
Table of Contents

.....	1
Question 2	6
Question 3	9
Question 4	9
Question 5	9
Question 6 Méthode de Fletcher le Maréchal	11
Attention important j'ai epsilon 2 qui est inversé donc probablement epsilon 1 aussi	676
Question 6.2	676
Question 8	677
Question 9	950

`% Projet d'optimisation`

`xi ;
yi ;`

`%clear; close all; clc %clear efface le workspace, close all ferme les
close all; clc`

`dbtype('ctls.m') ;
dbtype('grad_ctls.m') ;
dbtype('fletcher.m');
dbtype('quasi_newton.m');`

`ctls(0.2,0.2,xi,yi) ;`

`cx = linspace(-1,1,100); % Valeur prise par Cx
cy = linspace(-1,2,100); % Ensemble de valeur prise par Cy`

`% Intervalle -1 4
cx2 = linspace(-1,4,200);
cy2 = linspace(-1,4,200);`

`epsilon = zeros(100,100) ; % Premier intervalle`

`epsilon2 = zeros(200,200) ; % Second intervalle`

`for j = 1:100
 for k = 1: 100
 %epsilon = [epsilon, ctls(cx(j),cy(k),xi,yi)];
 epsilon(j,k) = ctls(cx(j),cy(k),xi,yi) ;
 end`

`end`

`for j = 1:200`

```

    for k = 1:200
        %epsilon = [epsilon, ctls( cx(j),cy(k),xi,yi ) ];
        epsilon2(j,k) = ctls( cx2(j),cy2(k),xi,yi ) ;
    end
end

% figure;
%     surf( cx,cy,epsilon)
% figure;
%     surf( cx2,cy2,epsilon2)

figure;
    contour( cx,cy,epsilon,100)
    xlabel ( 'cx' )
    ylabel ( 'cy' )
    axis equal
figure;
    contour( cx2,cy2,epsilon2,100)
    xlabel ( 'cx' )
    ylabel ( 'cy' )
    axis equal

% On remarque l'existence d'un maximum local, mais nous recherchons un/des
% minimums locaux/globaux

% On étudie la fonction sur deux intervalles différents, donc pour le
% graphe n2 on observe dans les valeurs de l'écart (la fonction de cout)
% De plus le nombre de points pour l'intervalle [-1,4] est identique que
% pour l'intervalle [-1 1] donc le graphe est moins précis

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;

```

```

5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1
2
3      %function[s]=fletcher_function(cx,cy,xi,yi,epsilon,cxo,cyo)
4      function[s]=fletcher(cx,cy,a,d,xi,yi) % d est un doublet cx, cy
5          dbtype('grad_ctls.m') ;
6          dbtype('ctls.m') ;
7
8          al = 0 ; % alpha left
9          ar = inf ; % alpha right
10
11          lambda = 20 ;
12
13          B1 = 10^-3 ;
14          B2 = 0.99 ;
15          %y = 0 ; % : Gamma On le déclare et on lui donne sa valeur
16
17          % Nous devons calculer gamma à partir de a,B1,B2, d est moins le
18          % gradient
19
20          y = -B1*(grad_ctls(cx,cy,xi,yi)') * d; % Il faut que d soit un
      vecteur colonne
21
22
23
24          % Condition de Wolf 1 et Wolf 2 Il vaut mieux faire un while
25          while (ctls(cx+a*d(1),cy+a*d(2),xi,yi) > ctls(cx,cy,xi,yi) - a*y )
      || ((grad_ctls(cx+a*d(1),cy+a*d(2),xi,yi)')*d/((grad_ctls(cx,cy,xi,yi)')*d) >
      B2 ) % On calcule la fonction de cout et on vérifie
26
27          % Condition de Wolf 1
28          if(ctls(cx+a*d(1),cy+a*d(2),xi,yi) <= ctls(cx,cy,xi,yi) - a*y )
      % Si la condition de Wolf 1 est respectée
29              al = a;
30              if(ar >= inf )
31                  a = lambda*a ;
32              else
33                  a = (al+ar)/2 ;
34              end
35          else % Si elle n'est pas respectée

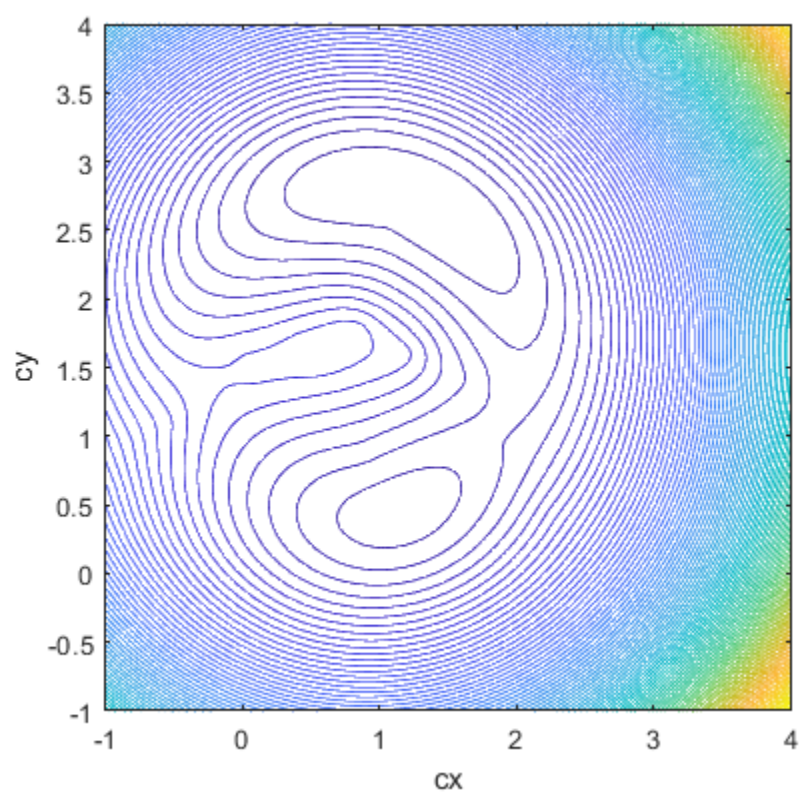
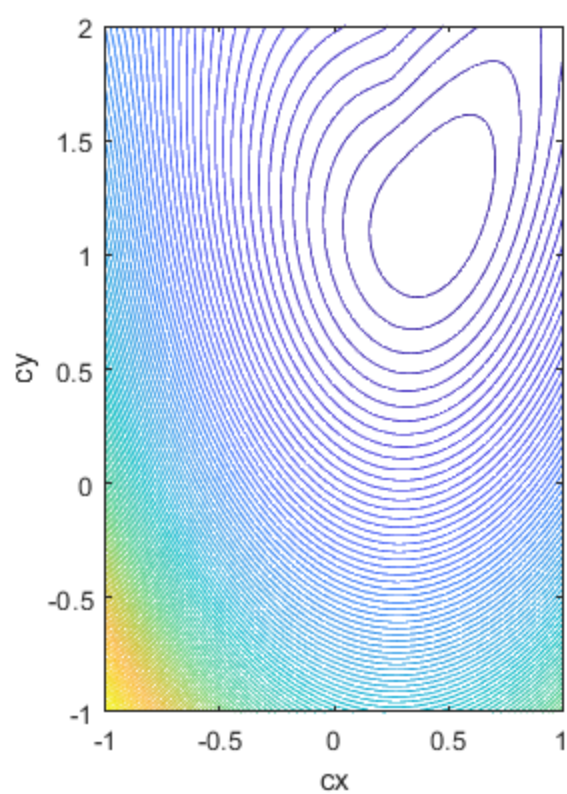
```

```

36         ar = a ;
37         a = (a1 + ar)/2 ;
38     end
39 end
40 s = a ;
41 end

1     function[s,result,counter]=quasi_newton(cx,cy,xi,yi,epsilon_newton) % d
    est un doublet cx, cy
2         dbtype('grad_ctls.m') ;
3         dbtype('ctls.m') ;
4         dbtype('fletcher.m')
5         % On initialise la matrice Hk à 0
6         % Attention dans ce code je choisis la notation Hk mais ici en
    réalité
7         % nous avons  $H_k^{-1}$  c'est la matrice inverse de Hk
8
9         I = eye(2);
10        alpha = 1 ;
11        Hk = eye(2); % On doit avoir une matrice de taille 2
12        disp(Hk)
13        result = [] ;
14        counter = 0 ;
15
16
17        Grad_fk = grad_ctls(cx,cy,xi,yi)
18
19        while (norm(Grad_fk)>epsilon_newton)
20            Grad_fk = grad_ctls(cx,cy,xi,yi)
21            dk = -Hk*Grad_fk ;
22
23            alpha = fletcher(cx,cy,alpha,dk,xi,yi);
24
25            cx = cx + alpha*dk(1) ;
26            cy = cy + alpha*dk(2) ;
27
28            Grad_fk1 = grad_ctls(cx,cy,xi,yi) ;
29
30            yk = Grad_fk1 - Grad_fk ;
31
32            dk_ = alpha*dk ; % dk barre On peut aussi l'écrire comme la
    différence des  $x_{k+1}$   $x_k$ 
33
34            Hk = (I - dk_*(yk')/((dk_')*yk) )*Hk*(I- yk*(dk_')/((dk_')*yk)
    ) + dk_*(dk_')/((dk_')*yk) ;
35
36            result = [result;[cx,cy]] ;
37            counter = counter + 1
38        end
39        s = [cx,cy] ;
40
41    end

```



Question 2

```
[min_cx,min_cy]=find(epsilon==min(epsilon(:)));
%cx(min_cx)
%disp(" LE Minimum de cy est :")
%cy(min_cy)

% On calcule un minimum de : 17.1935 pour cx = 0.4545 et cy = 1.1515 avec
% 100points

[min_cx2,min_cy2]=find(epsilon2==min(epsilon2(:)));

disp("Le Minimum de cx2 est :")
cx2(min_cx2)
disp("Le Minimum de cy2 est :")
cy2(min_cy2)

% On calcule un minimum de l'écart : 14.0446 pour cx2 = 2.6869 et cy =
% 1.3737 avec 100points

figure;
    plot(xi,yi,'+')
    %plot([cx(min_cx),cy(min_cy)])
    viscircles([0.4545,1.1515],1.5)
    viscircles([2.6869,1.3737],1.5)

% Le centre obtenu au second cercle semble cohérent, dû à la présence
% d'outlayer (le point tout à droite) est excentré donc à un "pooids" plus
% grand donc contribue à décaler le minimum global

% Ppour un intervalle de taille [-1,1]*[-1,2] On a besoin de
%  $(2/10^{-4}) \cdot (3/10^{-4})$  donc 600 Millions de valeurs

% Ppour un intervalle de taille [-1,4]*[-1,4] On a besoin de
%  $(5/10^{-4}) \cdot (5/10^{-4})$  donc 2.5 Milliards de valeurs

% On sait que pour chaque couple cx,cy on doit évaluer la fonction pour R
% [0.5,2.5]. On veut une précision de  $10^{-4}$  près donc on doit multiplier le nom
% bre d'évaluation de la fonction de coût que l'on a déterminé précédemment
% par 20 000.

% Nous allons donc chercher à trouver des algorithmes d'optimisations pour
% réduire le nombre d'évaluations de la fonction de coût à réaliser

Le Minimum de cx2 est :

ans =

    2.7186
```

Le Minimum de cy2 est :

ans =

1.3367

ans =

Group with properties:

Children: [2×1 Line]

Visible: on

HitTest: on

Use GET to show all properties

ans =

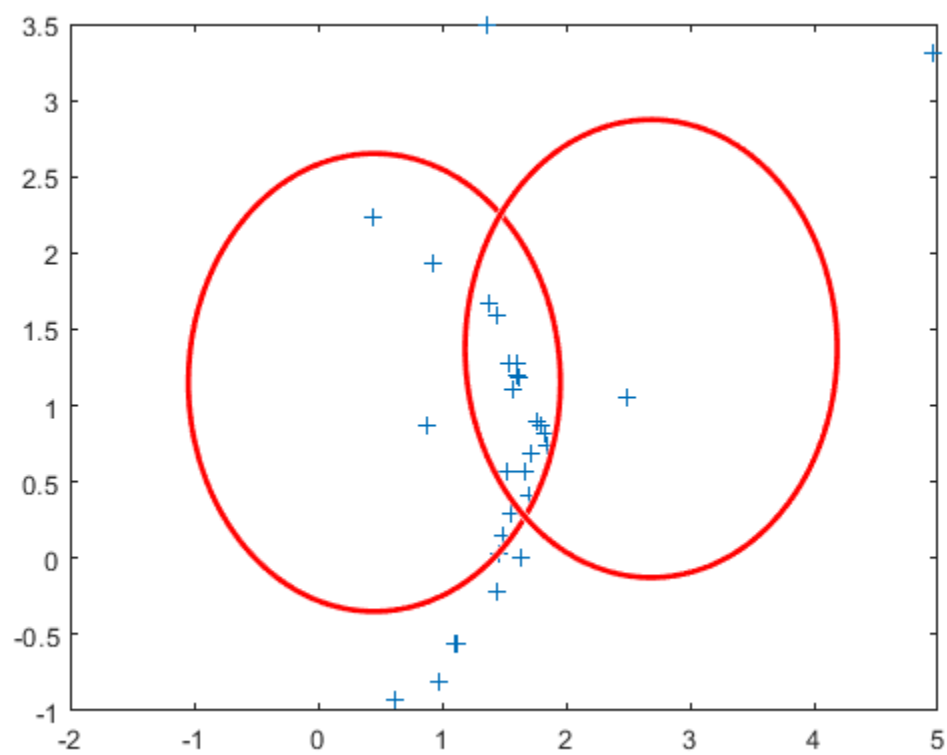
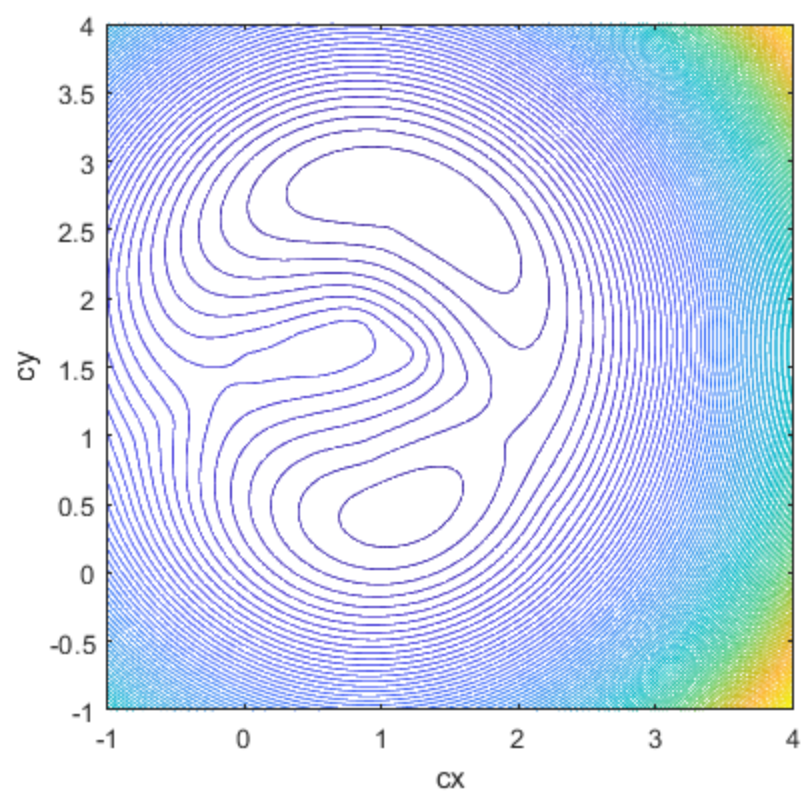
Group with properties:

Children: [2×1 Line]

Visible: on

HitTest: on

Use GET to show all properties



Question 3

Cf. feuille

Question 4

```
%
% [FX,FY] = gradient(ctls) ;
%
% FX(-1,-1,xi,yi)
% FY(-1,-1,xi,yi)
%

h = 10^(-8) ;

vtiq_cx = (ctls(-3+h,-2,xi,yi)-ctls(-3,-2,xi,yi)) / h ; % Composante selon cx
vtiq_cy = (ctls(-3,-2+h,xi,yi)-ctls(-3,-2,xi,yi)) / h ; % Composante selon cy
vexp = grad_ctls(-3,-2,xi,yi) ;

e_cx = (vtiq_cx - vexp(1))/vtiq_cx % Ecart relatif
e_cy = (vtiq_cy - vexp(2))/vtiq_cy % Ecart relatif

% Le calcul du gradient semble cohérent avec le calcul du gradient par
% différence finie

e_cx =

    -2.2779e-08

e_cy =

    1.1242e-08
```

Question 5

```
% On calcule lors de l'échantillonnage régulier

epsilon3 = zeros(100,100) ; % Premier intervalle
grad_epsilon3_cx = zeros(100,100) ; % Gradient selon cx
grad_epsilon3_cy = zeros(100,100) ; % Gradient selon cy

epsilon3 = zeros(200,200) ; % Second intervalle

for j = 1:100
    for k = 1:100
        epsilon3(j,k) = ctls( cx(j),cy(k),xi,yi ) ;
```

```

        %grad_epsilon3_cx(j,k) = grad_ctls(cx(j),cy(k),xi,yi)(1) ; % C'est une
matrice de vecteur normalement
        %grad_epsilon3_cy(j,k) = grad_ctls(cx(j),cy(k),xi,yi)(2) ;

        G = grad_ctls(cx(j),cy(k),xi,yi); % On doit passer par une variable
intermédiaire car lorsque le tableau est en lecture il ne peut pas etre en
écriture au meme moment

        grad_epsilon3_cx(j,k) = G(1);
        grad_epsilon3_cy(j,k) = G(2);

    end

end

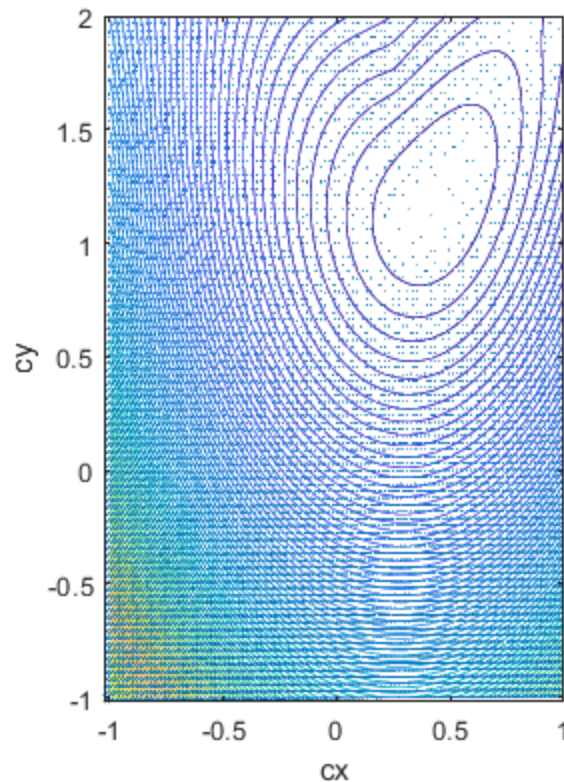
figure;
    contour( cx,cy,epsilon,100)
    xlabel ('cx')
    ylabel ('cy')
    axis equal
    hold on

    quiver(cx,cy,grad_epsilon3_cx,grad_epsilon3_cy);
    axis equal;

    hold off

% Plus le gradient

```



Question 6 Méthode de Fletcher le Maréchal

```
% Il faut que notre fonction gradient renvoie un vecteur colonne IMPORTANT

% ON CHERCHE LA DIRECTION Dk à xk fixé .On se servira surement du
  gradient_ctls
% On évalue le minimum de alpha tel que f(xk + alpha*dk)
% On calcule xk+1

% On vérifie que le gradient évaluée en xk ||Nabla(xk)|| <= v epsilon. Si ce
  n'est pas le cas on recommence

cxk = 2 ; % Première approximation du minimum en cx
cyk = 2 ; % Première approximation du minimum en cy

%a = 50 ;
b = 50 ;
d = -grad_ctls(0.5,0.5,xi,yi)
y = 0.5
%dbtype('fletcher.m');

% Il faut tester avec des valeurs opposées au gradient
d = -grad_ctls(0.5,0.5,xi,yi)
```

```
fletcher(0.5,0.5,10^-6,-grad_ctls(0.5,0.5,xi,yi),xi,yi) % Calcul de alpha
%fletcher_complet(0,3,10^-3,xi,yi,10^-4)
```

```
% ON utilise FLETCHER_Le_Marechal avec les coordonnées de départ (0.5,0.5)
[b, it, i] = fletcher_complet(-0.5,-0.5,10^-3,xi,yi,10^-4)
```

```
% Question 6.1 On représente l'ens des points
```

```
figure ;
    contour(cx2,cy2,epsilon2', 100)
    hold on
    axis equal

    plot(it(:,1), it(:,2))
    hold off
```

```
d =
```

```
    -2.7379
     7.5389
```

```
y =
```

```
    0.5000
```

```
d =
```

```
    -2.7379
     7.5389
```

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
17
18   function[d]=ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8  ) ;
9
10     for k = 1:30
11         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12     end
13 end

```

```
ans =
```

```
0.0080
```

```

1
2
3      %function[s]=fletcher_function(cx,cy,xi,yi,epsilon,cxo,cyo)
4      function[s]=fletcher(cx,cy,a,d,xi,yi) % d est un doublet cx, cy
5          dbtype('grad_ctls.m') ;
6          dbtype('ctls.m') ;
7
8          al = 0 ; % alpha left
9          ar = inf ; % alpha right
10
11          lambda = 20 ;
12
13          B1 = 10^-3 ;
14          B2 = 0.99 ;
15          %y = 0 ; % : Gamma On le déclare et on lui donne sa valeur
16
17          % Nous devons calculer gamma à partir de a,B1,B2, d est moins le
18          % gradient
19
20          y = -B1*(grad_ctls(cx,cy,xi,yi)') * d; % Il faut que d soit un
21          vecteur colonne
22
23
24          % Condition de Wolf 1 et Wolf 2 Il vaut mieux faire un while
25          while (ctls(cx+a*d(1),cy+a*d(2),xi,yi) > ctls(cx,cy,xi,yi) - a*y )
26              || ((grad_ctls(cx+a*d(1),cy+a*d(2),xi,yi)')*d)/((grad_ctls(cx,cy,xi,yi)')*d) >
27              B2 ) % On calcule la fonction de cout et on vérifie
28
29          % Condition de Wolf 1
30          if(ctls(cx+a*d(1),cy+a*d(2),xi,yi) <= ctls(cx,cy,xi,yi) - a*y )
31              % Si la condition de Wolf 1 est respectée
32              al = a;
33              if(ar >= inf )
34                  a = lambda*a ;
35              else

```

```

33             a = (al+ar)/2 ;
34             end
35         else % Si elle n'est pas respectée
36             ar = a ;
37             a = (al + ar)/2 ;
38         end
39     end
40     s = a ;
41 end

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 ) ;
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 ) ;
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
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5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
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7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

1     function[d]=grad_ctls(cx,cy,xi,yi)
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3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
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14            cy)^2)) - 1 );
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16    end

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7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

```

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
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5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
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11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
17
18   function[d]=ctls(cx,cy,xi,yi)
19       n = length(xi) ;
20       d = 0 ;
21       R = 1.5 ;
22
23       %syms k ;
24       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
25   ) ;
26
27   for k = 1:30
28       d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29   end
30   end
31
32   function[d]=grad_ctls(cx,cy,xi,yi)
33       n = length(xi) ;
34       d = [0;0] ;
35       R = 1.5 ;
36
37       %syms k ;
38       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
39   ) ;
40
41   for k = 1:length(xi)
42       d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
43           cy)^2)) - 1 );
44       d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
45           cy)^2)) - 1 );
46   end
47   end
48
49   function[d]=ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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2      n = length(xi) ;
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cy)^2)) - 1 );
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cy)^2)) - 1 );
13
14     end
15 end

1      function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
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1      function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
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9     for k = 1:length(xi)
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9          for k = 1:length(xi)
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11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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```

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12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
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2         n = length(xi) ;
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2        n = length(xi) ;
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6        %syms k ;
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1     function[d]=ctls(cx,cy,xi,yi)
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1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
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9      for k = 1:length(xi)
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11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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14      end
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1  function[d]=ctls(cx,cy,xi,yi)
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9          for k = 1:length(xi)
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11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
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6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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2        n = length(xi) ;
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6      %syms k ;
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14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
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```

```

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10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
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1      function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
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6      %syms k ;
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```

```

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9     for k = 1:length(xi)
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12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
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6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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```

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1    function[d]=grad_ctls(cx,cy,xi,yi)
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18   function[d]=ctls(cx,cy,xi,yi)
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7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
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9      for k = 1:length(xi)
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11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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      cy)^2)) - 1 );
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14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;

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4         R = 1.5 ;
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6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
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1      function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
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```

```

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1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
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12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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15         end
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1     function[d]=ctls(cx,cy,xi,yi)
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10            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
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2        n = length(xi) ;
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6        %syms k ;
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```

```

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10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
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1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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14      end
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1  function[d]=ctls(cx,cy,xi,yi)
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12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
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11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
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```

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
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6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
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10       for k = 1:length(xi)
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18   function[d]=ctls(cx,cy,xi,yi)
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49   function[d]=ctls(cx,cy,xi,yi)

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7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
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9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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14            cy)^2)) - 1 );
15        end
16    end

```

```

15     end

1     function[d]=ctls(cx,cy,xi,yi)
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```

```

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1      function[d]=grad_ctls(cx,cy,xi,yi)
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12              cy)^2)) - 1 );

```

```

12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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1     function[d]=ctls(cx,cy,xi,yi)
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1     function[d]=grad_ctls(cx,cy,xi,yi)

```

```

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      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;

```

```

4         R = 1.5 ;
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6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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52        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
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```

```

10
11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
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```

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11          end
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b =

    0.4496    1.1563

it =

-0.5000    -0.5000
-0.4498    -0.4603
-0.4025    -0.4224
-0.3580    -0.3861
-0.3160    -0.3513
-0.2764    -0.3180
-0.2391    -0.2860
-0.2039    -0.2553
-0.1707    -0.2258
-0.1394    -0.1975
-0.1097    -0.1701
-0.0818    -0.1438
-0.0553    -0.1184
-0.0303    -0.0939
-0.0067    -0.0702
 0.0157    -0.0474
 0.0368    -0.0253
 0.0569    -0.0039
 0.0758     0.0168
 0.0938     0.0369

```

0.1107	0.0563
0.1268	0.0752
0.1421	0.0935
0.1565	0.1112
0.1702	0.1284
0.1831	0.1452
0.1954	0.1615
0.2070	0.1773
0.2180	0.1927
0.2285	0.2077
0.2384	0.2224
0.2477	0.2366
0.2566	0.2505
0.2650	0.2640
0.2730	0.2772
0.2805	0.2901
0.2877	0.3027
0.2944	0.3150
0.3008	0.3270
0.3069	0.3387
0.3126	0.3502
0.3180	0.3614
0.3232	0.3724
0.3280	0.3832
0.3326	0.3937
0.3369	0.4040
0.3410	0.4141
0.3449	0.4240
0.3485	0.4338
0.3520	0.4433
0.3552	0.4526
0.3583	0.4618
0.3612	0.4708
0.3639	0.4796
0.3664	0.4883
0.3688	0.4968
0.3711	0.5052
0.3732	0.5134
0.3752	0.5215
0.3771	0.5294
0.3789	0.5373
0.3805	0.5449
0.3821	0.5525
0.3835	0.5599
0.3849	0.5673
0.3861	0.5745
0.3873	0.5816
0.3884	0.5886
0.3895	0.5955
0.3904	0.6022
0.3913	0.6089
0.3922	0.6155
0.3929	0.6220
0.3936	0.6284

0.3943	0.6347
0.3949	0.6409
0.3955	0.6470
0.3960	0.6531
0.3965	0.6590
0.3970	0.6649
0.3974	0.6707
0.3977	0.6765
0.3981	0.6821
0.3984	0.6877
0.3987	0.6932
0.3990	0.6986
0.3992	0.7040
0.3994	0.7093
0.3996	0.7145
0.3998	0.7197
0.4000	0.7248
0.4001	0.7298
0.4002	0.7348
0.4004	0.7397
0.4005	0.7445
0.4006	0.7493
0.4007	0.7540
0.4007	0.7587
0.4008	0.7633
0.4009	0.7679
0.4009	0.7724
0.4010	0.7768
0.4010	0.7812
0.4011	0.7856
0.4011	0.7899
0.4012	0.7941
0.4012	0.7983
0.4013	0.8025
0.4013	0.8066
0.4014	0.8106
0.4014	0.8146
0.4014	0.8186
0.4015	0.8225
0.4015	0.8263
0.4016	0.8301
0.4016	0.8339
0.4017	0.8377
0.4017	0.8413
0.4018	0.8450
0.4018	0.8486
0.4019	0.8521
0.4020	0.8557
0.4020	0.8591
0.4021	0.8626
0.4022	0.8660
0.4023	0.8693
0.4024	0.8727
0.4025	0.8759

0.4025	0.8792
0.4026	0.8824
0.4028	0.8856
0.4029	0.8887
0.4030	0.8918
0.4031	0.8948
0.4032	0.8979
0.4033	0.9009
0.4035	0.9038
0.4036	0.9067
0.4037	0.9096
0.4039	0.9125
0.4040	0.9153
0.4042	0.9181
0.4043	0.9208
0.4045	0.9236
0.4046	0.9263
0.4048	0.9289
0.4050	0.9316
0.4051	0.9342
0.4053	0.9367
0.4055	0.9393
0.4057	0.9418
0.4059	0.9443
0.4061	0.9467
0.4063	0.9491
0.4064	0.9515
0.4066	0.9539
0.4068	0.9562
0.4071	0.9586
0.4073	0.9609
0.4075	0.9631
0.4077	0.9653
0.4079	0.9676
0.4081	0.9697
0.4083	0.9719
0.4086	0.9740
0.4088	0.9761
0.4090	0.9782
0.4092	0.9803
0.4095	0.9823
0.4097	0.9843
0.4099	0.9863
0.4102	0.9883
0.4104	0.9902
0.4106	0.9921
0.4109	0.9940
0.4111	0.9959
0.4114	0.9978
0.4116	0.9996
0.4119	1.0014
0.4121	1.0032
0.4123	1.0050
0.4126	1.0067

0.4128	1.0084
0.4131	1.0101
0.4133	1.0118
0.4136	1.0135
0.4138	1.0151
0.4141	1.0168
0.4143	1.0184
0.4146	1.0200
0.4148	1.0215
0.4151	1.0231
0.4153	1.0246
0.4156	1.0261
0.4158	1.0276
0.4161	1.0291
0.4163	1.0306
0.4166	1.0320
0.4168	1.0335
0.4171	1.0349
0.4173	1.0363
0.4176	1.0376
0.4178	1.0390
0.4181	1.0404
0.4183	1.0417
0.4186	1.0430
0.4188	1.0443
0.4191	1.0456
0.4193	1.0469
0.4196	1.0481
0.4198	1.0494
0.4201	1.0506
0.4203	1.0518
0.4206	1.0530
0.4208	1.0542
0.4210	1.0554
0.4213	1.0565
0.4215	1.0577
0.4217	1.0588
0.4220	1.0599
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0.4227	1.0632
0.4229	1.0643
0.4232	1.0653
0.4234	1.0664
0.4236	1.0674
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0.4241	1.0694
0.4243	1.0704
0.4245	1.0714
0.4247	1.0724
0.4250	1.0733
0.4252	1.0743
0.4254	1.0752
0.4256	1.0761

0.4258	1.0771
0.4261	1.0780
0.4263	1.0789
0.4265	1.0797
0.4267	1.0806
0.4269	1.0815
0.4271	1.0823
0.4273	1.0832
0.4275	1.0840
0.4277	1.0848
0.4279	1.0857
0.4281	1.0865
0.4283	1.0873
0.4285	1.0880
0.4287	1.0888
0.4289	1.0896
0.4291	1.0904
0.4293	1.0911
0.4295	1.0918
0.4297	1.0926
0.4299	1.0933
0.4301	1.0940
0.4303	1.0947
0.4305	1.0954
0.4306	1.0961
0.4308	1.0968
0.4310	1.0975
0.4312	1.0982
0.4314	1.0988
0.4315	1.0995
0.4317	1.1001
0.4319	1.1008
0.4321	1.1014
0.4322	1.1020
0.4324	1.1026
0.4326	1.1032
0.4328	1.1038
0.4329	1.1044
0.4331	1.1050
0.4332	1.1056
0.4334	1.1062
0.4336	1.1068
0.4337	1.1073
0.4339	1.1079
0.4340	1.1084
0.4342	1.1090
0.4344	1.1095
0.4345	1.1100
0.4347	1.1106
0.4348	1.1111
0.4350	1.1116
0.4351	1.1121
0.4353	1.1126
0.4354	1.1131

0.4355	1.1136
0.4357	1.1141
0.4358	1.1146
0.4360	1.1150
0.4361	1.1155
0.4362	1.1160
0.4364	1.1164
0.4365	1.1169
0.4366	1.1173
0.4368	1.1178
0.4369	1.1182
0.4370	1.1186
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0.4373	1.1195
0.4374	1.1199
0.4376	1.1203
0.4377	1.1207
0.4378	1.1211
0.4379	1.1215
0.4380	1.1219
0.4382	1.1223
0.4383	1.1227
0.4384	1.1231
0.4385	1.1234
0.4386	1.1238
0.4387	1.1242
0.4389	1.1245
0.4390	1.1249
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0.4392	1.1256
0.4393	1.1259
0.4394	1.1263
0.4395	1.1266
0.4396	1.1270
0.4397	1.1273
0.4398	1.1276
0.4399	1.1279
0.4400	1.1283
0.4401	1.1286
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0.4403	1.1292
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0.4406	1.1301
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0.4494	1.1557

[illegible]

[illegible]

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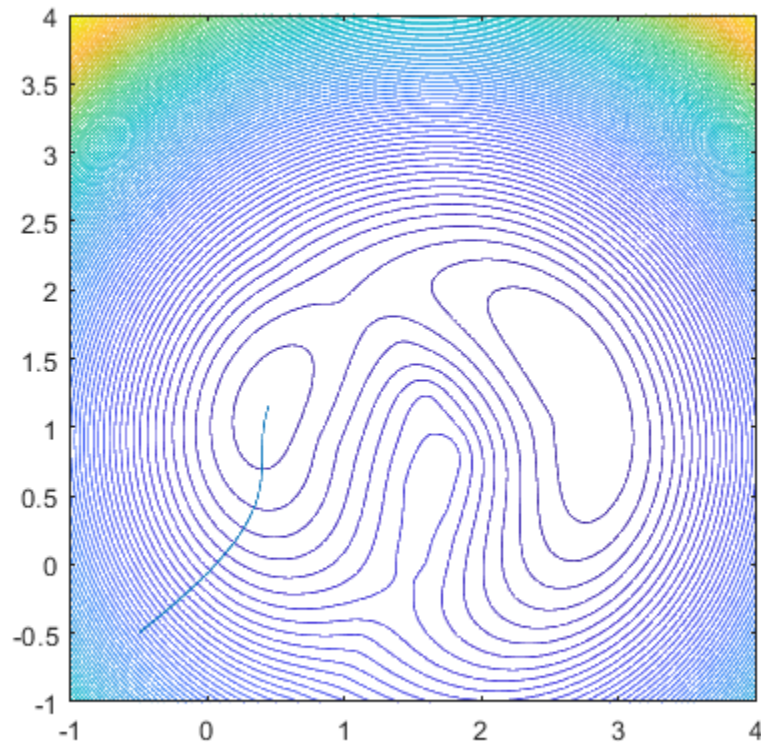
[illegible]

[illegible]

```
0.4496    1.1563
0.4496    1.1563
0.4496    1.1563
```

$i =$

1048



Attention important j'ai epsilon 2 qui est inversé donc probablement epsilon 1 aussi

```
% Rapport sous forme d'un pdf, on peut le générer avec un rapport
% automatique matlab. Il faut pouvoir interpréter les résultats obtenus
```

Question 6.2

```
% cx_iter= linspace(-1,4,1049) ;
% cy_iter= linspace(-1,4,1049) ;
% figure;
%     contour(cx_iter,cy_iter,[it(:,1), it(:,2)]);
```

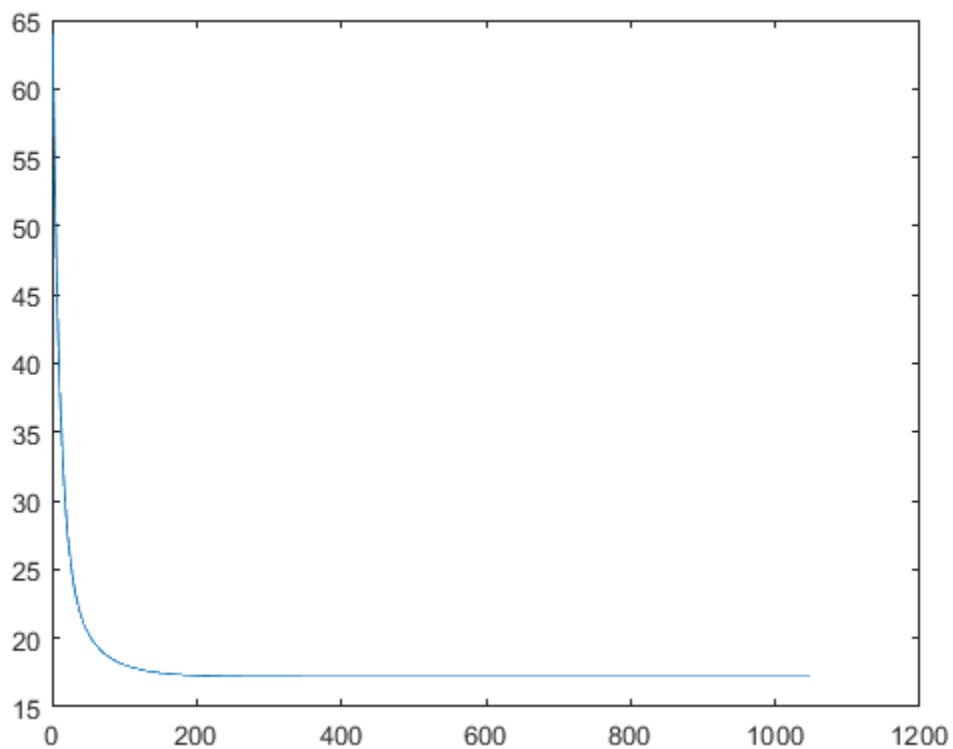
```
% figure;
% plot(ctls(it(:,1), it(:,2),xi,yi),i)
%

result_q6_2 = [] ;

for (variable = 1:size(it))
    result_q6_2 = [result_q6_2;ctls(it(variable,1),it(variable,2),xi,yi) ] ;
end

figure;
plot(result_q6_2)

% hold on
% plot(abs(it(:,1)-it(:,2)))
%
% hold off
```



Question 8

```
[b_newton, it_newton, i_newton] = quasi_newton(0.5,0.5,xi,yi,10^-3);

[b_newton2, it_newton2, i_newton2] = quasi_newton(2.67,1.37,xi,yi,10^-3);
```

```

figure ;
    contour(cx2,cy2,epsilon2', 100)
    hold on
    axis equal

    plot(it_newton(:,1), it_newton(:,2))
    hold off

    % Test affichage des solutions de la fonction de ciyt
figure;
    plot(xi,yi,'+')
    %plot([cx(min_cx),cy(min_cy)])
    viscircles(b_newton,1.5)
    viscircles(b_newton2,1.5)%

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:30
11             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12         end

1
2
3      %function[s]=fletcher_function(cx,cy,xi,yi,epsilon,cxo,cyo)
4      function[s]=fletcher(cx,cy,a,d,xi,yi) % d est un doublet cx, cy

```

```

5      dbtype('grad_ctls.m') ;
6      dbtype('ctls.m') ;
7
8      al = 0 ; % alpha left
9      ar = inf ; % alpha right
10
11     lambda = 20 ;
12
13     B1 = 10^-3 ;
14     B2 = 0.99 ;
15     %y = 0 ; % : Gamma On le déclare et on lui donne sa valeur
16
17     % Nous devons calculer gamma à partir de a,B1,B2, d est moins le
18     % gradient
19
20     y = -B1*(grad_ctls(cx,cy,xi,yi)') * d; % Il faut que d soit un
    vecteur colonne
21
22
23
24     % Condition de Wolf 1 et Wolf 2 Il vaut mieux faire un while
25     while (ctls(cx+a*d(1),cy+a*d(2),xi,yi) > ctls(cx,cy,xi,yi) - a*y )
    || ((grad_ctls(cx+a*d(1),cy+a*d(2),xi,yi)')*d/((grad_ctls(cx,cy,xi,yi)')*d) >
    B2 ) % On calcule la fonction de cout et on vérifie
26
27         % Condition de Wolf 1
28         if(ctls(cx+a*d(1),cy+a*d(2),xi,yi) <= ctls(cx,cy,xi,yi) - a*y )
    % Si la condition de Wolf 1 est respectée
29             al = a;
30             if(ar >= inf )
31                 a = lambda*a ;
32             else
33                 a = (al+ar)/2 ;
34             end
35         else % Si elle n'est pas respectée
36             ar = a ;
37             a = (al + ar)/2 ;
38         end
39     end
40     s = a ;
41     end
    1      0
    0      1

```

Grad_fk =

2.7379
-7.5389

Grad_fk =

2.7379

-7.5389

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
```

```
1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end
```

counter =

1

Grad_fk =

-3.5373

-1.7487

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    2

Grad_fk =

    2.4618
   -0.3485

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    3

Grad_fk =

    2.3038
   -0.2934

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

      4

Grad_fk =

      2.1584
     -0.2780

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

2.0222
-0.2608

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end

```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end

```

counter =

6

Grad_fk =

1.8949
-0.2448

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

      7

Grad_fk =

      1.7756
     -0.2298

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    8

Grad_fk =

    1.6639
   -0.2157

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
      ) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    9

Grad_fk =

    1.5593
   -0.2024

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    10

Grad_fk =

    1.4614
   -0.1900

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    11

Grad_fk =

    1.3696

```

-0.1783

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

12

Grad_fk =

1.2836
-0.1673

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    13

Grad_fk =

    1.2031
   -0.1569

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    14

Grad_fk =

    1.1276
   -0.1472

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    15

Grad_fk =

    1.0569
   -0.1381


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.9906
-0.1296

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
17
18   function[d]=ctls(cx,cy,xi,yi)
19       n = length(xi) ;
20       d = 0 ;
21       R = 1.5 ;
22
23       %syms k ;
24       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
25   ) ;
26
27   for k = 1:30
28       d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29   end
30   end

```

counter =

17

Grad_fk =

0.9285
-0.1215

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    18

Grad_fk =

    0.8703
   -0.1140

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    19

Grad_fk =

    0.8158
   -0.1069

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
      ) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    20

Grad_fk =

    0.7647
   -0.1003

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    21

Grad_fk =

    0.7168
   -0.0941

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    22

Grad_fk =

    0.6719

```

-0.0882

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

23

Grad_fk =

0.6299
-0.0827

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    24

Grad_fk =

    0.5904
   -0.0776

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    25

Grad_fk =

    0.5535
   -0.0728

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    26

Grad_fk =

    0.5188
   -0.0682

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.4864
-0.0640

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end

```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end

```

counter =

28

Grad_fk =

0.4559
-0.0600

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    29

Grad_fk =

    0.4274
   -0.0563

```

```

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    30

Grad_fk =

    0.4007
   -0.0528

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    31

Grad_fk =

    0.3756
   -0.0495

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    32

Grad_fk =

    0.3521
   -0.0464


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    33

Grad_fk =

    0.3301

```

-0.0435

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

34

Grad_fk =

0.3094
-0.0408

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

      35

Grad_fk =

      0.2901
     -0.0382

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    36

Grad_fk =

    0.2719
   -0.0359

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    37

Grad_fk =

    0.2549
   -0.0336

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.2390
-0.0315

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end

```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end

```

counter =

39

Grad_fk =

0.2240
-0.0296

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    40

Grad_fk =

    0.2100
   -0.0277

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8         ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    41

Grad_fk =

    0.1969
   -0.0260

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8         ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    42

Grad_fk =

    0.1846
   -0.0244

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    43

Grad_fk =

    0.1730
   -0.0228

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    44

Grad_fk =

    0.1622

```

-0.0214

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
```

```
1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end
```

counter =

45

Grad_fk =

0.1521
-0.0201

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    46

Grad_fk =

    0.1426
   -0.0188

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    47

Grad_fk =

    0.1337
   -0.0176

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    48

Grad_fk =

    0.1253
   -0.0165

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.1175
-0.0155

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end

```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end

```

counter =

50

Grad_fk =

0.1101
-0.0145

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    51

Grad_fk =

    0.1032
   -0.0136

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    52

Grad_fk =

    0.0968
   -0.0128

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    53

Grad_fk =

    0.0907
   -0.0120

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    54

Grad_fk =

    0.0851
   -0.0112


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    55

Grad_fk =

    0.0797

```

-0.0105

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

56

Grad_fk =

0.0748
-0.0099

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    57

Grad_fk =

    0.0701
   -0.0093

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    58

Grad_fk =

    0.0657
   -0.0087

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    59

Grad_fk =

    0.0616
   -0.0081

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

60

Grad_fk =

0.0577
-0.0076

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

61

Grad_fk =

0.0541
-0.0072

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    62

Grad_fk =

    0.0508
   -0.0067

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    63

Grad_fk =

    0.0476
   -0.0063

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    64

Grad_fk =

    0.0446
   -0.0059

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    65

Grad_fk =

    0.0418
   -0.0055


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    66

Grad_fk =

    0.0392

```

-0.0052

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

67

Grad_fk =

0.0368
-0.0049

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end
31
32 counter =
33
34     68
35
36
37
38 Grad_fk =
39
40     0.0345
41     -0.0046

```

```

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    69

Grad_fk =

    0.0323
   -0.0043

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    70

Grad_fk =

    0.0303
   -0.0040

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

71

Grad_fk =

0.0284
-0.0038

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9     for k = 1:length(xi)
10
11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12 cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14 cy)^2)) - 1 );
15     end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9     for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end
```

counter =

72

Grad_fk =

0.0266
-0.0035

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    73

Grad_fk =

    0.0250
   -0.0033

```

```

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    74

Grad_fk =

    0.0234
   -0.0031

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8      ) ;
9
10     for k = 1:30
11         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12     end
13
14 counter =
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12     end

counter =

    76

Grad_fk =

    0.0206
   -0.0027


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    77

Grad_fk =

    0.0193

```

-0.0025

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

78

Grad_fk =

0.0181
-0.0024

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    79

Grad_fk =

    0.0169
   -0.0022

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    80

Grad_fk =

    0.0159
   -0.0021

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    81

Grad_fk =

    0.0149
   -0.0020

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0140
-0.0018

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end

```

counter =

83

Grad_fk =

0.0131
-0.0017

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

      84

Grad_fk =

      0.0123
     -0.0016

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    85

Grad_fk =

    0.0115
   -0.0015

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
      ) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    86

Grad_fk =

    0.0108
   -0.0014

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    87

Grad_fk =

    0.0101
   -0.0013


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    88

Grad_fk =

    0.0095

```

-0.0013

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
```

```
1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end
```

counter =

89

Grad_fk =

0.0089

-0.0012

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    90

Grad_fk =

    0.0083
   -0.0011

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    91

Grad_fk =

    0.0078
   -0.0010

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    92

Grad_fk =

    0.0073
   -0.0010

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0069
-0.0009

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end

```

counter =

94

Grad_fk =

0.0064
-0.0009

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    95

Grad_fk =

    0.0060
   -0.0008

```

```

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    96

Grad_fk =

    0.0057
   -0.0007

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    97

Grad_fk =

    0.0053
   -0.0007

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    98

Grad_fk =

    0.0050
   -0.0007


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    99

Grad_fk =

    0.0047

```

-0.0006

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

100

Grad_fk =

0.0044

-0.0006

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    101

Grad_fk =

    0.0041
   -0.0005

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    102

Grad_fk =

    0.0038
   -0.0005

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:30
11             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
12         end
13     end

counter =

    103

Grad_fk =

    0.0036
   -0.0005

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
12        end
13    end

counter =

```

Grad_fk =

0.0034
-0.0004

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end

```

counter =

105

Grad_fk =

0.0032
-0.0004

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    106

Grad_fk =

    0.0030
   -0.0004

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    107

Grad_fk =

    0.0028
   -0.0004

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    108

Grad_fk =

    0.0026
   -0.0003

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    109

Grad_fk =

    0.0024
   -0.0003

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    110

Grad_fk =

    0.0023

```

-0.0003

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

111

Grad_fk =

0.0021
-0.0003

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11          end
12      end

```

counter =

112

Grad_fk =

0.0020
-0.0003

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    113

Grad_fk =

    0.0019
   -0.0002

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    114

Grad_fk =

    0.0018
   -0.0002

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

115

Grad_fk =

0.0017
-0.0002

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9     for k = 1:length(xi)
10
11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12 cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14 cy)^2)) - 1 );
15     end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9     for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end
```

counter =

116

Grad_fk =

0.0016
-0.0002

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    117

Grad_fk =

    0.0015
   -0.0002

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    118

Grad_fk =

    0.0014
   -0.0002

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    119

Grad_fk =

    0.0013
   -0.0002

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    120

Grad_fk =

    0.0012
   -0.0002

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    121

Grad_fk =

    0.0011

```

-0.0001

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

122

Grad_fk =

0.0011

-0.0001

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    123

Grad_fk =

    1.0e-03 *

    0.9900
   -0.1309

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );

```

```

12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    124

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30

```

```

10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

1
2
3     %function[s]=fletcher_function(cx,cy,xi,yi,epsilon,cxo,cyo)
4     function[s]=fletcher(cx,cy,a,d,xi,yi) % d est un doublet cx, cy
5         dbtype('grad_ctls.m') ;
6         dbtype('ctls.m') ;
7
8         al = 0 ; % alpha left
9         ar = inf ; % alpha right
10
11         lambda = 20 ;
12
13         B1 = 10^-3 ;
14         B2 = 0.99 ;
15         %y = 0 ; % : Gamma On le déclare et on lui donne sa valeur
16
17         % Nous devons calculer gamma à partir de a,B1,B2, d est moins le
18         % gradient
19
20         y = -B1*(grad_ctls(cx,cy,xi,yi)') * d; % Il faut que d soit un
    vecteur colonne
21
22
23
24         % Condition de Wolf 1 et Wolf 2 Il vaut mieux faire un while
25         while (ctls(cx+a*d(1),cy+a*d(2),xi,yi) > ctls(cx,cy,xi,yi) - a*y )
    || ((grad_ctls(cx+a*d(1),cy+a*d(2),xi,yi)')*d)/((grad_ctls(cx,cy,xi,yi)')*d) >
    B2 ) % On calcule la fonction de cout et on vérifie
26
27         % Condition de Wolf 1
28         if(ctls(cx+a*d(1),cy+a*d(2),xi,yi) <= ctls(cx,cy,xi,yi) - a*y )
    % Si la condition de Wolf 1 est respectée
29             al = a;
30             if(ar >= inf )
31                 a = lambda*a ;
32             else
33                 a = (al+ar)/2 ;
34             end
35         else % Si elle n'est pas respectée
36             ar = a ;
37             a = (al + ar)/2 ;
38         end
39     end
40     s = a ;
41 end
1    0
0    1

```

Grad_fk =

-0.9336
-0.3518

Grad_fk =

-0.9336
-0.3518

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

1

Grad_fk =

0.3894
0.4062

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
17
18   function[d]=ctls(cx,cy,xi,yi)
19       n = length(xi) ;
20       d = 0 ;
21       R = 1.5 ;
22
23       %syms k ;
24       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
25   ) ;
26
27   for k = 1:30
28       d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29   end
30   end
31
32   counter =
33
34       2
35
36   Grad_fk =
37
38       0.3849
39       0.3782
40
41   function[d]=grad_ctls(cx,cy,xi,yi)
42       n = length(xi) ;
43       d = [0;0] ;
44       R = 1.5 ;
45
46       %syms k ;
47       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
48   ) ;
49
50

```

```

9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8         ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    3

Grad_fk =

    0.3709
    0.3655

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8         ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ;
12       end
13   end
14
15   counter =
16
17       4
18
19
20   Grad_fk =
21
22       0.3595
23       0.3541
24
25
26
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```

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12   cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14   cy)^2)) - 1 );
15       end
16   end
17
18
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```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30

```

```

10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    5

Grad_fk =

    0.3482
    0.3431

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    6

Grad_fk =

```

0.3374
0.3324

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

7

Grad_fk =

0.3268
0.3221

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
```

```

6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

      8

Grad_fk =

      0.3166
      0.3120

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );

```

```

13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    9

Grad_fk =

    0.3067
    0.3023

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:30
11             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
12         end
13     end

counter =

    10

Grad_fk =

    0.2972
    0.2929


1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end


1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:30
11             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
12         end
13     end

counter =

```

11

Grad_fk =

0.2879
0.2838

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9     for k = 1:length(xi)
10
11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12 cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14 cy)^2)) - 1 );
15     end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9     for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end
```

counter =

12

Grad_fk =

0.2789
0.2749

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    13

Grad_fk =

    0.2702
    0.2664

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    14

Grad_fk =

    0.2618
    0.2581

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    15

Grad_fk =

    0.2536
    0.2500

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    16

Grad_fk =

    0.2457
    0.2422


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    17

Grad_fk =

    0.2380

```

0.2347

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

18

Grad_fk =

0.2306

0.2274

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    19

Grad_fk =

    0.2234
    0.2203

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    20

Grad_fk =

    0.2164
    0.2134

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    21

Grad_fk =

    0.2096
    0.2068


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.2031
0.2003

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end

```

counter =

23

Grad_fk =

0.1967
0.1941

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    24

Grad_fk =

    0.1906
    0.1880

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    25

Grad_fk =

    0.1846
    0.1822

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
      ) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    26

Grad_fk =

    0.1789
    0.1765

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    27

Grad_fk =

    0.1733
    0.1710

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    28

Grad_fk =

    0.1679

```

0.1657

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

29

Grad_fk =

0.1626

0.1605

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    30

Grad_fk =

    0.1576
    0.1555

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    31

Grad_fk =

    0.1526
    0.1506

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    32

Grad_fk =

    0.1479
    0.1459


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.1433
0.1414

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end

```

counter =

34

Grad_fk =

0.1388
0.1370

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

      35

Grad_fk =

      0.1345
      0.1327

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    36

Grad_fk =

    0.1303
    0.1286

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    37

Grad_fk =

    0.1262
    0.1246

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    38

Grad_fk =

    0.1222
    0.1207


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    39

Grad_fk =

    0.1184

```

0.1169

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

40

Grad_fk =

0.1147

0.1133

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    41

Grad_fk =

    0.1111
    0.1097

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    42

Grad_fk =

    0.1077
    0.1063

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11          end
12      end

counter =

    43

Grad_fk =

    0.1043
    0.1030

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11          end
12      end

counter =

```

44

Grad_fk =

0.1011
0.0998

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

45

Grad_fk =

0.0979
0.0967

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    46

Grad_fk =

    0.0948
    0.0936

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    47

Grad_fk =

    0.0919
    0.0907

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    48

Grad_fk =

    0.0890
    0.0879

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    49

Grad_fk =

    0.0862
    0.0852

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    50

Grad_fk =

    0.0835

```

0.0825

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

51

Grad_fk =

0.0809

0.0799

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    52

Grad_fk =

    0.0784
    0.0774

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    53

Grad_fk =

    0.0759
    0.0750

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    54

Grad_fk =

    0.0736
    0.0727


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0713
0.0704

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
17
18   function[d]=ctls(cx,cy,xi,yi)
19       n = length(xi) ;
20       d = 0 ;
21       R = 1.5 ;
22
23       %syms k ;
24       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
25   ) ;
26
27   for k = 1:30
28       d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29   end
30   end

```

counter =

56

Grad_fk =

0.0690
0.0682

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    57

Grad_fk =

    0.0669
    0.0661

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    58

Grad_fk =

    0.0648
    0.0640

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    59

Grad_fk =

    0.0628
    0.0620

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    60

Grad_fk =

    0.0608
    0.0601

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    61

Grad_fk =

    0.0589

```

0.0582

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

62

Grad_fk =

0.0571

0.0564

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    63

Grad_fk =

    0.0553
    0.0546

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    64

Grad_fk =

    0.0536
    0.0529

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11          end
12      end

counter =

    65

Grad_fk =

    0.0519
    0.0513


1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end


1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11          end
12      end

counter =

```

Grad_fk =

0.0503
0.0497

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
17
18   function[d]=ctls(cx,cy,xi,yi)
19       n = length(xi) ;
20       d = 0 ;
21       R = 1.5 ;
22
23       %syms k ;
24       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
25   ) ;
26
27   for k = 1:30
28       d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29   end
30   end

```

counter =

67

Grad_fk =

0.0487
0.0481

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    68

Grad_fk =

    0.0472
    0.0466

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    69

Grad_fk =

    0.0457
    0.0452

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    70

Grad_fk =

    0.0443
    0.0437

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    71

Grad_fk =

    0.0429
    0.0424

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    72

Grad_fk =

    0.0416

```

0.0411

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
```

```
1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end
```

counter =

73

Grad_fk =

0.0403

0.0398

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12              cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14              cy)^2)) - 1 );
15          end
16      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

```

counter =

74

Grad_fk =

0.0390
0.0385

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12              cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14              cy)^2)) - 1 );
15          end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    75

Grad_fk =

    0.0378
    0.0373

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    76

Grad_fk =

    0.0366
    0.0362

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

77

Grad_fk =

0.0355
0.0350

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

78

Grad_fk =

0.0343
0.0339

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

      79

Grad_fk =

      0.0333
      0.0329

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    80

Grad_fk =

    0.0322
    0.0319

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    81

Grad_fk =

    0.0312
    0.0309

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    82

Grad_fk =

    0.0303
    0.0299

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    83

Grad_fk =

    0.0293

```

0.0290

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

84

Grad_fk =

0.0284

0.0281

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

counter =

    85

Grad_fk =

    0.0275
    0.0272

```

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                  cy)^2)) - 1 );
13              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                  cy)^2)) - 1 );
15          end
16      end

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    86

Grad_fk =

    0.0266
    0.0263

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    87

Grad_fk =

    0.0258
    0.0255

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0250
0.0247

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
17
18   function[d]=ctls(cx,cy,xi,yi)
19       n = length(xi) ;
20       d = 0 ;
21       R = 1.5 ;
22
23       %syms k ;
24       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
25   ) ;
26
27   for k = 1:30
28       d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29   end
30   end

```

counter =

89

Grad_fk =

0.0242
0.0239

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    90

Grad_fk =

    0.0235
    0.0232

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    91

Grad_fk =

    0.0227
    0.0225

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    92

Grad_fk =

    0.0220
    0.0218

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    93

Grad_fk =

    0.0213
    0.0211

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    94

Grad_fk =

    0.0207

```

0.0204

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

95

Grad_fk =

0.0200

0.0198

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

```

counter =

96

Grad_fk =

0.0194
0.0192

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    97

Grad_fk =

    0.0188
    0.0186

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:30
11             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
12         end
13     end

counter =

    98

Grad_fk =

    0.0182
    0.0180

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
12        end
13    end

counter =

```

Grad_fk =

0.0176
0.0174

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end

```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end

```

counter =

100

Grad_fk =

0.0171
0.0169

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    101

Grad_fk =

    0.0166
    0.0164

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    102

Grad_fk =

    0.0160
    0.0158

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    103

Grad_fk =

    0.0155
    0.0154

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    104

Grad_fk =

    0.0150
    0.0149


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    105

Grad_fk =

    0.0146

```

0.0144

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

106

Grad_fk =

0.0141

0.0140

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

```

counter =

107

Grad_fk =

0.0137
0.0135

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    108

Grad_fk =

    0.0133
    0.0131

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    109

Grad_fk =

    0.0128
    0.0127


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

110

Grad_fk =

0.0124
0.0123

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

111

Grad_fk =

0.0120
0.0119

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    112

Grad_fk =

    0.0117
    0.0115

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    113

Grad_fk =

    0.0113
    0.0112

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    114

Grad_fk =

    0.0110
    0.0108

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    115

Grad_fk =

    0.0106
    0.0105


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    116

Grad_fk =

    0.0103

```

0.0102

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

117

Grad_fk =

0.0100

0.0098

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11          end
12      end

```

counter =

118

Grad_fk =

0.0096
0.0095

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    119

Grad_fk =

    0.0093
    0.0092

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    120

Grad_fk =

    0.0091
    0.0089

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

121

Grad_fk =

0.0088
0.0087

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
17
18 function[d]=ctls(cx,cy,xi,yi)
19     n = length(xi) ;
20     d = 0 ;
21     R = 1.5 ;
22
23     %syms k ;
24     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
25 ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end
```

counter =

122

Grad_fk =

0.0085
0.0084

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    123

Grad_fk =

    0.0082
    0.0081

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    124

Grad_fk =

    0.0080
    0.0079

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    125

Grad_fk =

    0.0077
    0.0076

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    126

Grad_fk =

    0.0075
    0.0074

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    127

Grad_fk =

    0.0073

```

0.0072

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

128

Grad_fk =

0.0070

0.0069

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

```

counter =

129

Grad_fk =

0.0068
0.0067

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    130

Grad_fk =

    0.0066
    0.0065

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    131

Grad_fk =

    0.0064
    0.0063

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0062
0.0061

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end

```

counter =

133

Grad_fk =

0.0060
0.0059

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    134

Grad_fk =

    0.0058
    0.0057

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    135

Grad_fk =

    0.0056
    0.0056

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    136

Grad_fk =

    0.0054
    0.0054

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    137

Grad_fk =

    0.0053
    0.0052

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    138

Grad_fk =

    0.0051

```

0.0051

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

139

Grad_fk =

0.0050

0.0049

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

```

counter =

140

Grad_fk =

0.0048
0.0047

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    141

Grad_fk =

    0.0046
    0.0046

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    142

Grad_fk =

    0.0045
    0.0045


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

143

Grad_fk =

0.0044
0.0043

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

144

Grad_fk =

0.0042
0.0042

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
```

```

2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                cy)^2)) - 1 );
15        end
16    end
17
18    function[d]=ctls(cx,cy,xi,yi)
19        n = length(xi) ;
20        d = 0 ;
21        R = 1.5 ;
22
23        %syms k ;
24        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25    ) ;
26
27    for k = 1:30
28        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29    end
30    end
31
32    counter =
33
34        145
35
36
37    Grad_fk =
38
39        0.0041
40        0.0040
41
42
43    function[d]=grad_ctls(cx,cy,xi,yi)
44        n = length(xi) ;
45        d = [0;0] ;
46        R = 1.5 ;
47
48        %syms k ;
49        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
50    ) ;
51
52    for k = 1:length(xi)
53
54

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    146

Grad_fk =

    0.0040
    0.0039

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    147

Grad_fk =

    0.0038
    0.0038

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    148

Grad_fk =

    0.0037
    0.0037

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    149

Grad_fk =

    0.0036

```

0.0036

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

150

Grad_fk =

0.0035

0.0035

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

```

counter =

151

Grad_fk =

0.0034
0.0033

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    152

Grad_fk =

    0.0033
    0.0032

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    153

Grad_fk =

    0.0032
    0.0031

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0031
0.0030

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end

```

counter =

155

Grad_fk =

0.0030
0.0029

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11      end
12  end

counter =

    156

Grad_fk =

    0.0029
    0.0029

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    157

Grad_fk =

    0.0028
    0.0028

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
      ) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    158

Grad_fk =

    0.0027
    0.0027

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
          ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    159

Grad_fk =

    0.0026
    0.0026

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    160

Grad_fk =

    0.0025

```

0.0025

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
```

```
1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end
```

counter =

161

Grad_fk =

0.0025

0.0024

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

```

counter =

162

Grad_fk =

0.0024
0.0024

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    163

Grad_fk =

    0.0023
    0.0023

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    164

Grad_fk =

    0.0022
    0.0022


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0022
0.0021

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:30
11             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12         end
13     end

```

counter =

166

Grad_fk =

0.0021
0.0021

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    167

Grad_fk =

    0.0020
    0.0020

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    168

Grad_fk =

    0.0020
    0.0019

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2))) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    169

Grad_fk =

    0.0019
    0.0019

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    170

Grad_fk =

    0.0019
    0.0018


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    171

Grad_fk =

    0.0018

```

0.0018

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
```

```
1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end
```

counter =

172

Grad_fk =

0.0017

0.0017

```
1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end
12      end

```

counter =

173

Grad_fk =

0.0017
0.0017

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

```

14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    174

Grad_fk =

    0.0016
    0.0016

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    175

Grad_fk =

    0.0016
    0.0016


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0015
0.0015

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end
17
18   function[d]=ctls(cx,cy,xi,yi)
19       n = length(xi) ;
20       d = 0 ;
21       R = 1.5 ;
22
23       %syms k ;
24       %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
25   ) ;
26
27   for k = 1:30
28       d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29   end
30   end

```

counter =

177

Grad_fk =

0.0015
0.0015

```

1    function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12                cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14                cy)^2)) - 1 );
15        end
16    end
17
18    function[d]=ctls(cx,cy,xi,yi)
19        n = length(xi) ;
20        d = 0 ;
21        R = 1.5 ;
22
23        %syms k ;
24        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25    ) ;
26
27    for k = 1:30
28        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29    end
30    end
31
32    counter =
33
34        178
35
36    Grad_fk =
37
38        0.0014
39        0.0014
40
41    function[d]=grad_ctls(cx,cy,xi,yi)
42        n = length(xi) ;
43        d = [0;0] ;
44        R = 1.5 ;
45
46        %syms k ;
47        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
48    ) ;
49
50    for k = 1:length(xi)
51

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12         cy)^2)) - 1 );
13         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14         cy)^2)) - 1 );
15     end
16 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    179

Grad_fk =

    0.0014
    0.0014

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    180

Grad_fk =

    0.0013
    0.0013

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11          end

```

```

12     end

counter =

    181

Grad_fk =

    0.0013
    0.0013

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    182

Grad_fk =

    0.0013

```

0.0013

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

183

Grad_fk =

0.0012

0.0012

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14          end
15      end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10              d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11          end
12      end

```

counter =

184

Grad_fk =

0.0012
0.0012

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13

```

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14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    185

Grad_fk =

    0.0011
    0.0011

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;

```

```

7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9          for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    186

Grad_fk =

    0.0011
    0.0011


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

```

Grad_fk =

0.0011
0.0011

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end
17
18     function[d]=ctls(cx,cy,xi,yi)
19         n = length(xi) ;
20         d = 0 ;
21         R = 1.5 ;
22
23         %syms k ;
24         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
25     ) ;
26
27     for k = 1:30
28         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
29     end
30 end

```

counter =

188

Grad_fk =

0.0010
0.0010

```

1      function[d]=grad_ctls(cx,cy,xi,yi)

```

```

2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10
11          d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
12          d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
      cy)^2)) - 1 );
13
14      end
15  end

1  function[d]=ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:30
10          d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11      end
12  end

counter =

    189

Grad_fk =

    0.0010
    0.0010

1  function[d]=grad_ctls(cx,cy,xi,yi)
2      n = length(xi) ;
3      d = [0;0] ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9      for k = 1:length(xi)
10

```

```

11         d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    190

Grad_fk =

    1.0e-03 *

    0.9811
    0.9698

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end
14
15   counter =
16
17       191
18
19   Grad_fk =
20
21       1.0e-03 *
22
23       0.9504
24       0.9395
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```

```

8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    192

Grad_fk =

    1.0e-03 *

    0.9207
    0.9101


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end

counter =

```

Grad_fk =

1.0e-03 *

0.8920

0.8817

```

1    function[d]=grad_ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = [0;0] ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:length(xi)
11           d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12               cy)^2)) - 1 );
13           d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14               cy)^2)) - 1 );
15       end
16   end

```

```

1    function[d]=ctls(cx,cy,xi,yi)
2        n = length(xi) ;
3        d = 0 ;
4        R = 1.5 ;
5
6        %syms k ;
7        %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2    ,k,0,29
8    ) ;
9
10       for k = 1:30
11           d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12       end
13   end

```

counter =

194

Grad_fk =

1.0e-03 *

0.8641

0.8541

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

195

Grad_fk =

1.0e-03 *

0.8371

0.8275

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
```

```

6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ;
11         end
12     end

counter =

    196

Grad_fk =

    1.0e-03 *

    0.8109
    0.8016

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
      ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
              cy)^2)) - 1 );

```

```

12         d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14     end
15 end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
    ) ;
8
9         for k = 1:30
10             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11         end
12     end

counter =

    197

Grad_fk =

    1.0e-03 *

    0.7856
    0.7765

1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
    ) ;
8
9         for k = 1:length(xi)
10
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
12             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
    cy)^2)) - 1 );
13
14         end
15     end

1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;

```

```

3      d = 0 ;
4      R = 1.5 ;
5
6      %syms k ;
7      %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9      for k = 1:30
10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    198

Grad_fk =

    1.0e-03 *

    0.7610
    0.7523

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:length(xi)
10
11              d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
12              d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
cy)^2)) - 1 );
13
14          end
15      end

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
) ;
8
9          for k = 1:30

```

```

10         d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
11     end
12 end

counter =

    199

Grad_fk =

    1.0e-03 *

    0.7373
    0.7288


1     function[d]=grad_ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = [0;0] ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:length(xi)
11            d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12            cy)^2)) - 1 );
13            d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14            cy)^2)) - 1 );
15        end
16    end


1     function[d]=ctls(cx,cy,xi,yi)
2         n = length(xi) ;
3         d = 0 ;
4         R = 1.5 ;
5
6         %syms k ;
7         %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8     ) ;
9
10        for k = 1:30
11            d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12        end
13    end

counter =

    200

```

Grad_fk =

1.0e-03 *

0.7142

0.7060

```
1 function[d]=grad_ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = [0;0] ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:length(xi)
11        d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12        cy)^2)) - 1 );
13        d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14        cy)^2)) - 1 );
15    end
16 end
```

```
1 function[d]=ctls(cx,cy,xi,yi)
2     n = length(xi) ;
3     d = 0 ;
4     R = 1.5 ;
5
6     %syms k ;
7     %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ,k,0,29
8 ) ;
9
10    for k = 1:30
11        d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12    end
13 end
```

counter =

201

Grad_fk =

1.0e-03 *

0.6919

0.6839

```

1      function[d]=grad_ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = [0;0] ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:length(xi)
11             d(1) = d(1) + 2*(xi(k)-cx)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
12             cy)^2)) - 1 );
13             d(2) = d(2) + 2*(yi(k)-cy)*(R/(sqrt((xi(k)-cx)^2 + (yi(k) -
14             cy)^2)) - 1 );
15         end
16     end

```

```

1      function[d]=ctls(cx,cy,xi,yi)
2          n = length(xi) ;
3          d = 0 ;
4          R = 1.5 ;
5
6          %syms k ;
7          %d = symsum( ( sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2      ,k,0,29
8      ) ;
9
10         for k = 1:30
11             d = d + (sqrt((xi(k)-cx)^2 + (yi(k) - cy)^2)-R )^2 ;
12         end
13     end

```

counter =

202

ans =

Group with properties:

Children: [2×1 Line]

Visible: on

HitTest: on

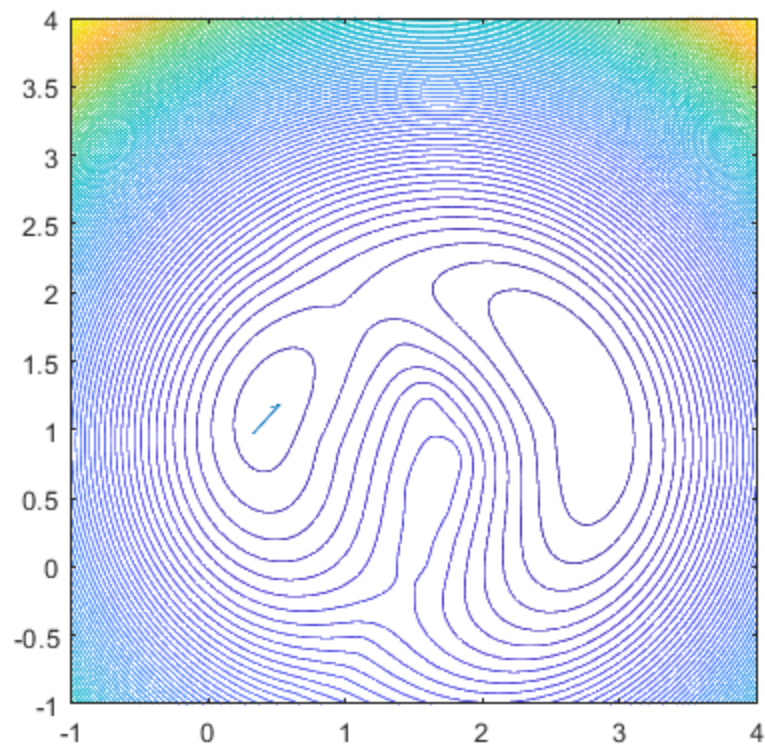
Use GET to show all properties

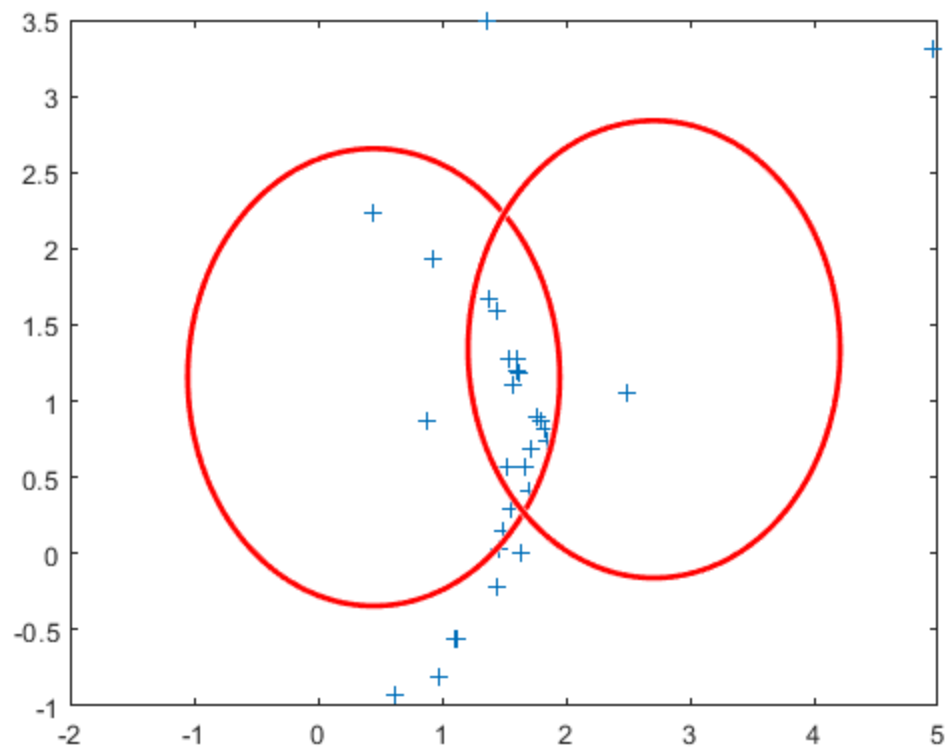
ans =

Group with properties:

Children: [2×1 Line]
Visible: on
HitTest: on

Use GET to show all properties





Question 9

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