21BDS0340

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Digital Lab Assignment 3

Problem 1

Locate and classify all critical points for $f(x, y) = x^3 - 2y^2 - 2y^4 + 3x^2y$.

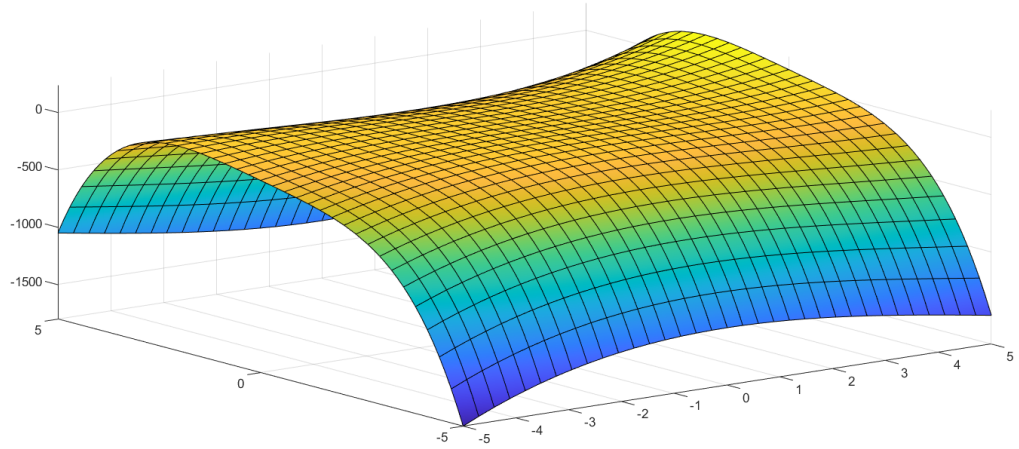
Code:

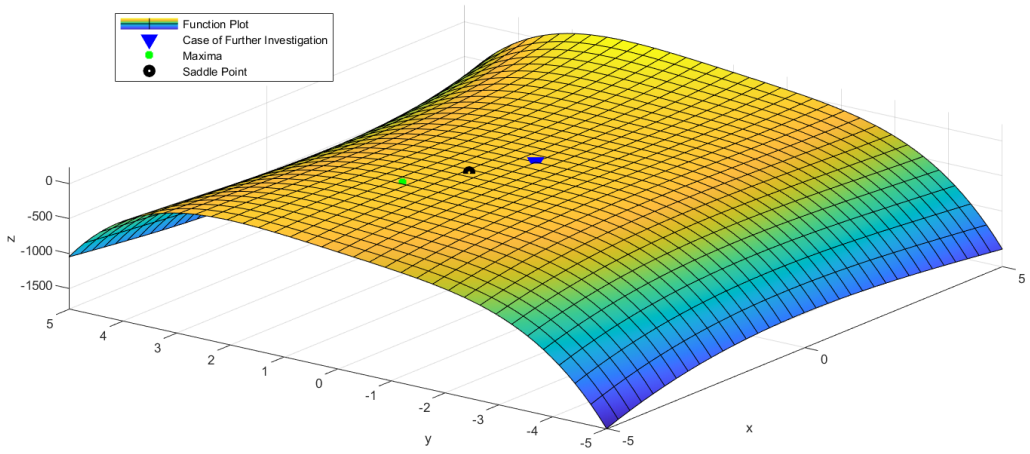
```
syms x y

equation(x, y) = x^3 - 2*y^2 - 2*y^4 + 3*x^2*y;

fx = diff(equation, x);
fy = diff(equation, y);
fxx = diff(fx, x);
fyy = diff(fy, y);
fxy = diff(fy, x);

[ax, ay] = solve(fx, fy);
ax = double(ax);
ay = double(ay);

S = size(ax);
S = S(1) * S(2);

subplot(1,2,1)
fsurf(equation)
subplot(1,2,2)
fsurf(equation)
leg = ['Function Plot'];
hold on

for i = 1:S
    xval = ax(i);
    yval = ay(i);
    zval = equation(xval, yval);

    m = subs(subs(fxx * fyy - fxy * fxy, x, xval), y,
yval);
    r = subs(subs(fxx, x, xval), y, yval);

    if isreal(m) && isreal(r)
```

```
        if m > 0 && r < 0
            msg = sprintf('Maxima at x = %f and y = %f',
xval, yval);
            leg = [leg, {'Maxima'}];
            mkr = 'g+';
        elseif m > 0 && r > 0
            msg = sprintf('Minima at x = %f and y = %f',
xval, yval);
            leg = [leg, {'Minima'}];
            mkr = 'r*';
        elseif m < 0
            msg = sprintf('Saddle point at x = %f and y =
%f', xval, yval);
            leg = [leg, {'Saddle Point'}];
            mkr = 'ko';
        elseif m == 0
            msg = sprintf('Not known at x = %f and y =
%f', xval, yval);
            leg = [leg, {'Case of Further
Investigation'}];
            mkr = 'bv';
        end

        plot3(xval, yval, zval, mkr, "Linewidth", 4)
        disp(msg)
    end
end

legend(leg, 'Location', 'best');

xlabel('x')
ylabel('y')
zlabel('z')
```

Output:

```
>> Question1
Equation: x^3 - 2*y^2 - 2*y^4 + 3*x^2*y
Not known at x = 0.000000 and y = 0.000000
Maxima at x = -2.000000 and y = 1.000000
Saddle point at x = -1.000000 and y = 0.500000
```





Problem 2

Let $x^2 + y^2$ represent the utility function or customer satisfaction derived by a consumer from the consumption of a certain amount of product x and certain amount of product y. Maximize the utility function subject to the constraint 2x + 4y = 40

Code:

```
syms x y L

f(x, y) = x^2 + y^2;
g(x, y) = 2*x + 4*y - 40;

F = f + L * g;
Fx = diff(F, x);
Fy = diff(F, y);

S = solve(g, Fx, Fy, 'Real', true);
points = [S.x, S.y];
points = double(points);
value = double(f(S.x, S.y))

X = double(linspace(min(S.x) - 3, max(S.x) + 3, 25));
Y = double(linspace(min(S.y) - 3, max(S.y) + 3, 25));

[X, Y] = meshgrid(X, Y);
Z = double(f(X, Y));

surf(X, Y, Z)
hold on
xlabel('x');
ylabel('y');
zlabel('f(x,y)');

gv = fimplicit(g, 'b');
xv = get(gv, 'XData');
yv = get(gv, 'YData');
fv = double(f(xv, yv));

plot3(xv, yv, fv, '-r')
```

Output:

```
>> Question2

value =

    80
```