Physics 3344 **Professor Scalise**
Fall 2006 **Assignment #4**

Due: 14 September 2006

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. Suppose that $\vec{A}(r, \theta, \phi)$ is a vector field with a radial component which can depend on all three spherical coordinates $A_r(r, \theta, \phi)$, a polar component which can depend on all three spherical coordinates $A_\theta(r, \theta, \phi)$, and an azimuthal component which can depend on all three spherical coordinates $A_\phi(r, \theta, \phi)$. What is the polar component of the curl of $\vec{A}$? $(\vec{\nabla} \times \vec{A})_\theta = ?$

3. A particle moves in a plane elliptical orbit described by the displacement vector

$$\vec{r}(t) = 2b \sin(\omega t)\hat{e}_x + b \cos(\omega t)\hat{e}_y$$

where b and ω are constants. Find

   (a) the velocity vector $\vec{v}$

   (b) the scalar speed v

   (c) the acceleration vector $\vec{a}$

   (d) the angle between $\vec{v}$ and $\vec{a}$ at time $t = \frac{\pi}{2\omega}$

4. If the derivative

$$\frac{d}{dt}[\vec{r} \times (\vec{v} \times \vec{r})] = f\vec{a} + g\vec{v} + h\vec{r}$$

find the scalars f, g, and h.

5. For the vector function of time $\vec{A}(t)$, evaluate

$$\int (\vec{A} \times \ddot{\vec{A}}) dt$$