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1. (a) Find the equation of the tangent plane to this saddle at the point $(x, y, z) = (3, 5, 15)$.

   (b) The tangent plane you just found intersects the saddle at many points. Find the set of all such points. (*Hint: set the z for the saddle equal to the z for the tangent plane, and solve for x, y. It helps to factor by grouping.*)

   (c) Repeat the above two problems for an arbitrary point (a, b, ab) on this saddle. Here, a, b are constants.

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2. Let $z = xe^{xy}$, $x = st$, and $y = t^2 - s^2$. Find z_s and z_t using the chain rule.

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3. Suppose that a differentiable function f satisfies

$$\frac{\partial f}{\partial x}(x, y) = xy, \quad \frac{\partial f}{\partial y}(x, y) = x^2/2.$$

   Furthermore suppose

$$x = ts^2, \quad y = s/t.$$

   Find $\frac{\partial f}{\partial t}$ and $\frac{\partial f}{\partial s}$ using the chain rule.

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4. Let $f(x, y) = x^2 + y^2$.

   (a) Sketch the level set corresponding to $c = 1$.

   (b) Find a parametrization $\vec{r}(t)$ for this level set.

   (c) Evaluate $f(\vec{r}(t))$. If you remember what a level set is, this is easier than you might think!

   (d) Compute $\frac{d}{dt} f(\vec{r}(t))$ in two ways: first, by directly differentiating the expression for $f(\vec{r}(t))$ you found in the previous part, then by using the chain rule.

   (e) Repeat the above for $f(x, y) = x^2 + 4y^2$.

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5. Let $f(x, y) = xy \ln(xy)$. Find the equation of the tangent line to the level set of f at $(3, 5)$.