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
```

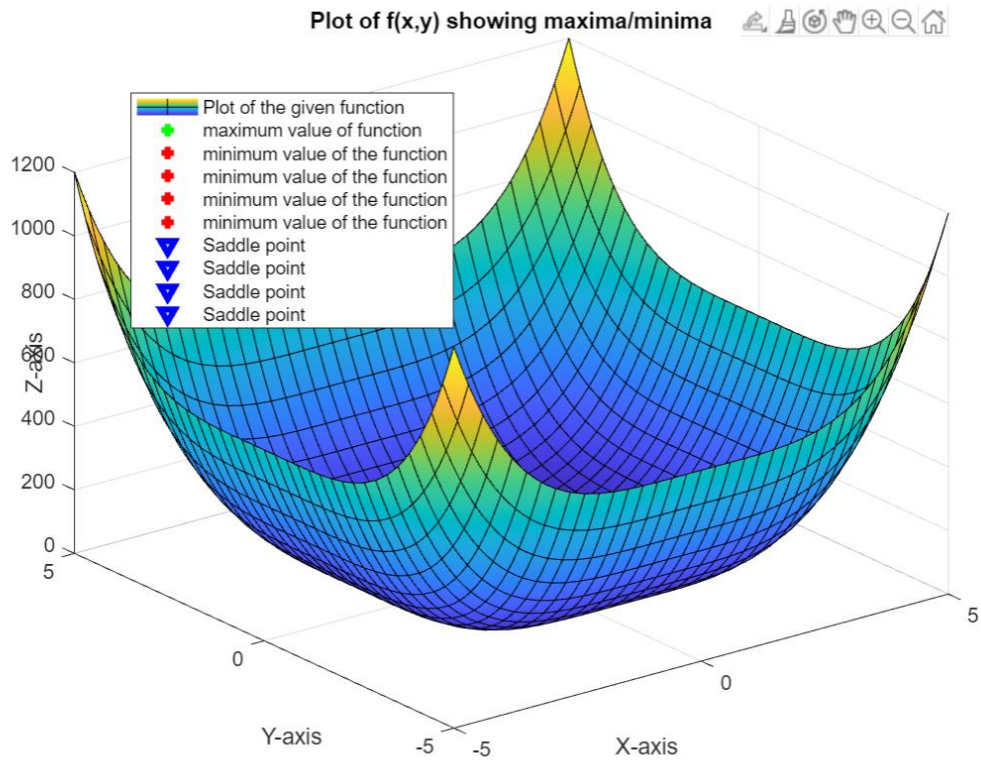
OUTPUT:

```
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'
```

```
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')
```



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 + 3*x*y^2 - 15*x^2 - 15*y^2 +72*x
```

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'
```

```
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')
```

```
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