1) Let $\phi(x, y, z)$ be a function with continuous second order partial derivatives. Show that $\nabla \times (\nabla\phi) = \vec{0}$. Also, if $\vec{F}$ is a vector field with continuous second order partial derivatives for each component, show that $\nabla \bullet (\nabla \times \vec{F}) = 0$.

2) Consider $S_r = \{x^2 + y^2 + z^2 = 1, z \geq r\}$ oriented using the unit normal vector, $\vec{n}$, whose $\vec{k}$ component is $\geq 0$. Let $\vec{V} = \nabla \times (z\,\vec{i} + y\,\vec{j} + x\,\vec{k})$. Compute

$$\iint_{S_r} \vec{V} \bullet \vec{n}\, d\sigma$$

3) Look at the math department website: **math.msu.edu**. Click on "Sample Finals". Click "I agree". Go down to the math 234 finals and download **mth234b.pdf**. You should be able to do all the problems on this sample final.

We'll discuss these on Wednesday. I will be more specific about what else will be on the final at that time. On Friday we will go back to various hard topics and review them – suggestions would be appreciated. As a synopsis, we covered

1. Chapter 12: Vectors, dot and cross product, using vectors to parameterize lines and describe plane, using vectors to find angles between lines and planes, projections of vectors.

2. Chapter 13: derivatives and integrals of vector valued functions, finding tangent lines to parameterized curves, finding the arc-length of parameterized curves, finding the unit tangent vector, unit normal vector, and curvature of a parameterized curve.

3. Chapter 14: partial derivatives, higher order partial derivatives, limits of functions of two or mor variables, continuity, directional derivatives and gradients, finding the tangent plane to a graph or level set, the chain rule (many forms), finding critical points, classifying them as maxima/minima/saddles/neither, and LaGrange multipliers

4. Chapter 15: Double and triple integrals; areas, volumes; polar, cylindrical, spherical coordinates; Jacobians and substitution in multiple integrals

5. Chapter 16: Line and circuit integrals, vector fields, curl and divergence, tests for path independence, flux and circulation, Green's theorem, Stokes theorem, and the Divergence theorem. Parameterized surfaces and surface integrals.

In addition, anything that appeared on a mid-term would be an appropriate topic for a final question as well.