

## 1. DERIVATIVES OF MULTI-VARIABLE FUNCTIONS, I

1.1. **Partial Derivatives+ Linear Approximation.** Compute the partial derivatives of

$$f(x, y) = x^2 - y^2$$

at the point  $(1, 1)$ . Find the tangent plane to  $f$  at the point  $(1, 1, 0)$  and use this information to estimate the value of  $f(1.5, 1.5)$ .

1.2. **Limits.** Show that

$$f(x, y) = \frac{2xy}{x^2 + y^2}$$

is not continuous by

- Finding the limit as  $t$  goes to zero along the lines  $\langle t, t \rangle$  and  $\langle t, -t \rangle$ .

- Making a contour plot with level sets  $f = 0$ ,  $f = 1$  and  $f = -1$ .

**1.3. Partial Derivatives + Linear Approximation II.** The total differential of  $f$  is given by

$$df = (2x + y)dx + (x)dy.$$

Suppose that  $f(0, 1) = 1$ . Give the equation of the tangent plane at  $(0, 1, 1)$ , and estimate the value of  $f(1, 2)$ .