Student Name:

- The quiz is closed book, closed notes, and calculator free. No form of collaboration or help is allowed.
- The quiz is **45 minutes** long. This time includes downloading, working on, and submitting a quiz **in a PDF format via Gradescope**.
- The quiz have **20 points** in total.
- There is **no extension or quiz retake**.
- Show your full work to receive a full credit on each problem.

1. **[5 points]** For the given function $f(x, y) = x^2 \ln(y)$, the point $P(3, 1)$, and the unit vector $u = (-5/13)\mathbf{i} + (12/13)\mathbf{j}$ find:

   (a) the gradient of f

   (b) evaluate the gradient at the point P

   (c) find the rate of change of f at P in the direction of the vector u

2. **[5 points]** Find and classify (**using the Second Derivatives Test**) all critical points of

$$f(x, y) = (x - y)(1 - xy)$$

3. **[10 points]** For the given iterated integral

$$\int_0^2 \int_0^{y^2} x^2 y \, dx \, dy$$

(a) Draw the region of integration.

(b) Evaluate the integral over the region drawn in part (a).

(c) Reverse the order of integration. Evaluate the integral over a new region.