TRANSPORT PHENOMENA 052:144
Learning Experience I
February 14, 2002
Closed Book Exam

1. Let $\boldsymbol{u} = 2\boldsymbol{i} - 3\boldsymbol{j} + 4\boldsymbol{k}$, $\boldsymbol{v} = yx\boldsymbol{j} + y^2\boldsymbol{i}$ and $\boldsymbol{D} = y\boldsymbol{ik} + z\boldsymbol{jk}$ ($\boldsymbol{D}$ is a second rank tensor). Compute the following quantities in (RCCS) at (x,y,z) = (1,2,3). Indicate whether the result is a scalar, vector or second rank tensor.
   a. $\boldsymbol{u} \times \boldsymbol{D}$
   b. $\boldsymbol{v} \cdot \nabla\boldsymbol{v}$

2. The Laplacian, $\nabla \cdot \nabla(\cdot)$, is often written as $\nabla^2(\cdot)$ or even as $\Delta(\cdot)$. Show in RCCS whether or not the following is a correct relationships, $\Delta\vec{u} = \nabla(\nabla \cdot \vec{u}) - \nabla \times (\nabla \times \vec{u})$.

3. When Dr. Smooth measured the velocity flow field for an incompressible fluid in her new device, she obtained $\vec{v} = 4yz\vec{i} + 8xz\vec{j} - 12zy\vec{k}$. She is concerned about her instrumentation. Should she be? Why or why not?

4. Acceleration is usually written as $\vec{a} = \frac{\partial}{\partial t}\vec{v} + \vec{v} \cdot \nabla\vec{v}$. However, Professor Rodgers argued that this is the same as $\vec{a} = \frac{\partial}{\partial t}\vec{v} + (\nabla\vec{v}) \cdot \vec{v}$. Is he correct? Use RCCS to show.