**CET 513 Transportation Networks and Optimization**

**CET513**

**Homework #2**

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# Problem 1

1) decision variables,

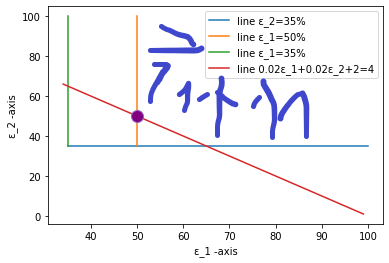
is removal efficiency in percent in 1, 2

2) objective function:  
 Minimize Z=20000

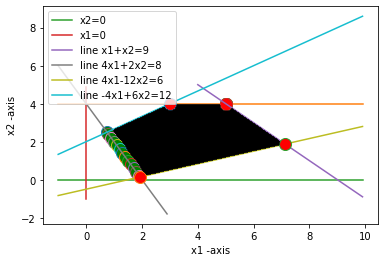
3) constraints:  
1.0+0.1>=6  
2+0.02+0.02>=4  
>=35%

4) Feasible region is above orange line, red line , blue line. In the picture, the blue arrow shows the area occurs in the outside of three line(direction betraying from these three lines).  
5) procedure :  
iterate the vertices of the crossline   
orange line cross red:

,  
redline cross blue line:  
,  
And we know the point which greater will be larger in Objective function Z, so the answer must occur nearby lowest part of the feasible region. We can get the answer by iterating vertices in this case, because vertices are the lowest part of the feasible region.   
After calculating, the minimize Z will occur when,.   
6) feasible region is not bounded



# Problem 2



Yes, the feasible region is bounded.

Extreme point:

*x*1= 3, *x*2= 4

*x*1= 27/14 , *x*2= 1/7

*x*1= 57/8 , *x*2= 15/8

*x*1= 5 , *x*2= 4

*x*1= 0.75 , *x*2= 2.5

Objective value=4; while *x*1, *x*2 @ 4 *x*1+2 *x*2=8, *x*1 in [0.75, 27/14], *x*2 in [2.5, 1/7]

# Problem 3

Standard form:

Minimize Z=2 *x*1+ 3*x*2+*x*3

2 *x*1+ *x*2- *x*3- *s*1=3

*x*1+ *x*2+*x*3- *s*2=2

*x*1,*x*2,*x*3, *s*1, *s*1

convert:

*variable:*

*y*1, *y*2

Maximize Z=3 *y*1+ 2*y*2

Yes, answer is same,

*y*1, *y*2=[0.33333333 1.33333333]

*x*1,*x*2,*x*3=[1.66666667e+00 2.17603713e-14 3.33333333e-01]

objective= 3.666666666666748

Problem 4:

Calculate the gradient and Hessian matrix of the following functions. Is any of them convex?

1. Gradient  
   =   
   Hessian  
   =
2. Gradient=   
   Hessian  
   =

Problem 5:

***Option 1:***

1. Node 3:  
   indegree is 3  
   outdegree is 2   
   Node 4:  
   indegree is 2  
   outdegree is 3
2. direct paths from node 1 to node 6:   
   1→2→4→6  
   1→2→3→5→4→6  
   1→3→5→4→6  
   1→3→2→4→6
3. the distance value change 3 times

(d) Yes, I get the same solution as that by Dikstra’s algorithm  
the code present of (c) and(d)

the value change! To 3 from 8.0 changes to 7.0

original path is:

1 → 3

New path is :

1 → 2 → 3

the value change! To 3 from 7.0 changes to 6.0

original path is:

1 → 2 → 3

New path is :

1 → 2 → 4 → 3

the value change! To 5 from 12.0 changes to 6.0

original path is:

1 → 2 → 4 → 5

New path is :

1 → 2 → 4 → 3 → 5

6 states expanded.

The link of each node and its cost:

1 → 2 is : 2

1 → 3 is : 8

2 → 3 is : 5

2 → 4 is : 3

4 → 3 is : 1

4 → 5 is : 7

4 → 6 is : 6

3 → 2 is : 6

3 → 5 is : 0

5 → 4 is : 4

6 → 5 is : 2

minimize cost to :1 is 0.0

1

minimize cost to :2 is 2.0

1 → 2

minimize cost to :4 is 5.0

1 → 2 → 4

minimize cost to :3 is 6.0

1 → 2 → 4 → 3

minimize cost to :5 is 6.0

1 → 2 → 4 → 3 → 5

minimize cost to :6 is 11.0

1 → 2 → 4 → 6

***Option 2:***

The following shows that the flow start from 1 with the min Cost

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

Minimum cost: 6

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

Minimum cost: 4

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 4 1 / 17111 4

Minimum cost: 8

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 4 1 / 17111 4

4 -> 5 1 / 17783 2

Minimum cost: 10

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

2 -> 6 1 / 4958 5

Minimum cost: 11

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

2 -> 6 1 / 4958 5

6 -> 8 1 / 4899 2

8 -> 7 1 / 7842 3

Minimum cost: 16

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

2 -> 6 1 / 4958 5

6 -> 8 1 / 4899 2

Minimum cost: 13

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 4 1 / 17111 4

4 -> 5 1 / 17783 2

5 -> 9 1 / 10000 5

Minimum cost: 15

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 4 1 / 17111 4

4 -> 5 1 / 17783 2

5 -> 9 1 / 10000 5

9 -> 10 1 / 13916 3

Minimum cost: 18

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 4 1 / 17111 4

4 -> 11 1 / 4909 6

Minimum cost: 14

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 12 1 / 23403 4

Minimum cost: 8

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 12 1 / 23403 4

12 -> 13 1 / 25900 3

Minimum cost: 11

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 12 1 / 23403 4

11 -> 14 1 / 4877 4

12 -> 11 1 / 4909 6

Minimum cost: 18

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 4 1 / 17111 4

4 -> 11 1 / 4909 6

11 -> 14 1 / 4877 4

14 -> 15 1 / 5128 5

Minimum cost: 23

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

2 -> 6 1 / 4958 5

6 -> 8 1 / 4899 2

8 -> 16 1 / 5046 5

Minimum cost: 18

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

2 -> 6 1 / 4958 5

6 -> 8 1 / 4899 2

8 -> 16 1 / 5046 5

16 -> 17 1 / 5230 2

Minimum cost: 20

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

2 -> 6 1 / 4958 5

6 -> 8 1 / 4899 2

7 -> 18 1 / 23403 2

8 -> 7 1 / 7842 3

Minimum cost: 18

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

2 -> 6 1 / 4958 5

6 -> 8 1 / 4899 2

8 -> 16 1 / 5046 5

16 -> 17 1 / 5230 2

17 -> 19 1 / 4824 2

Minimum cost: 22

Arc Flow / Capacity Cost

1 -> 2 1 / 25900 6

2 -> 6 1 / 4958 5

6 -> 8 1 / 4899 2

7 -> 18 1 / 23403 2

8 -> 7 1 / 7842 3

18 -> 20 1 / 23403 4

Minimum cost: 22

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 12 1 / 23403 4

12 -> 13 1 / 25900 3

13 -> 24 1 / 5091 4

24 -> 21 1 / 4885 3

Minimum cost: 18

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 12 1 / 23403 4

12 -> 13 1 / 25900 3

13 -> 24 1 / 5091 4

21 -> 22 1 / 5230 2

24 -> 21 1 / 4885 3

Minimum cost: 20

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 12 1 / 23403 4

12 -> 13 1 / 25900 3

13 -> 24 1 / 5091 4

24 -> 23 1 / 5079 2

Minimum cost: 17

Arc Flow / Capacity Cost

1 -> 3 1 / 23403 4

3 -> 12 1 / 23403 4

12 -> 13 1 / 25900 3

13 -> 24 1 / 5091 4

Minimum cost: 15