



University of Technology  
Building and Construction Eng Depart



Subject: Planning & management system

Branch: Construction Engineering and Management

Class: 3<sup>rd</sup>

Time: 3 hours

Examiner: Dr. Ibraheem Abid Mohammed

Date: /5/2015

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**Note: Answer only four questions**

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Q1//: Max  $Z = X_1 + 3X_2$

s.to

$$x_1 + x_2 \leq 6$$

$$x_1 \geq 3$$

$$x_2 \geq 3$$

$$2x_1 + 3x_2 \geq 3$$

$$X_1, x_2 \geq 0$$

1- Determine feasible region graphically.

2- Determine all redundant constraints.

3- Construct the dual of the problem.

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Q2// A: Min  $Z = 4X_1 + X_2$

S. to

$$3x_1 + x_2 = 3$$

$$4x_1 + 3x_2 \geq 6$$

$$x_1 + 2x_2 \leq 3$$

$$X_1, x_2 \geq 0$$

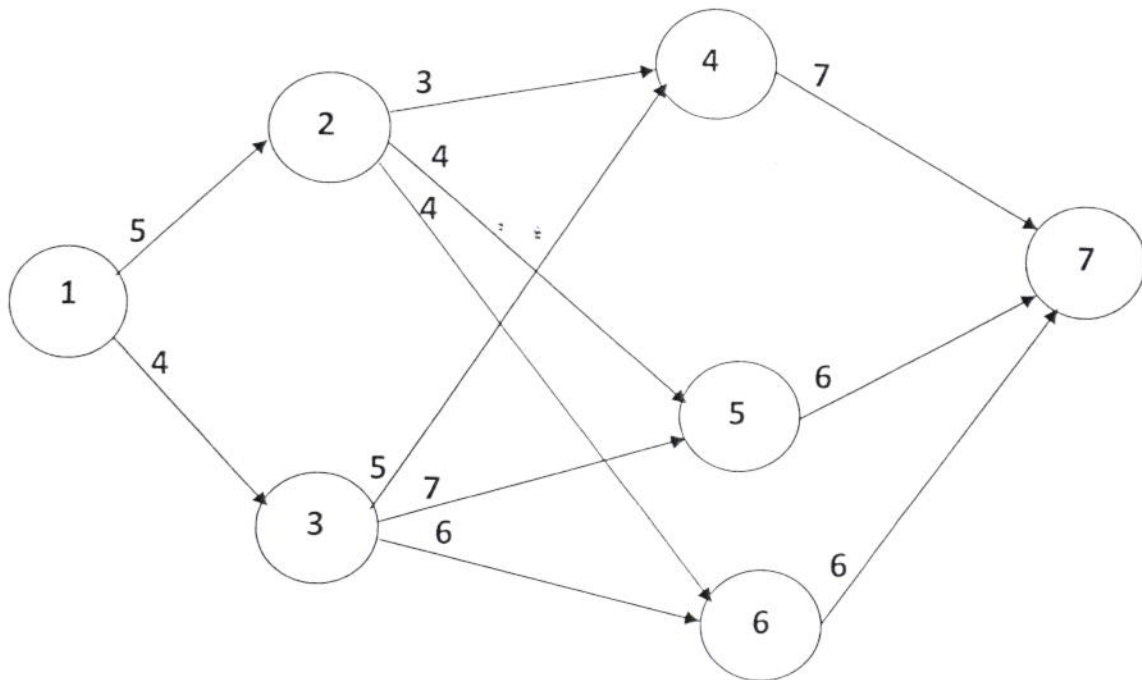
by using BIG.M find the second simplex tableau.

Q2// B: Explain the condition of project.

If 1.  $SPI > 1$  ,  $CPI < 1$

2.  $SPI < 1$  ,  $CPI > 1$

Q3//: Find the shortest path from 1 to 7 by using Dynamic programming method.



Q4//A: What is the difference between least cost method and Vogel method in transportation problems.

B//: Solve the following assignment problem to minimize time.

		jobs			
		1	2	3	4
Mens	1	6	8	7	6
	2	4	6	5	3
	3	4	2	7	3
	4	5	3	9	5

**Q5//:** A construction site requires a minimum of 20000 m<sup>3</sup> of sand and gravel mixture. The mixture must contain no less than 6000 m<sup>3</sup> of sand and no more than 7000 m<sup>3</sup> of gravel materials may be obtained from two sites:

Site	Delivery Cost \$/m <sup>3</sup>	Percent sand	Percent gravel
1	10	40	60
2	12	70	30

1. Formulate the mathematical model.
2. Rewrite the mathematical model formulated in standard form.

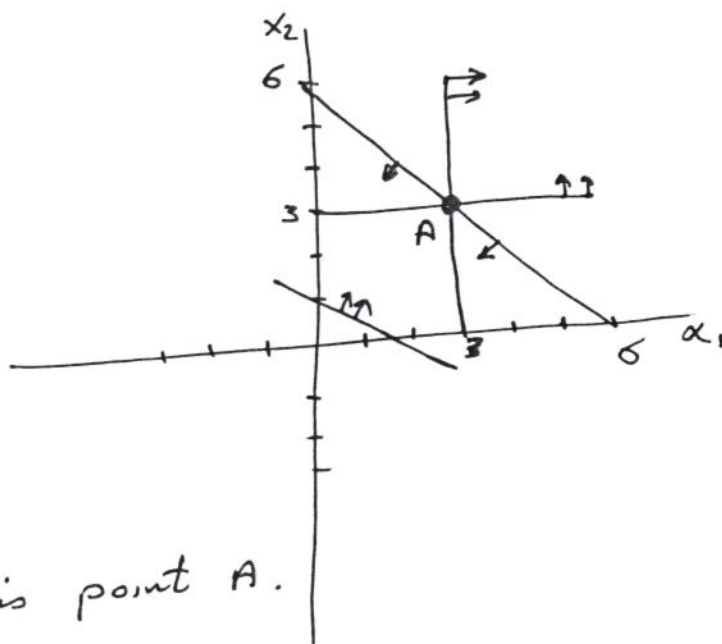
# حل مسألة نظام التخطيط وإدارة للصناعة، لثلاث / فرع صناعي، لبناء وإدارة

Q1  
Max  $Z = x_1 + 3x_2$

s.to

$$\begin{aligned} x_1 + x_2 &\leq 6 & \text{--- (1)} \\ x_1 &\geq 3 & \text{--- (2)} \\ x_2 &\geq 3 & \text{--- (3)} \\ 2x_1 + 3x_2 &\geq 3 & \text{--- (4)} \\ x_1, x_2 &\geq 0 \end{aligned}$$

$x_1$	$x_2$	
0	6	(1)
6	0	
3	0	(2)
0	3	(3)
0	1	
1.5	0	



Feasible region is point A.

(b) redundant constraints .  
 $2x_1 + 3x_2 \geq 3$

(c) Max  $Z = x_1 + 3x_2$

s.to

$$\begin{aligned} x_1 + x_2 &\leq 6 & \text{--- } y_1 \\ x_1 &\geq 3 & \rightarrow -x_1 \leq -3 & \text{--- } y_2 \\ x_2 &\geq 3 & \rightarrow -x_2 \leq -3 & \text{--- } y_3 \\ 2x_1 + 3x_2 &\geq 3 & \rightarrow -2x_1 - 3x_2 \leq -3 & \text{--- } y_4 \\ x_1, x_2 &\geq 0 \end{aligned}$$

Dual Problem  
Min  $W = 6y_1 - 3y_2 - 3y_3 - 3y_4$

s.to

$$\begin{aligned} y_1 + y_2 - 2y_4 &\geq 1 \\ y_1 - y_3 - 3y_4 &\geq 3 \\ y_1, y_2, y_3, y_4 &\geq 0 \end{aligned}$$

Pivot element 3

Pivot operation

	$x_1$	$x_2$	$s_1$	$s_2$	$R_1$	$R_2$	$s_3$	
$z$	$-4+7M$	$-1+4M$	$-M$	0	0	0	0	
$R_1$	3	1	0	0	1	0	0	3
$R_2$	4	3	-1	0	0	0	0	6
$s_3$	1	2	0	1	0	0	0	3
Ratio								$\frac{1}{3}$ $\frac{4}{6}$ $\frac{1}{3}$

$$\begin{aligned} \text{Min } z &= 4x_1 + x_2 + M R_1 + M R_2 \\ \text{Min } z &= 4x_1 + x_2 + M(3-3x_1-x_2) + M(6-4x_1-3x_2+s_1) \\ \text{Min } z &= 4x_1 + x_2 + M(-1+4M)x_1 + (-1+4M)x_2 - MS_1 = 9M \\ \text{Min } z &= (-4+7M)x_1 + (-1+4M)x_2 - MS_1 \end{aligned}$$

$$\begin{aligned} x_1, x_2 &\geq 0 \\ 3x_1 + x_2 + R_1 &= 3 \\ 4x_1 + 3x_2 - s_1 + R_2 &= 6 \\ x_1 + 2x_2 + s_3 &= 3 \end{aligned}$$

Constraints.

Q2 (A) Min  $z = 4x_1 + x_2$

## Second tableau

	$x_1$	$x_2$	$s_1$	$s_3$	$R_1$	$R_2$	R.H.S
Z	0	$\frac{1}{3} + \frac{5}{3}M$	$-M$	0	$\frac{4}{3} - \frac{7}{3}M$	0	$4 + 2M$
$x_1$	1	$\frac{1}{3}$	0	0	$\frac{1}{3}$	0	1
$R_2$	0	$\frac{5}{2}$	-1	0	$-\frac{4}{3}$	1	2
$s_3$	0	$\frac{5}{3}$	0	1	$-\frac{1}{3}$	0	2

Q211 B  
السؤال الثاني

①  $SPI > 1$   $CPI < 1$

if  $SPI > 1$  mean the project is currently a head of schedule .

$CPI < 1$  mean the project currently over budget

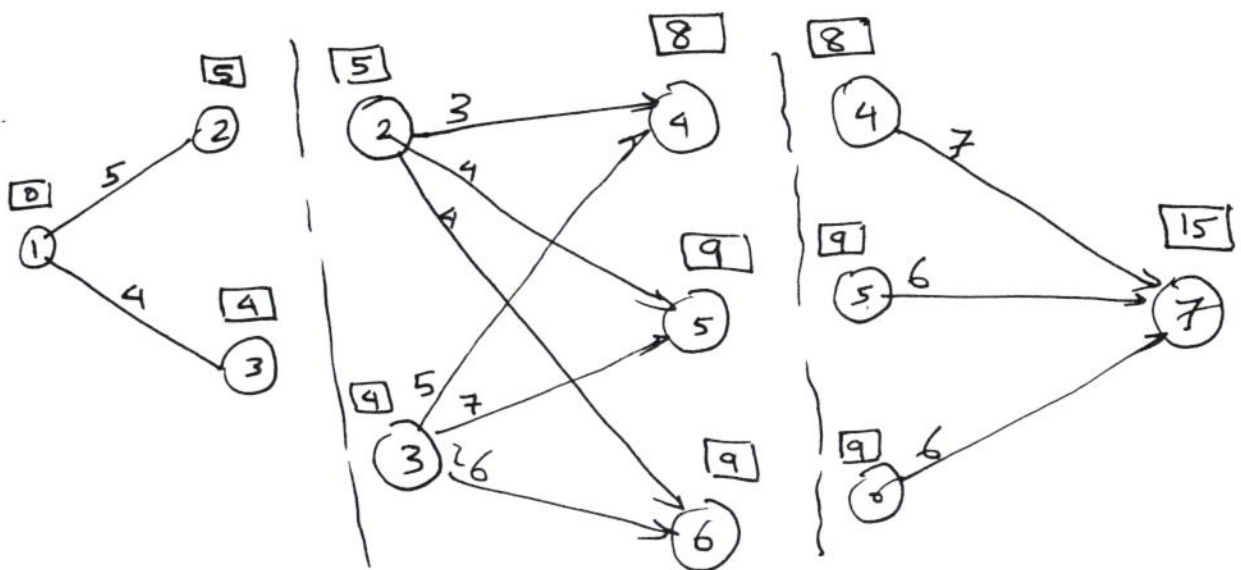
②  $SPI < 1$   $CPI > 1$

if  $SPI < 1$  mean the project is currently behind of schedule

$CPI > 1$  mean the project is currently under budget .



Q3  
السؤال الثالث



stage 1

Shortest distance from node 1 to 2 = 5  
Shortest distance from 1 to 3 = 4

Q2 Shortest distance to node 4 =  $\min_{i=2,3} = \begin{cases} 5+3=8 \\ 4+5=9 \end{cases} \rightarrow 8$

Shortest distance to node 5 =  $\min_{i=2,3} = \begin{cases} 5+4=9 \\ 4+7=11 \end{cases} \rightarrow 9$

Shortest distance to node 6 =  $\min_{i=2,3} = \begin{cases} 5+4=9 \\ 4+6=10 \end{cases} \rightarrow 9$

stage 3

Shortest distance to node 7 =  $\min_{i=4,5,6} = \begin{cases} 8+7=15 \\ 9+6=15 \\ 9+6=15 \end{cases}$

$\therefore$  shortest distance from 1 to 7 is = 15

1  $\rightarrow$  2  $\rightarrow$  4  $\rightarrow$  7  
1  $\rightarrow$  2  $\rightarrow$  5  $\rightarrow$  7  
1  $\rightarrow$  2  $\rightarrow$  6  $\rightarrow$  7

(4-7)

$P_4$   $\textcircled{A}$   
 السؤال الرابع

Least Cost

The method assigns as much as possible to the cell with the smallest unit cost. Next the satisfied row or column is crossed out and the amount of supply and demand are adjusted accordingly.

Vogel.

- for each row and column determine a penalty measure by subtracting the smallest unit cost element in the row from the next smallest unit cost element in the same row (column) and identify the row or column with largest penalty. Break ties arbitrarily, and any column or row with supply or demand equal zero, not enter in the same first step and continue.

السؤال الرابع  
 $\textcircled{B}$

	1	2	3	4
1	$\textcircled{6}$	8	7	6
2	4	6	5	$\textcircled{3}$
3	4	$\textcircled{2}$	7	3
4	5	$\textcircled{3}$	9	5

	1	2	3	4
1	$\textcircled{0}$	2	$\textcircled{1}$	$\textcircled{0}$
2	1	3	2	0
3	2	$\textcircled{0}$	5	1
4	2	0	6	2

(5-7)



	1	2	3	4
1	2	2	0	0
2	①	3	1	0
3	2	0	4	1
4	2	0	5	2

No of line  $\neq$  No column (Row)  
no primary solution

	1	2	3	4
1	0	3	0	1
2	0	3	0	0
3	1	0	3	①
4	1	0	4	2

	1	2	3	4
1	0	4	0	1
2	0	4	0	0
3	0	0	2	0
4	0	0	3	1

optimal

The best strategy

	jobs	prob ①	Min t	prob 2	Min t	prob 3	Min t	prob 4	Min t
		1	6	3	4	3	7	3	7
Men	1 1, 3	3	5	4	3	1	4	4	3
	2 1, 3, 4	4	3	2	2	4	3	1	4
	3 1, 2, 4	2	3	1	5	2	3	2	3
	4 1, 2		<u>17</u>		<u>17</u>		<u>17</u>		<u>17</u>

Q5  
المزيج

suppose mixture from site ① =  $x_1$   
 $=$   $=$   $=$   $=$   $=$   $=$   $x_2$ .

$$\text{Min } Z = 10x_1 + 12x_2$$

s.to

$$x_1 + x_2 \geq 20000$$

$$.4x_1 + .7x_2 \geq 6000$$

$$.6x_1 + .3x_2 \leq 7000$$

$$x_1, x_2 \geq 0$$

$$x_1 + x_2 - s_1 + R_1 = 20000$$

$$.4x_1 + .7x_2 - s_2 + R_2 = 6000$$

$$.6x_1 + .3x_2 + s_3 = 7000$$

$$x_1, x_2, s_1, s_2, s_3, R_1, R_2 \geq 0$$

$$\text{Min } Z = 10x_1 + 12x_2 + MR_1 + MR_2$$

$$\text{Min } Z = 10x_1 + 12x_2 + M(20000 - x_1 - x_2 + s_1)$$

$$+ M(6000 - .4x_1 - .7x_2 + s_2)$$

$$\text{Min } Z = (10 - 1.4M)x_1 + (12 - 1.7M)x_2 + Ms_1 + Ms_2 + 26000M$$