Physics 3344 **Professor Scalise**
Spring 2000 **Assignment #5**

Due: 22 February 2000

Read Marion & Thornton Chapter 2, Shankar Chapter 7.

1. If the scalar function $\Phi(x, y, z) = x^2 y \sin(z) + xy^3 z^2$, what is the gradient of Φ in Cartesian coordinates.

2. Show that these two forms of the Laplacian in circular cylindrical coordinates are equivalent.

$$\nabla^2 \Phi = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \frac{\partial \Phi}{\partial \rho}\right) + \frac{1}{\rho}\frac{\partial}{\partial \phi}\left(\frac{1}{\rho}\frac{\partial \Phi}{\partial \phi}\right) + \frac{1}{\rho}\frac{\partial}{\partial z}\left(\rho \frac{\partial \Phi}{\partial z}\right) = \frac{\partial^2 \Phi}{\partial \rho^2} + \frac{1}{\rho}\frac{\partial \Phi}{\partial \rho} + \frac{1}{\rho^2}\frac{\partial^2 \Phi}{\partial \phi^2} + \frac{\partial^2 \Phi}{\partial z^2}$$

3. Derive the scale factors h_r, h_θ, and h_ϕ for spherical polar coordinates from the equations relating $\{r, \theta, \phi\}$ to $\{x, y, z\}$.

4. Derive by integrating over the appropriate coordinates
   (a) the lateral surface area of a right circular cone of height h and base radius R
   (b) the volume of the same cone

5. What is the θ component of the curl in spherical polar coordinates? $(\vec{\nabla} \times \vec{A})_\theta = ?$

6. Evaluate the following. (You may find it convenient to work in spherical polar coordinates, although Cartesian will give the same answers.)
   (a) $\vec{\nabla}\, r$
   (b) $\vec{\nabla} \cdot \vec{r}$
   (c) $\vec{\nabla} \times \vec{r}$

7. Marion & Thornton 1.28, 1.31