

MATLAB-EXPERIMENT 3B

Maxima and minima of a function of two
variables



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MAT 1011 – Calculus for Engineers (MATLAB)

Experiment 3-B

Maxima and minima of a function of two variables

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1. Find the maxima and minima for the following functions

$$f(x,y)=x^4 + y^4 -x^2 -y^2 +1$$

CODES:

```
clc
close all
clc
syms x y
f(x,y)=input('Enter function f(x,y) to
calculate the maxima/minima');
```

```
p=diff(f,x); %df/dx
q=diff(f,y); %df/dy
[ax,ay]=solve(p,q);
ax=double(ax);
ay=double(ay);
```

```

r=diff(p,x);           %d2f/dx2
s=diff(p,y);           %d2f/dxdy
t=diff(q,y);           %d2f/dy2
D=r*t-s^2;

```

```

figure
fsurf(f);
xlabel('X-axis');
ylabel('Y-axis');
zlabel('Z-axis');
legstr={'Plot of the given function'};
for i=1:size(ax)
    t1=D(ax(i),ay(i));
    t2=r(ax(i),ay(i));
    t3=f(ax(i),ay(i));

    if (double(t1)==0)
        sprintf('At (%f,%f) further
investigation needed',ax(i),ay(i))
        legstr=[legstr,{'Case to investigate
further'}];
        mkr='ko';
    elseif (double(t1)<0)
        sprintf('The point(%f,%f) is a saddle
point',ax(i),ay(i))
        legstr=[legstr,{'Saddle point'}];
        mkr='bv';
    else

```

```

        if (double(t2)<0)
            sprintf('The maximum value is %f at
the point(%f,%f)',t3,ax(i),ay(i))
            legstr=[legstr,{'maximum value of
function'}}];
            mkr='g+';
        else
            sprintf('The minimum value is %f
at the point(%f,%f)',t3,ax(i),ay(i))
            legstr=[legstr,{'minimum value of
the function'}}];
            mkr='r+';
        end
    end
    hold on;
    plot3(ax(i),ay(i),t3,mkr,'linewidth',3);
end
legend(legstr,'location','best');
title('Plot of f(x,y) showing maxima/minima')

```

INPUT:

Enter function f(x,y) to calculate the maxima/minima
 $x^4 + y^4 - x^2 - y^2 + 1$

OUTPUT:

ans =

```
'The maximum value is 1.000000 at the point(0.000000,0.000000)'
```

ans =

'The minimum value is 0.500000 at the point(-0.707107,-0.707107)'

ans =

'The minimum value is 0.500000 at the point(0.707107,-0.707107)'

ans =

'The minimum value is 0.500000 at the point(-0.707107,0.707107)'

ans =

'The minimum value is 0.500000 at the point(0.707107,0.707107)'

ans =

'The point(-0.707107,0.000000) is a saddle point'

ans =

'The point(0.707107,0.000000) is a saddle point'

ans =

'The point(0.000000,-0.707107) is a saddle point'

ans =

'The point(0.000000,0.707107) is a saddle point'

```

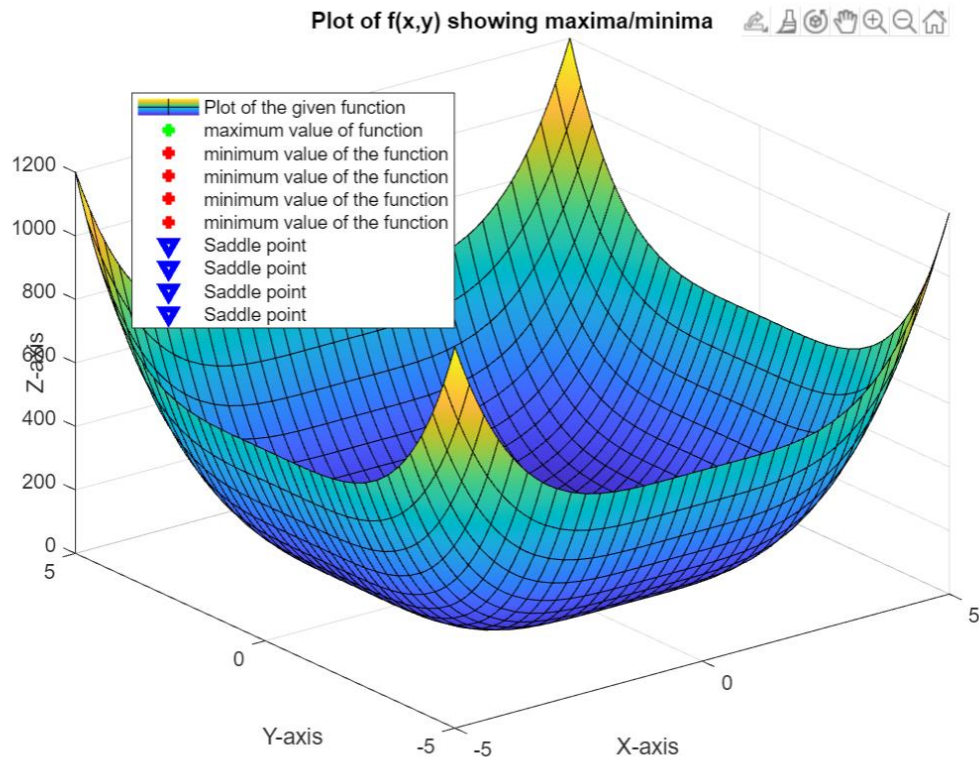
1  clc
2  close all
3  clc
4  syms x y
5  f(x,y)=input('Enter function f(x,y) to calculate the maxima/minima')
6
7
8  p=diff(f,x);           %df/dx
9  q=diff(f,y);           %df/dy
10 [ax,ay]=solve(p,q);
11 ax=double(ax);
12 ay=double(ay);
13
14 r=diff(p,x);           %d2f/dx2
15 s=diff(p,y);           %d2f/dxdy
16 t=diff(q,y);           %d2f/dy2
17 D=r*t-s^2;
18
19
20 figure
21 fsurf(f);
22 xlabel('X-axis');
23 ylabel('Y-axis');
24 zlabel('Z-axis');
25 legstr={'Plot of the given function'};
26 for i=1:size(ax)
27     t1=D(ax(i),ay(i));
28     t2=r(ax(i),ay(i));
29     t3=f(ax(i),ay(i));
30
31     if (double(t1)==0)

```

```

32     sprintf('At (%f,%f) further investigation needed',ax(i),ay(i))
33     legstr=[legstr,{ 'Case to investigate further' }];
34     mkr='ko';
35 elseif (double(t1)<0)
36     sprintf('The point(%f,%f) is a saddle point',ax(i),ay(i))
37     legstr=[legstr,{ 'Saddle point' }];
38     mkr='bv';
39 else
40     if (double(t2)<0)
41         sprintf('The maximum value is %f at the point(%f,%f)',t3,ax(i),ay(i))
42         legstr=[legstr,{ 'maximum value of function' }];
43         mkr='g+';
44     else
45         sprintf('The minimum value is %f at the point(%f,%f)',t3,ax(i),ay(i))
46         legstr=[legstr,{ 'minimum value of the function' }];
47         mkr='r+';
48     end
49 end
50 hold on;
51 plot3(ax(i),ay(i),t3,mkr,'linewidth',3);
52 end
53 legend(legstr,'location','best');
54 title('Plot of f(x,y) showing maxima/minima')

```



2. Find the maxima and minima for the following functions
- $$x^3 + 3*x*y^2 - 15*x^2 - 15*y^2 + 72*x$$

CODES:

```
clc
close all
clc
syms x y
f(x,y)=input('Enter function f(x,y) to
calculate the maxima/minima');

p=diff(f,x); %df/dx
q=diff(f,y); %df/dy
[ax,ay]=solve(p,q);
ax=double(ax);
ay=double(ay);

r=diff(p,x); %d2f/dx2
s=diff(p,y); %d2f/dxdy
t=diff(q,y); %d2f/dy2
D=r*t-s^2;

figure
fsurf(f);
```



```

xlabel('X-axis');
ylabel('Y-axis');
zlabel('Z-axis');
legstr={'Plot of the given function'};
for i=1:size(ax)
    t1=D(ax(i),ay(i));
    t2=r(ax(i),ay(i));
    t3=f(ax(i),ay(i));

    if (double(t1)==0)
        sprintf('At (%f,%f) further
investigation needed',ax(i),ay(i))
        legstr=[legstr,{'Case to investigate
further'}]];
        mkr='ko';
    elseif (double(t1)<0)
        sprintf('The point(%f,%f) is a saddle
point',ax(i),ay(i))
        legstr=[legstr,{'Saddle point'}]];
        mkr='bv';
    else
        if (double(t2)<0)
            sprintf('The maximum value is %f at
the point(%f,%f)',t3,ax(i),ay(i))
            legstr=[legstr,{'maximum value of
function'}]];
            mkr='g+';
        else
            sprintf('The minimum value is %f
at the point(%f,%f)',t3,ax(i),ay(i))

```

```

        legstr=[legstr,{'minimum value of
the function'}]];
        mkr='r+';
    end
end
hold on;
plot3(ax(i),ay(i),t3,mkr,'linewidth',3);
end
legend(legstr,'location','best');
title('Plot of f(x,y) showing maxima/minima')

```

INPUT:

Enter function f(x,y) to calculate the
maxima/minima

$x^3 + 3xy^2 - 15x^2 - 15y^2 + 72x$

OUTPUT:

ans =

'The maximum value is 112.000000 at the
point(4.000000,0.000000)'

ans =

'The minimum value is 108.000000 at the
point(6.000000,0.000000)'

ans =

'The point(5.000000,-1.000000) is a saddle
point'

ans =

'The point(5.000000,1.000000) is a saddle
point'

```

1  clc
2  close all
3  clc
4  syms x y
5  f(x,y)=input('Enter function f(x,y) to calculate the maxima/minima');
6
7
8  p=diff(f,x);           %df/dx
9  q=diff(f,y);           %df/dy
10 [ax,ay]=solve(p,q);
11 ax=double(ax);
12 ay=double(ay);
13
14 r=diff(p,x);           %d2f/dx2
15 s=diff(p,y);           %d2f/dxdy
16 t=diff(q,y);           %d2f/dy2
17 D=r*t-s^2;
18
19
20 figure
21 fsurf(f);
22 xlabel('X-axis');
23 ylabel('Y-axis');
24 zlabel('Z-axis');
25 legstr={'Plot of the given function'};
26 for i=1:size(ax)
27     t1=D(ax(i),ay(i));
28     t2=r(ax(i),ay(i));
29     t3=f(ax(i),ay(i));
30
31     if (double(t1)==0)
32         sprintf('At (%f,%f) further investigation needed',ax(i),ay(i))
33         legstr=[legstr,{'Case to investigate further'}];
34         mkr='ko';
35     elseif (double(t1)<0)
36         sprintf('The point(%f,%f) is a saddle point',ax(i),ay(i))
37         legstr=[legstr,{'Saddle point'}];
38         mkr='bv';
39     else
40         if (double(t2)<0)
41             sprintf('The maximum value is %f at the point(%f,%f)',t3,ax(i),ay(i))
42             legstr=[legstr,{'maximum value of function'}];
43             mkr='g+';
44         else
45             sprintf('The minimum value is %f at the point(%f,%f)',t3,ax(i),ay(i))
46             legstr=[legstr,{'minimum value of the function'}];
47             mkr='r+';
48         end
49     end
50     hold on;
51     plot3(ax(i),ay(i),t3,mkr,'linewidth',3);
52 end
53 legend(legstr,'location','best');
54 title('Plot of f(x,y) showing maxima/minima')

```

```

Enter function f(x,y) to calculate the maxima/minima
x^3 + 3*x*y^2 - 15*x^2 - 15*y^2 + 72*x

ans =

    'The maximum value is 112.000000 at the point(4.000000,0.000000)'

ans =

    'The minimum value is 108.000000 at the point(6.000000,0.000000)'

ans =

    'The point(5.000000,-1.000000) is a saddle point'

ans =

    'The point(5.000000,1.000000) is a saddle point'

```

Figure 1 x +

