

# 1. SIMPLEX METHOD

## (i). Feasible Solution –

$$\text{Max. } z = 2x_1 + 4x_2$$

Subjected to

$$x_1 + 4x_2 \leq 5$$

$$x_1 + x_2 \leq 4$$

$$x_1, x_2 \geq 0$$

## Final Iteration –

max <Primal Simplex>					<Final>Iteration No: 2
==> Alternative solution detected at x1					
Basic	x1	x2	sx3	sx4	Solution
z	0.00	0.00	2.00	0.00	10.00
1> x2	0.50	1.00	0.50	0.00	2.50
2> sx4	0.50	0.00	-0.50	1.00	1.50
+/-=<x+ - x-> s/s=slack/Surplus R=artif ' =upper bd =inv(B)					
<PgUp/PgDn>Scroll <F6>Optimum Menu					

max		Final Iteration No: 2	
*** OPTIMUM SOLUTION SUMMARY ***			
Obj value =	10.000	==> <Alternative solution detected at x1 >	
Variable	Value	Obj Coeff	Obj Val Contrib
x1	0.0000	2.0000	0.0000
x2	2.5000	4.0000	10.0000
More to come... Press PgDn/PgUp to scroll			
<PgUp/PgDn>Scroll <F6>Optimum Menu			

## (ii). Alternative Solution –

max <Primal Simplex>					<Final>Iteration No: 2
==> Alternative solution detected at x4					
Basic	x1	x2	sx3	sx4	Solution
z	0.00	0.00	2.00	0.00	10.00
1> x2	0.00	1.00	1.00	-1.00	1.00
2> x1	1.00	0.00	-1.00	2.00	3.00
+/-=<x+ - x-> s/\$=slack/Surplus R=artif ' =upper bd =inv<B>					
<PgUp/PgDn>Scroll <F6>Optimum Menu					

max		Final Iteration No: 2	
*** OPTIMUM SOLUTION SUMMARY ***			
Obj value =	10.000	==> <Alternative solution detected at x4 >	
Variable	Value	Obj Coeff	Obj Val Contrib
x1	3.0000	2.0000	6.0000
x2	1.0000	4.0000	4.0000
More to come... Press PgDn/PgUp to scroll			
<PgUp/PgDn>Scroll <F6>Optimum Menu			

### (iii). Unbounded Solution –

$$\text{Max. } z = x_1 + x_2$$

Subjected to

$$x_1 - x_2 \leq 0$$

$$-3x_1 + x_2 \leq 3$$

$$x_1, x_2 \geq 0$$

### Final Iteration –

max <Primal Simplex>					<Final>Iteration No: 1
==> Problem has NO BOUNDED solution. Condition detected at x1					
Basic	x1	x2	sx3	sx4	Solution
z	-1.00	-1.00	0.00	0.00	0.00
1) sx3	-3.00	1.00	1.00	0.00	3.00
2) sx4	-1.00	0.00	0.00	1.00	0.00
+/-=(x+ - x-) s/\$=slack/Surplus R=artif ' =upper bd ■=inv(B)					
<PgUp/PgDn>Scroll <F6>Optimum Menu					

max	Final Iteration No: 1
*** OPTIMUM SOLUTION SUMMARY ***	
Problem has NO BOUNDED solution. Condition detected at x1	

**(iv). Infeasible Solution** – This case cannot be achieved in the case where the constraints are all( $\leq$ ).

$$\text{Max. } z = 2x_1 + 5x_2$$

Subjected to

$$3x_1 + 2x_2 \geq 6$$

$$2x_1 + x_2 \leq 2$$

$$x_1, x_2 \geq 0$$

**Final Iteration –**

<phase_1> min				<Final>Iteration No: 3		
==> Problem has NO FEASIBLE solution. At least one artificial is positive						
Basic	x1	x2	Sx3	Rx4	sx5	Solution
z	-1.00	0.00	-1.00	0.00	-2.00	2.00
1> Rx4	-1.00	0.00	-1.00	1.00	-2.00	2.00
2> x2	2.00	1.00	0.00	0.00	1.00	2.00
+/-=<x+ - x-> s/S=slack/Surplus R=artif ' =upper bd ■ =inv<B>						
<PgUp/PgDn>Scroll <F6>Optimum Menu						

max		Final Iteration No: 3
*** OPTIMUM SOLUTION SUMMARY ***		
Problem has NO FEASIBLE solution		

## 2. BIG-M METHOD

### (i). Feasible Solution –

$$\text{Max. } z = 6x_1 + 4x_2$$

Subjected to

$$2x_1 + 3x_2 \leq 30$$

$$3x_1 + 2x_2 \leq 24$$

$$x_1 + x_2 \geq 3$$

$$x_1, x_2 \geq 0$$

### Final Iteration –

max <M-method>							<Final>Iteration No: 3
==> Alternative solution detected at x2							
Basic	x1	x2	sx3	sx4	sx5	Rx6	Solution
z	0.00	0.00	0.00	0.00	2.00	100000.00	48.00
1> sx4	0.00	1.67	0.00	1.00	-0.67	0.00	14.00
2> sx3	0.00	-0.33	1.00	0.00	0.33	-1.00	5.00
3> x1	1.00	0.67	0.00	0.00	0.33	0.00	8.00
+/-=(x+ - x-) s/s=slack/Surplus R=artif '=upper bd M=100000 ■=inv(B)							
<PgUp/PgDn>Scroll <F6>Optimum Menu							

max			Final Iteration No: 3
*** OPTIMUM SOLUTION SUMMARY ***			
Obj value =	48.000	==> <Alternative solution detected at x2	
Variable	Value	Obj Coeff	Obj Val Contrib
x1	8.0000	6.0000	48.0000
x2	0.0000	4.0000	0.0000
More to come... Press PgDn/PgUp to scroll			
<PgUp/PgDn>Scroll <F6>Optimum Menu			

## (ii). Alternative Solution –

max <M-method>							<Final>Iteration No: 3
==> Alternative solution detected at x4							
Basic	x1	x2	Sx3	sx4	sx5	Rx6	Solution
z	0.00	0.00	0.00	0.00	2.00	100000.00	48.00
1> x2	0.00	1.00	0.00	0.60	-0.40	0.00	8.40
2> Sx3	0.00	0.00	1.00	0.20	0.20	-1.00	7.80
3> x1	1.00	0.00	0.00	-0.40	0.60	0.00	2.40
+/-=<x+ - x-> s/S=slack/Surplus R=artif ' =upper bd M=100000 =inv<B>							
<PgUp/PgDn>Scroll <F6>Optimum Menu							

max		Final Iteration No: 3	
*** OPTIMUM SOLUTION SUMMARY ***			
Obj value =	48.000	==> <Alternative solution detected at x4	
Variable	Value	Obj Coeff	Obj Val Contrib
x1	2.4000	6.0000	14.4000
x2	8.4000	4.0000	33.6000
More to come... Press PgDn/PgUp to scroll			
<PgUp/PgDn>Scroll <F6>Optimum Menu			

(iii). Unbounded Solution –

Max.  $z = 6x_1 + x_2$

Subjected to

$2x_1 + x_2 \geq 3$

$-x_1 + x_2 \geq 0$

$x_1, x_2 \geq 0$

Final Iteration –

max <M-method>							<Final>Iteration No: 3
==> Problem has NO BOUNDED solution. Condition detected at x3							
Basic	x1	x2	Sx3	Sx4	Rx5	Rx6	Solution
z	0.00	0.00	-2.34	1.34100002	2.34	99998.66	7.00
1> x1	1.00	0.00	-0.33	0.33	0.33	-0.33	1.00
2> x2	0.00	1.00	-0.33	-0.67	0.33	0.67	1.00
+/-=<x+ - x-> s/S=slack/Surplus R=artif '=upper bd M=100000 =inv<B>							
<PgUp/PgDn>Scroll <F6>Optimum Menu							

max		Final Iteration No: 3
*** OPTIMUM SOLUTION SUMMARY ***		
Problem has NO BOUNDED solution. Condition detected at x3		

#### (iv). Infeasible Solution –

$$\text{Max. } z = x_1 + x_2$$

Subjected to

$$x_1 + x_2 \leq 1$$

$$-3x_1 + x_2 \geq 3$$

$$x_1, x_2 \geq 0$$

#### Final Iteration –

max <M-method>						<Final>Iteration No: 2
==> Problem has NO FEASIBLE solution. At least one artificial is positive						
Basic	x1	x2	Sx3	sx4	Rx5	Solution
z	400000.00	0.00100000.00	100001.00	0.00	0.00	-199999.00
1> x2	1.00	1.00	0.00	1.00	0.00	1.00
2> Rx5	-4.00	0.00	-1.00	-1.00	1.00	2.00
+/-=(x+ - x-) s/\$=slack/Surplus R=artif '=upper bd M=100000 =inv<B>						
<PgUp/PgDn>Scroll <F6>Optimum Menu						

  

max		Final Iteration No: 2
*** OPTIMUM SOLUTION SUMMARY ***		
Problem has NO FEASIBLE solution		



### 3. DUAL SIMPLEX METHOD

#### (i). Max problem –

$$\text{Max. } z = 10x_1 + 5x_2 + 8x_3$$

Subjected to

$$x_1 + 2x_2 + 2x_3 \leq 200$$

$$2x_1 + x_2 + x_3 \leq 220$$

$$3x_1 + x_2 + 2x_3 \leq 180$$

$$x_1 \geq 10, x_2 \geq 20, x_3 \geq 30$$

$$x_1, x_2, x_3 \geq 0$$

#### Final Iteration –

max <Primal Simplex> <Final>Iteration No: 3							
==> Alternative solution detected at x3							
Basic	x1	x2	x3	sx4	sx5	sx6	Solution
z	0.00	0.00	0.00	1.00	0.00	3.00	740.00
1> x2	0.00	1.00	0.80	0.60	0.00	-0.20	40.00
2> sx5	0.00	0.00	-0.60	-0.20	1.00	-0.60	90.00
3> x1	1.00	0.00	0.40	-0.20	0.00	0.40	10.00
Lower Bounds: 10 20 30							
+/-=<x+ - x-> s/S=slack/Surplus R=artif ' =upper bd ■=ino(B)							
<PgUp/PgDn>Scroll <F6>Optimum Menu							

max Final Iteration No: 3			
*** OPTIMUM SOLUTION SUMMARY ***			
Obj value =	740.000	==> <Alternative solution detected at x3 >	
Variable	Value	Obj Coeff	Obj Val Contrib
x1	20.0000	10.0000	200.0000
x2	60.0000	5.0000	300.0000
x3	30.0000	8.0000	240.0000
More to come... Press PgDn/PgUp to scroll			
<PgUp/PgDn>Scroll <F6>Optimum Menu			

## Alternative Solution –

max <Primal Simplex>      <Final>Iteration No: 3						
==> Alternative solution detected at x1						
Basic	x1	x2	x3	sx4	sx5	sx6 Solution
z	0.00	0.00	0.00	1.00	0.00	3.00 740.00
1> x2	-2.00	1.00	0.00	1.00	0.00	-1.00 20.00
2> sx5	1.50	0.00	0.00	-0.50	1.00	0.00 105.00
3> x3	2.50	0.00	1.00	-0.50	0.00	1.00 25.00
Lower Bounds:    10        20        30						
+/-=(x+ - x-)    s/S=slack/Surplus    R=artif    '=upper bd    =inv(B)						
<PgUp/PgDn>Scroll    <F6>Optimum Menu						

max                      Final Iteration No: 3			
*** OPTIMUM SOLUTION SUMMARY ***			
Obj value =	740.000	==> <Alternative solution detected at x1 >	
Variable	Value	Obj Coeff	Obj Val Contrib
x1	10.0000	10.0000	100.0000
x2	40.0000	5.0000	200.0000
x3	55.0000	8.0000	440.0000
More to come... Press PgDn/PgUp to scroll			
<PgUp/PgDn>Scroll    <F6>Optimum Menu			

## (ii). Min problem –

$$\text{Min. } z = 3x_1 + 2x_2 + x_3$$

Subjected to

$$3x_1 + x_2 + x_3 \geq 3$$

$$-3x_1 + 3x_2 + x_3 \geq 6$$

$$x_1 + x_2 + x_3 \leq 3$$

$$x_1, x_2, x_3 \geq 0$$

## Final Iteration –

min <Dual Simplex>							<Final>Iteration No: 3
Basic	x1	x2	x3	sx4	sx5	sx6	Solution
z	-3.00	0.00	0.00	-0.50	-0.50	0.00	4.50
1> x3	6.00	0.00	1.00	-1.50	0.50	0.00	1.50
2> x2	-3.00	1.00	0.00	0.50	-0.50	0.00	1.50
3> sx6	-2.00	0.00	0.00	1.00	0.00	1.00	0.00

+/-=(x+ - x-) s/s=slack/Surplus R=artif ' =upper bd ■ =inv(B)

<PgUp/PgDn>Scroll <F6>Optimum Menu

min				Final Iteration No: 3
*** OPTIMUM SOLUTION SUMMARY ***				
Obj value =	4.5000			
Variable	Value	Obj Coeff	Obj Val Contrib	
x1	0.0000	3.0000	0.0000	
x2	1.5000	2.0000	3.0000	
x3	1.5000	1.0000	1.5000	
More to come... Press PgDn/PgUp to scroll				

<PgUp/PgDn>Scroll <F6>Optimum Menu

## 4. SENSITIVITY ANALYSIS

(i). Max.  $z = 3x_1 + 2x_2 + 5x_3$

Subjected to

$$x_1 + 2x_2 + x_3 \leq 430$$

$$3x_1 + 2x_3 \leq 460$$

$$x_1 + 4x_2 \leq 420$$

$$x_1, x_2, x_3 \geq 0$$

max Final Iteration No: 3				
***** SENSITIVITY ANALYSIS *****				
Obj value = 1350.0000				
Obj Coeffs -- Single Changes:				
Variable	Current Coeff	Min Coeff	Max Coeff	Reduced Cost
x1	3.0000	-infinity	7.0000	4.0000
x2	2.0000	0.0000	10.0000	0.0000
x3	5.0000	2.3333	infinity	0.0000
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

max Final Iteration No: 3				
***** SENSITIVITY ANALYSIS *****				
Obj value = 1350.0000				
Righthand Side -- Single Changes:				
Constraint	Current RHS	Min RHS	Max RHS	Dual Price
1 (<>)	430.0000	230.0000	440.0000	1.0000
2 (<>)	460.0000	440.0000	860.0000	2.0000
3 (<>)	420.0000	400.0000	infinity	0.0000
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

(ii). Max.  $z = 10x_1 + 12x_2 - 2x_3$

Subjected to

$$x_1 + 2x_2 - x_3 \leq 320$$

$$3x_1 + x_2 \leq 350$$

$$x_3 \leq 10$$

$$x_1, x_2, x_3 \geq 0$$

max Final Iteration No: 4				
***** SENSITIVITY ANALYSIS *****				
Obj value = 2256.0000				
Obj Coeffs -- Single Changes:				
Variable	Current Coeff	Min Coeff	Max Coeff	Reduced Cost
x1	10.0000	6.0000	26.0000	0.0000
x2	12.0000	6.6667	20.0000	0.0000
x3	-2.0000	-5.2000	infinity	0.0000
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

max Final Iteration No: 4				
***** SENSITIVITY ANALYSIS *****				
Obj value = 2256.0000				
Righthand Side -- Single Changes:				
Constraint	Current RHS	Min RHS	Max RHS	Dual Price
1 (<>)	320.0000	106.6667	690.0000	5.2000
2 (<>)	350.0000	165.0000	990.0000	1.6000
3 (<>)	10.0000	0.0000	380.0000	3.2000
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

(iii). Max.  $z = x_1 + x_2$

Subjected to

$$2x_1 + x_2 \leq 6$$

$$x_1 + 2x_2 \leq 6$$

$$x_1 + x_2 \geq 0$$

$$x_1, x_2 \geq 0$$

max		Final Iteration No: 4		
***** SENSITIVITY ANALYSIS *****				
Obj value =		4.0000		
Obj Coeffs -- Single Changes:				
Variable	Current Coeff	Min Coeff	Max Coeff	Reduced Cost
x1	1.0000	0.5000	2.0000	0.0000
x2	1.0000	0.5000	2.0000	0.0000
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

max		Final Iteration No: 4		
***** SENSITIVITY ANALYSIS *****				
Obj value =		4.0000		
Righthand Side -- Single Changes:				
Constraint	Current RHS	Min RHS	Max RHS	Dual Price
1 (<)	6.0000	3.0000	12.0000	0.3333
2 (<)	6.0000	3.0000	12.0000	0.3333
3 (>)	0.0000	-infinity	4.0000	0.0000
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

## 5. TRANSPORTATION PROBLEM

(i).

	D1	D2	D3	Supply
S1	0	2	1	6
S2	2	1	5	7
S3	2	4	3	7
Demand	5	5	10	

Final Iteration –

<Optimal> Iteration No: 2				
Total cost = 33.0000 <Alternate soln detected at route <3,1>>				
	D1	D2	D3	Supply
S1	0	2	1	5
S2	2	1	5	7
S3	2	4	3	7
Uj	-1.00	-2.00	0.00	
DEMAND	5	5	10	

<Final> Iteration No: 2				
*** OPTIMUM TRANSPORTATION SOLUTION ***				
Total cost = 33.0000 <Alternate soln detected at route <3,1>>				
From	To	Amount	Unit Cost	Route Cost
S1	D1	3	0.00	0.00
	D2	0	2.00	0.00
	D3	3	1.00	3.00
S2	D1	2	2.00	4.00
	D2	5	1.00	5.00
	D3	0	5.00	0.00
S3	D1	0	2.00	0.00
	D2	0	4.00	0.00
	D3	7	3.00	21.00

<Final> Iteration No: 2				
*** OPTIMUM TRANSPORTATION SOLUTION ***				
<Summary of Transportation Costs>				
Total cost = 33.0000 <Alternate soln detected at route <3,1>>				
Node	Supply/Demand	Total Cost	Av. Cost/unit	
S1	6	3.00	0.50	
S2	7	9.00	1.29	
S3	7	21.00	3.00	
D1	5	4.00	0.80	
D2	5	5.00	1.00	
D3	10	24.00	2.40	

## Alternative Solution –

<Optimal> Iteration No: 5

Total cost = 33.0000 <Alternate soln detected at route <1,1>>

	D1	D2	D3	U1 SUPPLY
S1	0 0.00	2 -3.00	1 5	1.00
S2	2 2	1 5	5 -2.00	3.00
S3	2 8	4 -3.00	3 4	3.00
Uj DEMAND	-1.00 5	-2.00 5	0.00 10	

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 5

\*\*\* OPTIMUM TRANSPORTATION SOLUTION \*\*\*

Total cost = 33.0000 <Alternate soln detected at route <1,1>>

From	To	Amount	Unit Cost	Route Cost
S1	D1	0	0.00	0.00
	D2	0	2.00	0.00
	D3	6	1.00	6.00
S2	D1	2	2.00	4.00
	D2	5	1.00	5.00
	D3	0	5.00	0.00
S3	D1	3	2.00	6.00
	D2	0	4.00	0.00
	D3	4	3.00	12.00

More to come... Press PgDn/PgUp to scroll

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 5

\*\*\* OPTIMUM TRANSPORTATION SOLUTION \*\*\*

<Summary of Transportation Costs>

Total cost = 33.0000 <Alternate soln detected at route <1,1>>

Node	Supply/Demand	Total Cost	Av. Cost/unit
S1	6	6.00	1.00
S2	7	9.00	1.29
S3	7	18.00	2.57
D1	5	10.00	2.00
D2	5	5.00	1.00
D3	10	18.00	1.80

<PgUp/PgDn>Scroll <F6>Optimum Menu



(ii).

	D1	D2	D3	Supply
S1	1	2	6	7
S2	0	4	2	12
S3	3	1	5	11
Demand	10	10	10	

Final Iteration –

<Optimal> Iteration No: 1				
Total cost = 40.0000 <Alternate soln detected at route <3,3>>				
	D1	D2	D3	U <sub>i</sub> SUPPLY
S1	1 7	2 -3.00	6 -3.00	7 3.00
S2	0 2	4 -6.00	2 10	12 2.00
S3	3 1	1 10	5 0.00	11 5.00
U <sub>j</sub> DEMAND	-2.00 10	-4.00 10	0.00 10	

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 1				
*** OPTIMUM TRANSPORTATION SOLUTION ***				
Total cost = 40.0000 <Alternate soln detected at route <3,3>>				
From	To	Amount	Unit Cost	Route Cost
S1	D1	7	1.00	7.00
	D2	0	2.00	0.00
	D3	0	6.00	0.00
S2	D1	2	0.00	0.00
	D2	0	4.00	0.00
	D3	10	2.00	20.00
S3	D1	1	3.00	3.00
	D2	10	1.00	10.00
	D3	0	5.00	0.00

More to come... Press PgDn/PgUp to scroll

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 1			
*** OPTIMUM TRANSPORTATION SOLUTION ***			
<Summary of Transportation Costs>			
Total cost = 40.0000 <Alternate soln detected at route <3,3>>			
Node	Supply/Demand	Total Cost	Av. Cost/unit
S1	7	7.00	1.00
S2	12	20.00	1.67
S3	11	13.00	1.18
D1	10	10.00	1.00
D2	10	10.00	1.00
D3	10	20.00	2.00

<PgUp/PgDn>Scroll <F6>Optimum Menu

(iii).

	D1	D2	D3	Supply
S1	5	1	8	12
S2	2	4	0	14
S3	3	6	7	4
Demand	9	10	11	

Final Iteration –

<Optimal> Iteration No: 1

Total cost = 38.0000

	D1	D2	D3	U <sub>i</sub>	SUPPLY
S1	5 2	1 10	8 -5.00	12	3.00
S2	2 0	4 -6.00	0 11	14	0.00
S3	3 4	6 -7.00	7 -6.00	4	1.00
U <sub>j</sub>	2.00	-2.00	0.00		
DEMAND	9	10	11		

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 1

\*\*\* OPTIMUM TRANSPORTATION SOLUTION \*\*\*

Total cost = 38.0000

From	To	Amount	Unit Cost	Route Cost
S1	D1	2	5.00	10.00
	D2	10	1.00	10.00
	D3	0	8.00	0.00
S2	D1	3	2.00	6.00
	D2	0	4.00	0.00
	D3	11	0.00	0.00
S3	D1	4	3.00	12.00
	D2	0	6.00	0.00
	D3	0	7.00	0.00

More to come... Press PgDn/PgUp to scroll

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 1

\*\*\* OPTIMUM TRANSPORTATION SOLUTION \*\*\*  
<Summary of Transportation Costs>

Total cost = 38.0000

Node	Supply/Demand	Total Cost	Av. Cost/unit
S1	12	20.00	1.67
S2	14	6.00	0.43
S3	4	12.00	3.00
D1	9	28.00	3.11
D2	10	10.00	1.00
D3	11	0.00	0.00

<PgUp/PgDn>Scroll <F6>Optimum Menu

## 6. ASSIGNMENT PROBLEM

(i).

		JOBS			
		1	2	3	4
OP	1	1	4	6	3
ER	2	9	7	10	9
AT	3	4	5	11	7
OR	4	8	7	8	5

Final Iteration –

<Optimal> Iteration No: 5					
Total cost = 21.0000 <Alternate soln detected at route <1,3>>					
	D1	D2	D3	D4	U <sub>i</sub> SUPPLY
S1	1 1	4 -2.00	6 0.00	3 0	3.00
S2	9 -4.00	7 -1.00	10 1	9 -2.00	7.00
S3	4 0	5 1	11 -2.00	7 -1.00	6.00
S4	8 -5.00	7 -3.00	8 0	5 1	5.00
U <sub>j</sub> DEMAND	-2.00 1	-1.00 1	3.00 1	0.00 1	

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 5				
*** OPTIMUM TRANSPORTATION SOLUTION ***				
Total cost = 21.0000 <Alternate soln detected at route <1,3>>				
From	To	Amount	Unit Cost	Route Cost
S1	D1	1	1.00	1.00
	D2	0	4.00	0.00
	D3	0	6.00	0.00
	D4	0	3.00	0.00
S2	D1	0	9.00	0.00
	D2	0	7.00	0.00
	D3	1	10.00	10.00
	D4	0	9.00	0.00
S3	D1	0	4.00	0.00
	D2	1	5.00	5.00

More to come... Press PgDn/PgUp to scroll

ERROR: Top of file; press appropriate F-key if done

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 5				
*** OPTIMUM TRANSPORTATION SOLUTION ***				
Total cost =	21.0000	<Alternate soln detected at route <1,3>>		
From	To	Amount	Unit Cost	Route Cost
S3	D3	0	11.00	0.00
	D4	0	7.00	0.00
S4	D1	0	8.00	0.00
	D2	0	7.00	0.00
	D3	0	8.00	0.00
	D4	1	5.00	5.00
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

## Alternative Solution –

<Optimal> Iteration No: 6					
Total cost =	21.0000	<Alternate soln detected at route <4,3>>			
	D1	D2	D3	D4	U <sub>i</sub> SUPPLY
S1	1 1	4 -2.00	6 3	3 3	1 3.00
S2	9 -4.00	7 -1.00	10 1	9 -2.00	1 7.00
S3	4 3	5 1	11 -2.00	7 -1.00	1 6.00
S4	8 -5.00	7 -3.00	8 0.00	5 1	1 5.00
U <sub>j</sub> DEMAND	-2.00 1	-1.00 1	3.00 1	0.00 1	U <sub>4</sub> = 0.00
<PgUp/PgDn>Scroll <F6>Optimum Menu					

<Final> Iteration No: 6				
*** OPTIMUM TRANSPORTATION SOLUTION ***				
Total cost =	21.0000	<Alternate soln detected at route <4,3>>		
From	To	Amount	Unit Cost	Route Cost
S1	D1	1	1.00	1.00
	D2	0	4.00	0.00
	D3	0	6.00	0.00
	D4	0	3.00	0.00
S2	D1	0	9.00	0.00
	D2	0	7.00	0.00
	D3	1	10.00	10.00
	D4	0	9.00	0.00
S3	D1	0	4.00	0.00
	D2	1	5.00	5.00
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

<Final> Iteration No: 6				
*** OPTIMUM TRANSPORTATION SOLUTION ***				
Total cost = 21.0000 <Alternate soln detected at route <4,3>>				
From	To	Amount	Unit Cost	Route Cost
S3	D3	0	11.00	0.00
	D4	0	7.00	0.00
S4	D1	0	8.00	0.00
	D2	0	7.00	0.00
	D3	0	8.00	0.00
	D4	1	5.00	5.00
More to come... Press PgDn/PgUp to scroll				
<PgUp/PgDn>Scroll <F6>Optimum Menu				

(ii).

### JOBS

		1	2	3	4	5
OP	1	30	37	40	28	40
ER	2	40	24	27	21	36
AT	3	40	32	33	30	35
OR	4	25	38	40	36	36
S	5	29	62	41	34	39

Final Iteration –

<Optimal> Iteration No: 1						
Total cost = 149.0000						
		1 D1	1 D2	1 D3	1 D4	1 D5
S1	1	30 1	37 -1.00	40 -2.00	28 -2.00	40 0
S2	1	40 -22.00	24 1	27 0	21 -4.00	36 -7.00
S3	1	40 -16.00	32 -2.00	33 1	30 -7.00	35 0
S4	1	25 1	38 -7.00	40 -6.00	36 -12.00	36 0
More to come... Press PgDn/PgUp to scroll						
<PgUp/PgDn>Scroll <F6>Optimum Menu						

<Optimal> Iteration No: 1

Total cost = 149.0000

	1 D1	1 D2	1 D3	1 D4	1 D5
S5 1	29	62	41	34	39
	-1.00	-28.00	-4.00	-7.00	1
Uj	-11.00	-5.00	-2.00	-12.00	U5 = 0.00
DEMAND	1	1	1	1	1

<Final> Iteration No: 1

\*\*\* OPTIMUM TRANSPORTATION SOLUTION \*\*\*

Total cost = 149.0000

From	To	Amount	Unit Cost	Route Cost
S1 1	D1 1	0	30.00	0.00
	D2 1	0	37.00	0.00
	D3 1	0	40.00	0.00
	D4 1	1	28.00	28.00
	D5 1	0	40.00	0.00
S2 1	D1 1	0	40.00	0.00
	D2 1	1	24.00	24.00
	D3 1	0	27.00	0.00
	D4 1	0	21.00	0.00
	D5 1	0	36.00	0.00

More to come... Press PgDn/PgUp to scroll

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 1

\*\*\* OPTIMUM TRANSPORTATION SOLUTION \*\*\*

Total cost = 149.0000

From	To	Amount	Unit Cost	Route Cost
S3 1	D1 1	0	40.00	0.00
	D2 1	0	32.00	0.00
	D3 1	1	33.00	33.00
	D4 1	0	30.00	0.00
	D5 1	0	35.00	0.00
S4 1	D1 1	1	25.00	25.00
	D2 1	0	38.00	0.00
	D3 1	0	40.00	0.00
	D4 1	0	36.00	0.00
	D5 1	0	36.00	0.00

More to come... Press PgDn/PgUp to scroll

<PgUp/PgDn>Scroll <F6>Optimum Menu

<Final> Iteration No: 1

\*\*\* OPTIMUM TRANSPORTATION SOLUTION \*\*\*

Total cost = 149.0000

From	To	Amount	Unit Cost	Route Cost
S5 1	D1 1	0	29.00	0.00
	D2 1	0	62.00	0.00
	D3 1	0	41.00	0.00
	D4 1	0	34.00	0.00
	D5 1	1	39.00	39.00

More to come... Press PgDn/PgUp to scroll

## 7. INTEGER LINEAR PROGRAMMING PROBLEM

(i).

$$\text{Max. } z = 7x_1 + 9x_2$$

Subjected to

$$-x_1 + 3x_2 \leq 6$$

$$7x_1 + x_2 \leq 35$$

$$x_1, x_2 \geq 0$$

$x_1, x_2$  are integers.

Final Iteration –

max					<Final>Iteration No: 5
Basic	x1'	x2'	sx3	sx4	Solution
z	7.00	9.00	0.00	0.00	55.00
1> sx3	1.00	-3.00	1.00	0.00	1.00
2> sx4	-7.00	-1.00	0.00	1.00	5.00
Lower Bounds:	0	0			
Upper Bounds:	4	3			
+/-=(x+ - x-) s/\$=slack/Surplus R=artif ' =upper bd ■ =inv(B)					
<PgUp/PgDn>Scroll <F6>Optimum Menu					

max			
*** OPTIMUM INTEGER SOLUTION ***			
Current solution found at node 5 and optimality verified at node 5			
Obj value = 55.00000			
Variable	Value	Obj Coeff	Obj Val Contrib
x1	4.0000	7.0000	28.0000
x2	3.0000	9.0000	27.0000
More to come... Press PgDn/PgUp to scroll			
<PgUp/PgDn>Scroll <F6>Optimum Menu			

(ii).

$$\text{Max. } z = x_1 + x_2$$

Subjected to

$$-x_1 + 2x_2 \leq 8$$

$$2x_1 + x_2 \leq 16$$

$$x_1 \leq 6$$

$$x_1, x_2 \geq 0$$

$x_1$  is an integer.

**Final Iteration –**

max					<Final>Iteration No: 3
Basic	x1	x2	sx3	sx4	Solution
z	1.00	0.00	0.00	1.00	11.00
1> sx3	-5.00	0.00	1.00	-2.00	1.00
2> x2	2.00	1.00	0.00	1.00	3.00
Lower Bounds:	5	0			
Upper Bounds:	1	inf			
+/-=(x+ - x-) s/S=slack/Surplus R=artif ' =upper bd ■ =inv(B)					
<PgUp/PgDn>Scroll <F6>Optimum Menu					

max			
*** OPTIMUM INTEGER SOLUTION ***			
Current solution found at node 3 and optimality verified at node 3			
Obj value = 11.00000			
Variable	Value	Obj Coeff	Obj Val Contrib
x1	5.0000	1.0000	5.0000
x2	6.0000	1.0000	6.0000
More to come... Press PgDn/PgUp to scroll			
<PgUp/PgDn>Scroll <F6>Optimum Menu			



## 8. NETWORK PROBLEM

(i). Crisp –

Activities	1	2	3	4	5	6	7	8
1	-	5.33	7.16	3.5	-	-	-	-
2	-	-	10.66	-	-	-	-	-
3	-	-	-	-	7	-	-	-
4	-	-	-	-	9.5	12	-	-
5	-	-	-	-	-	5	6.33	-
6	-	-	-	-	-	-	-	8
7	-	-	-	-	-	-	-	9.96
8	-	-	-	-	-	-	-	-

CPM Solution –

Size: 8 nodes x 11 activities							
*** CPM SOLUTION ***							
Project duration = 39.279999							
Activity	Duration	Earliest start	Earliest Compl.	Latest start	Latest compl.	Total float	Free float
c 1-2	5.3	0.0	5.3	0.0	5.3	0.0	0.0
1-3	7.2	0.0	7.2	8.8	16.0	8.8	8.8
1-4	3.5	0.0	3.5	10.0	13.5	10.0	0.0
c 2-3	10.7	5.3	16.0	5.3	16.0	0.0	0.0
c 3-5	7.0	16.0	23.0	16.0	23.0	0.0	0.0
4-5	9.5	3.5	13.0	13.5	23.0	10.0	10.0
4-6	12.0	3.5	15.5	19.3	31.3	15.8	12.5
5-6	5.0	23.0	28.0	26.3	31.3	3.3	0.0
c 5-7	6.3	23.0	29.3	23.0	29.3	0.0	0.0
6-8	8.0	28.0	36.0	31.3	39.3	3.3	3.3
More to come... Press PgDn/PgUp to scroll							

Size: 8 nodes x 11 activities							
*** CPM SOLUTION ***							
Project duration = 39.279999							
Activity	Duration	Earliest start	Earliest Compl.	Latest start	Latest compl.	Total float	Free float
7-8	10.0	29.3	39.3	29.3	39.3	-0.0	-0.0

## (ii). Probabilistic Case –

Table consists of values (a,b,m),  
where **a** –Optimistic Time, **m** – Most likely Time, **b** – Pessimistic time.

Activities	1	2	3	4	5	6
1	-	(3,7,5)	(4,8,6)	-	-	-
2	-	-	(1,5,3)	(5,11,8)	-	-
3	-	-	-	-	(1,3,2)	(9,13,11)
4	-	-	-	-	-	(1,1,1)
5	-	-	-	-	-	(10,14,12)
6	-	-	-	-	-	-

## CPM Solution –

Size: 6 nodes x 8 activities						
*** PERT SOLUTION (activities) ***						
Expected project duration = 22.000000						
activity	Duration a	estimates b	m	Expected duration	Variance	
1-2	3.0	7.0	5.0	5.0	0.44	
1-3	4.0	8.0	6.0	6.0	0.44	
2-3	1.0	5.0	3.0	3.0	0.44	
2-4	5.0	11.0	8.0	8.0	1.00	
3-5	1.0	3.0	2.0	2.0	0.11	
3-6	9.0	13.0	11.0	11.0	0.44	
4-6	1.0	1.0	1.0	1.0	0.00	
5-6	10.0	14.0	12.0	12.0	0.44	

Size: 6 nodes x 8 activities		
*** PERT SOLUTION (nodes) ***		
Expected project duration = 22.000000		
Node	Expected occurrence time	Standard deviation
1	0.00	0.00
2	5.00	0.67
3	8.00	0.94
4	13.00	1.20
5	10.00	1.00
6	22.00	1.20