$\boxed{\textbf{Math2E - Practice Midterm2}}$

1. Label each expression as a scalar quantity, a vector quantity or undefined, if f is a scalar function and $\mathbf{F}$ is a vector field.
   a. $\nabla \cdot (\nabla f)$
   b. $\nabla \times (\nabla \cdot \mathbf{F})$
   c. $\nabla(\nabla \times \mathbf{F})$
   d. $\nabla(\nabla \cdot \mathbf{F})$
   e. $\nabla \times (\nabla f)$

2. $\mathbf{F} = (z^2+2xy)\mathbf{i}+x^2\mathbf{j}+2xz\mathbf{k}$. (a): Determine whether the vector field is conservative; (b): Evaluate $\int_C \mathbf{F}\cdot d\mathbf{r}$, where C runs from $(2,3,1)$ to $(4,-1,0)$.

3. Evaluate $\int_C (y + e^{\sqrt{x}})dx + (2x + \cos y^2)dy$, where C is the boundary of the region enclosed by the parabolas $y = x^2$ and $x = y^2$, and C is positively oriented.

4. Evaluate $\int\int_S (x - z)dS$, where S is the portion of the cylinder $x^2 + z^2 = 1$ above the xy-plane between $y = 1$ and $y = 2$.

5. Evaluate the flux integral $\int\int_S \mathbf{F} \cdot \mathbf{n} dS$, where $\mathbf{F} =< y, -x, z >$, S is the portion of $z = \sqrt{x^2 + y^2}$ below $z = 4$. ($\mathbf{n}$ downward).