

Recitation due Sep 13, 2021 20:30 IST Completed



**Practice** 

### Critical points 1

1.0/1 point (graded) Consider the function

$$f(x,y) = x^2 + y^2 - x^2 y^2. (4.38)$$

The partial derivatives of  $m{f}$  are

$$f_x(x,y) = 2x - 2xy^2 (4.39)$$

$$f_y(x,y) = 2y - 2x^2y.$$
 (4.40)

Find the critical point(s) of f(x,y). (Enter ordered pairs in parentheses, e.g. (x, y). If there is more than one point, separate with semicolons, e.g. (a, b); (c, d). You may type e for Euler's number, and pi for the mathematical constant  $\pi$ .)

Critical points of f(x,y):

**✓ Answer:** (0,0);(1,1);(-1,1);(1,-1);(-1,-1)

#### **Solution:**

We have

$$f_x(x,y) = 2x - 2xy^2 = 2x(1-y^2)$$
 (4.41)

$$f_y(x,y) = 2y - 2x^2y = 2y(1-x^2).$$
 (4.42)

For a point to be a critical point, both equations must equal 0 simultaneously. We know  $f_x=0$  when x=0. Plugging this into the equation for  $f_y$  gives

$$f_{y}(0,y) = 2y(1-0) = 2y.$$
 (4.43)

So we need y=0. Therefore, one of the critical points is (0,0).

We also see that  $f_x=0$  when  $y=\pm 1$ . Plugging y=1 into the equation for  $f_y$  gives

$$f_{u}(x,1) = 2(1-x^{2}) \tag{4.44}$$

which will equal zero when  $x=\pm 1$ . So two more critical points are (1,1) and (-1,1).

Plugging y=-1 into the equation for  $f_y$  gives

$$f_y(x,-1) = -2(1-x^2)$$
 (4.45)

which will equal zero when  $x=\pm 1$ . Therefore, two more critical points are given by (1,-1) and (-1,-1).

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You have used 1 of 3 attempts

Answers are displayed within the problem

## Critical points 2

1.0/1 point (graded)
Find the critical points of

$$g(x,y) = -xye^{-(x^2+y^2)/8}$$
 (4.46)

(Enter ordered pairs in parentheses, e.g. (x, y). If there is more than one point, separate with semicolons, e.g. (a, b); (c, d). You may type e for Euler's number, and pi for the mathematical constant  $\pi$ .)

Critical points of g(x, y): (0,0);(2,2);(-2,2);(-2,2);(-2,-2)  $\checkmark$  Answer: (0,0);(2,2);(-2,2);(-2,-2)

#### Solution:

Using the product rule and chain rule, we have

$$g_x(x,y) = -ye^{(-x^2-y^2)/8} + x^2y/4e^{(-x^2-y^2)/8} = ye^{(-x^2-y^2)/8} (x^2/4 - 1)$$
 (4.47)

$$g_y(x,y) = -xe^{(-x^2-y^2)/8} + xy^2/4e^{(-x^2-y^2)/8} = xe^{(-x^2-y^2)/8} (y^2/4-1).$$
 (4.48)

These equations are simultaneously zero when:

- x=0 and y=0
- $x^2/4-1=0$  and  $y^2/4-1=0$  which gives  $x=\pm 2$  and  $y=\pm 2$ .

This leads to the following five critical points:

$$(0,0),(2,2),(-2,2),(2,-2),(-2,-2)$$
 (4.49)

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You have used 1 of 3 attempts

**1** Answers are displayed within the problem

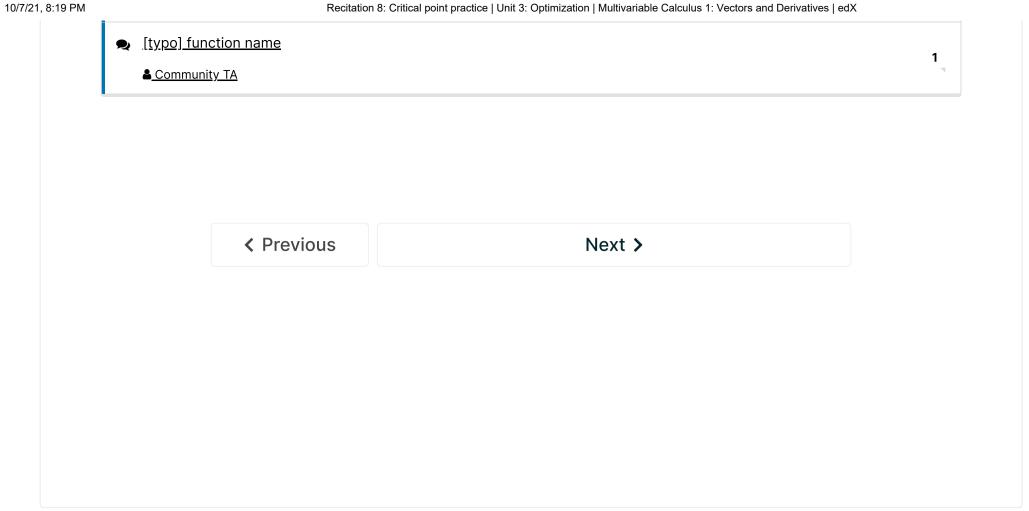
#### 2. Exploration of critical points

**Topic:** Unit 3: Optimization / 2. Exploration of critical points

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