2.20 Marine Hydrodynamics Homework #1(a)
Due: September 22, 2009

Question 1: Tensor Notation

Given:

$$\vec{A} = \langle 2, 3, 4 \rangle \qquad B = \begin{bmatrix} 0 & 2 & -2 \\ -3 & 1 & -1 \\ 6 & -3 & -1 \end{bmatrix} \qquad \vec{C} = \langle 1, 3, 8 \rangle$$

$$\varepsilon_{jkl} = \begin{cases} 1 & \text{if (j,k,l) is (1,2,3), (2,3,1) or(3,1,2)} \\ -1 & \text{if (j,k,l) is (3,2,1), (2,1,3) or(1,3,2)} \\ 0 & \text{otherwise} \end{cases}$$

calculate

1. $A_i B_{kk} C_j$
2. $A_i C_j \delta_{ij} B_{km}$
3. $A_i B_{jk} C_m \delta_{ij} \delta_{km}$
4. $\varepsilon_{jkl} A_i C_k B_{li}$

Question 2: Taylor Series

Given $f(x) = e^{2x} \sin(x)$ where $x \in \mathbb{R}$ calculate a $f(0.1)$ using a three term Taylor Series expansion of $f(x)$ about $x = 0$. Show the procedure.

Question 3: Vector Calculus

1. Given $\phi(x, y, z) = x^3 y^2 z + \cos(x^2) + 2\ln(yz)$ and $\vec{V}(x, y, z) = u\hat{i} + v\hat{j} + w\hat{k}$, calculate:
   (a) $\nabla \phi$
   (b) $\nabla^2 \phi$
   (c) $\nabla \cdot \vec{V}$
   (d) $\nabla \vec{V}$
   (e) $\vec{V} \cdot \nabla \vec{V}$

   and state if the result is a scalar, vector, or tensor.
2. Solve C5, C6, and C10 from the Supplemental Problems