1. Prove:

   Proposition 1. *Suppose that all of the partial derivatives of f exist in a neighborhood of $\vec{p}$ and are continuous at $\vec{p}$. Then, f is differentiable at $\vec{p}$.*

2. Suppose that $f(x, y) = x\cos(\pi y) + y^2 e^x$. What are the values of the total derivative of f, at the point $(-1, 1)$, with respect to the vectors $(4, -2)$ and $(-3, 5)$, i.e., what are $D_{(-1,1)}f(4, -2)$ and $D_{(-1,1)}f(-3, 5)$?

3. Show that $f(x, y) = \sqrt{x^2 + y^2}$ is not differentiable at the origin.

4. (#16 p 400)
   Let $r > 0$, let $I(r) = \displaystyle\int_{-r}^{+r} e^{-u^2}\,du$.

   (a) Show that $I^2(r) = \displaystyle\iint_R e^{-(x^2+y^2)}\,dx\,dy$ where $R = [-r, r] \times [-r, r]$.

   (b) Let C_1 and C_2 be disks circumscribing and inscribing R. Show that

   $$\iint_{C_1} e^{-(x^2+y^2)}\,dx\,dy \le I^2(r) \le \iint_{C_2} e^{-(x^2+y^2)}\,dx\,dy$$

   (c) Change the integrals over C_1 and C_2 to polar coordinates.

   (d) Show that $I^2(r) \to \pi$, therefore $I(r) \to \sqrt{\pi}$. Aha! Whence $\displaystyle\int_0^\infty e^{-u^2}\,du = \frac{1}{2}\sqrt{\pi}$.

5. State Green's Theorem for the annulus $A(\vec{c}, r_{inner}, r_{outer})$.

6. Compute the double integral $\displaystyle\iint_R f(x, y)\,dx\,dy$ where R is the unit square $[0, 1] \times [0, 1]$ and where $f(x, y) = \sin(\pi(x + y)/2)$.