	1.5	0	1	-1.5	0	5001.5=33.3333
x_1	4 5	10 0	1	1	3.5	2.5	0	-0.5	0	0	0.5	0	---
A_3	M	10 0	0	-2	-14	-11	0	(3)	-1	0	-3	1	1003=33.3333→
$Z=600$ $M+4500$		Z_j	4 5	- $M+45$	- $16.5M+157.5$	- $12.5M+112.5$	- M	$4.5M-22.5$	- M	M	- $4.5M+22.5$	M	
		Z_j C_j	0	- $M+5$	- $16.5M+72.5$	- $12.5M+47.5$	- M	$4.5M-22.5$ ↑	- M 0		- $5.5M+22.5$	0	

Enter =S2, Drop =A3.

$R_3=R_3/3$, $R_1=R_1-1.5R_3$, $R_2=R_2+.5R_3$. 4-tablon
or table

Iteration n-4	C_j	4 5	40	85	65	0	0	0	M	M	M	
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B	C_B	XB	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XB/x_3
A1	M	450	0	2	(4.5)	4	-1	0	0.5	1	0	-0.5	450/4.5=100 →
x_1	45	116.6667	1	0.6667	1.1667	0.6667	0	0	-0.1667	0	0	0.1667	116.6667/1.1667=100
S_2	0	33.3333	0	-0.6667	-4.6667	-3.6667	0	1	-0.3333	0	-1	0.3333	---
$Z=450M+5250$		Z_j	45	$2M+30$	$4.5M+52.5$	$4M+30$	$-M$	0	$0.5M-7.5$	M	0	$-0.5M+7.5$	
		Z_j-C_j	0	$2M-10$	$4.5M-32.5$ ↑	$4M-35$	$-M$	0	$0.5M-7.5$	0	$-M$	$-1.5M+7.5$	

Enter $=x_3$, Drop $=A_1$

$R_1=R_1/4.5$, $R_2=R_2-1.1667R_1$, $R_3=R_3-4.6667R_1$. 5-tablon
or table

Iteration-5		C_j	45	40	85	65	0	0	0	M	M	M	
B	C_B	XB	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio XB/x_2

x_3	8 5	10 0	0	0.44 44	1	0.88 89	- 0.22 22	0	0.11 11	0.2222	0	- 0.1111	1000.4444= 225
x_1	4 5	0	1	(0.14 81)	0	- 0.37 04	0.25 93	0	- 0.29 63	- 0.2593	0	0.2963	00.1481=0 →
S_2	0	50 0	0	1.40 74	0	0.48 15	- 1.03 7	1	0.18 52	1.037	- 1	- 0.1852	5001.4074= 355.2632
$Z=850$ 0		Z_j	4 5	44.4 444	8 5	58.8 889	- 7.22 22	0	- 3.88 89	7.2222	0	3.8889	
		$Z_j - C_j$	0	4.44 44↑	0	- 6.11 11	- 7.22 22	0	- 3.88 89	- $M+7.2$ 222	- M	- $M+3.8$ 889	

Enter = x_2 , Drop = x_1 .

$R_2 = R_2 / 0.01481$.

$R_1 = R_1 - 4.444R_2$.

$R_3 = R_3 - 1.4074R_2$.

6-tablon or table

Iteration6		C_j	45	40	85	65	0	0	0	M	M	M	
B	C_B	X_B	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio $X_B x_4$
x_3	85	100	-3	0	1	(2)	-1	0	1	1	0	-1	1002=50 →
x_2	40	0	6.7 5	1	0	- 2.5	1.7 5	0	-2	-1.75	0	2	---

S2	0	500	-9.5	0	0	4	-3.5	1	3	3.5	-1	-3	5004=125
Z=8500		Zj	15	4 0	8 5	70	-15	0	5	15	0	-5	
		Zj- Cj	-30	0	0	5 ↑	-15	0	5	- M+15	- M	-M- 5	

Enter =x4, Drop =x3.

R1=R1/2.

R2=R2+2.5R1.

R3=R3-4R1.

7-tablon or table

Iteration n-7		Cj	45	4 0	85	6 5	0	0	0	M	M	M	
B	C B	XB	x1	x 2	x3	x 4	S1	S 2	S3	A1	A 2	A3	MinRatio XBS3
x4	65	50	-1.5	0	0.5	1	-0.5	0	(0.5)	0.5	0	-0.5	500.5=100 →
x2	40	125	3	1	1.2 5	0	0.5	0	0.7 5	-0.5	0	0.75	---
S2	0	300	-3.5	0	-2	0	-1.5	1	1	1.5	-1	-1	3001=300

$Z=8250$		Z_j	22. 5	4 0	82. 5	6 5	12. 5	0	2.5	12.5	0	-2.5	
		$Z_j - C_j$	22. 5	0	- 2.5	0	12. 5	0	2.5 ↑	- $M+12.5$	- M	- M - 2.5	

Enter=S3, Drop =x4.

$R1=R1/0.5$

$R2=R2-.75R1$.

$R3=R3-R1$.

8-tablon or table

Iteration8		C_j	45	4 0	8 5	65	0	0	0	M	M	M	
B	C_B	XB	x_1	x_2	x_3	x_4	S_1	S_2	S_3	A_1	A_2	A_3	MinRatio
S3	0	100	-3	0	1	2	-1	0	1	1	0	-1	
x_2	40	200	0.7 5	1	2	1. 5	- 0.25	0	0	0.25	0	0	
S2	0	200	-0.5	0	-3	-2	-0.5	1	0	0.5	-1	0	
$Z=8000$		Z_j	30	4 0	8 0	60	-10	0	0	10	0	0	
		$Z_j - C_j$	-15	0	-5	-5	-10	0	0	- $M+10$	- M	- M	

$X_2=200, x_1=0, x_3=0, x_4=0$ then $z=40*200=8000$.

Final tablon .

6- Solve the Problem Using Dual Simplex Method, if possible

The condition is met min+ so can solve it but Need to adjust the constraints

1-constraints hit *-1 to <=

Then add slacks

Min : $z = 45x_1 + 40x_2 + 85x_3 + 65x_4 + 0s_1 + 0s_2 + 0s_3$

$-3x_1 - 4x_2 - 8x_3 - 6x_4 + s_1 = -800$, for proteins

$-2x_1 - 2x_2 - 7x_3 - 5x_4 - s_2 = -200$, for fats

$-6x_1 - 4x_2 - 7x_3 - 4x_4 + s_3 = -700$, for carbohydrates where $x_1, x_2, x_3, x_4, s_1, s_2, s_3 \geq 0$ hidden.

		X1	X2	X3	X4	S1	S2	S3	
		45	40	85	65	0	0	0	
S1	0	-3	-4	-8	-6	1	0	0	-800
S2	0	-2	-2	-7	-5	0	1	0	-200
S3	0	-6	-4	-7	-4	0	0	1	-700
		45	40	85	65	0	0	0	

Enter x2, Drop s1

$R1 = R1 * -1$ THEN $R1 = R1/4$

$R2 = R2 - 2R1$

$R3 = R3 - 4R1$

		X1	X2	X3	X4	S1	S2	S3	
		45	40	85	65	0	0	0	
X2	40	3/4	1	2	3/2	-1/4	0	0	200
S2	0	-1/2	0	-3	-2	-1/2	1	0	200

S3	0	-3	0	1	2	-1	0	1	100
		15	0	5	5	10	0	0	

$X_2=200, x_1=0, x_3=0, x_4=0$ then $z=40*200=8000$.

7- By using any computer software (e.g. TORA, MATLAB, ...) solve this optimization problem, or write down a program that solve the Problem using any programming language you know (program one method ONLY; Regular method, Dual Simplex method, or Dual Problem)

(Reference 1)

<https://cbom.atozmath.com/CBOM/Simplex.aspx?q=sm&q1=4%603%60MIN%60Z%60x1%2Cx2%2Cx3%2Cx4%6045%2C40%2C85%2C65%603%2C4%2C8%2C6%3B2%2C2%2C7%2C5%3B6%2C4%2C7%2C4%60%3E%3D%2C%3E%3D%2C%3E%3D%60800%2C200%2C700%60%60D%60false%60true%60false%60false%60false%60false%60true&do=1#tblSolution>

Or

From this link the code from matlab program :

<https://matlab.mathworks.com/>

the code:

```

prob = optimproblem('ObjectiveSense','min');
x = optimvar('x',4,3,2,1,'LowerBound',0);
prob.Objective = 45*x(1) + 40*x(2)+85*x(3)+65*x(4);
cons1 = 3*x(1) + 4*x(2)+ 8*x(3)+6*x(4) >=800;
cons2 = 2*x(1) + 2*x(2)+ 7*x(3)+5*x(4) >=200;
cons3 = 6*x(1) + 4*x(2)+ 7*x(3)+4*x(4) >=700;

```

```

prob.Constraints.cons1 = cons1;
prob.Constraints.cons2 = cons2;
prob.Constraints.cons3 = cons3;
show(prob)
sol = solve(prob);

```

sol.x

The image shows the MATLAB Online R2020a interface. The browser tabs include 'Operations research', 'Phases of Operation R...', 'Operations Research/S...', 'Watch 'Sec9_sensitivity'', 'MATLAB Online R2020a', and '(2/3) WhatsApp'. The address bar shows 'matlab.mathworks.com'. The interface has a top menu bar with 'HOME', 'PLOTS', 'APPS', 'LIVE EDITOR', 'INSERT', and 'VIEW'. Below this is a toolbar with icons for file operations (New, Save, Find Files), navigation (Go To, Find), text formatting (Normal, Bold, Italic, Underline, Monospace), code editing (Code, Refactor), and execution (Run Section, Run and Advance, Run to End, Run, Step, Stop). The main workspace is titled 'MATLAB Drive' and contains a file 'CreateAndSolveOptimizationProblemExample.mlx'. The editor shows the following code:

```

1  prob = optimproblem('ObjectiveSense','min');
2  x = optimvar('x',4,3,2,1,'LowerBound',0);
3  prob.Objective = 45*x(1) + 40*x(2)+85*x(3)+65*x(4);
4  cons1 = 3*x(1) + 4*x(2)+ 8*x(3)+6*x(4) >=800;
5  cons2 = 2*x(1) + 2*x(2)+ 7*x(3)+5*x(4) >=200;
6  cons3 = 6*x(1) + 4*x(2)+ 7*x(3)+4*x(4) >=700;
7
8  prob.Constraints.cons1 = cons1;
9  prob.Constraints.cons2 = cons2;
10 prob.Constraints.cons3 = cons3;
11 show(prob)
12 sol = solve(prob);
13 sol.x

```

Below the code, the text 'Copyright 2012 The MathWorks, Inc.' is displayed. On the right side of the workspace, the output of the code is shown:

```

0 <= x(4, 3, 1)
0 <= x(1, 1, 2)
0 <= x(2, 1, 2)
0 <= x(3, 1, 2)
0 <= x(4, 1, 2)
0 <= x(1, 2, 2)
0 <= x(2, 2, 2)
0 <= x(3, 2, 2)
0 <= x(4, 2, 2)
0 <= x(1, 3, 2)
0 <= x(2, 3, 2)
0 <= x(3, 3, 2)
0 <= x(4, 3, 2)

Solving problem using linprog.

Optimal solution found.

ans =
ans(:,1) =
    0         0         0
200.0000    0         0
    0         0         0

ans(:,2) =
    0         0         0
    0         0         0
    0         0         0
    0         0         0

```

The bottom of the interface shows a 'COMMAND WINDOW' and a Windows taskbar with the date '5/13/2020' and time '2:49 PM'.

To show the out put on the program .