As before, the appearance of a problem on this review doesn't guarantee the appearance of a similar problem on the exam. Equally, the non-appearance of a sort of problem does not guarantee that a problem of that sort won't appear on the exam. This is a review, intended as something helpful for studying. (FWIW: This is the test I gave to a Calc II class last fall.)

1. (10 points) Let $\vec{r}(t) = \langle \cos(t^2), \sin(t^2) \rangle$, where $t \in [0, 2\pi]$, be a vector-valued function. What is the equation of the tangent line at the point $\vec{r}(\pi)$?

(10 points) What is the arclength of $\vec{r}(t) = \langle \cos(t^2), \sin(t^2) \rangle$, where $t \in [0, 2\pi]$?

2. (20 points) Let $f(x, y) = \sin(xy)$. Find $D_{\vec{u}} f(\pi, 2)$ in the direction of $\vec{v} = \langle -3, 4 \rangle$.

3. (20 points) Suppose $f : \mathbb{R}^2 \to \mathbb{R}$ and $\nabla f = \langle (2xy^2)e^{x^2y^2} + y^3, (2x^2y)e^{x^2y^2} + 3xy^2 \rangle$. What is f?

4. (20 points) Let $g(x, y) = x^3/3 - x + y^2/2$. Find and classify all critical points for g. Show your work!

5. Let $f : \mathbb{R}^3 \to \mathbb{R}$ be the following scalar field:

$$f(x, y, z) = z \cdot \ln(xy + e)$$

(20 points) Find the equation of the plane passing through the point $(1, 0, 1)$ that is perpendicular to the vector $\nabla f(1, 0, 1)$.

Extra Credit (5 points) Solve the following double integral, where R is the unit square, $[0, 1] \times [0, 1]$.

$$\iint_{\mathrm{R}} x^2 \cdot y^3 \ \mathrm{dA}$$