1. (10 pts.) A rectangular box has a square base. Find the rate at which its surface area is changing if its base edge is increasing at 2 cm per minute and its height is decreasing at 3 cm per minute at the instant at which each dimension is 100 cm.

2. (10 pts.) Find $\frac{\partial f}{\partial s}$ and $\frac{\partial f}{\partial t}$ when $f(x, y) = y \cos(x)$, $x = t^3s^2$, and $y = e^{st}$.

3. (10 pts. each)
   (a) Find the gradient vector $\nabla f(2, -3)$ where $f(x, y) = (x^2 + 2y^3)$.
   (b) Find $D_uf(\pi/3, \pi/4)$ where $f(x, y) = \sin(3x - 4y)$ and $u$ is the unit vector in the same direction as the vector $v = \langle 4, -3 \rangle$.
   (c) Find the maximum rate of increase of the function $f(x, y) = \ln(x^2 - xy)$ at the point $(1, -1)$, and a unit vector pointing in the direction of greatest increase.

4. (10 pts.) Two resistors have resistances $R_1$ and $R_2$. When connected in parallel the total resistance $R$ of the resulting circuit is

$$R = \left( \frac{1}{R_1} + \frac{1}{R_2} \right)^{-1}.$$ 

Suppose that $R_1$ is measured to be 300 ohms with a maximum error of 3 ohms and $R_2$ is measured to be 600 ohms with a maximum error of 6 ohms. Use differentials to estimate the maximum error (in ohms) in the calculated value of $R$.

5. (12 pts.) Find all critical points of the function $f(x, y) = 4xy - 2x^4 - y^2$. (Hint: There are three.)

6. (12 pts.) Given that the critical points of the function $f(x, y) = 2x^3 + y^3 - 3x^2 - 12x - 3y$ are $(-1, 1)$, $(-1, -1)$, $(2, 1)$ and $(2, -1)$, identify each point as a local maximum, local minimum, or a saddle point.

7. (10 pts. each)
   (a) Evaluate the iterated integral $\int_1^3 \int_0^2 \frac{x}{y^2} \, dx \, dy$.
   (b) Reverse the order of integration and evaluate the new integral. Do you get the same answer?