STUDENT NAME: _____

STUDENT ID NUMBER: _____

DISCUSSION SECTION NUMBER: _____

**Directions**

Answer each question in the space provided. Please write clearly and legibly. Show all of your work—your work must both justify and clearly identify your final answer. No books, notes or calculators are allowed. You must simplify results of function evaluations when it is possible to do so.

**For instructor use only**

| Page | Points | Score |
|---|---|---|
| 2 | 8 | |
| 3 | 10 | |
| 4 | 12 | |
| 5 | 12 | |
| 6 | 8 | |
| Total: | 50 | |

1. [8 pts] Find the volume of the ice cream cone bounded above by the sphere of radius 6, and bounded below by the cone $x^2 + y^2 = 3z^2$.

2. [10 pts] Evaluate

$$\iint_R \frac{x-y}{x+y} dA$$

where $R$ is the square with vertices (0,2), (1,1), (2,2), and (1,3). HINT: Use change of variables!

3. [6 pts] Let $f(x,y) = x^2 + 3y$, and let $L$ be the line segment from $(3,0)$ to $(0,4)$. Find $\int_L f(x,y)ds$.

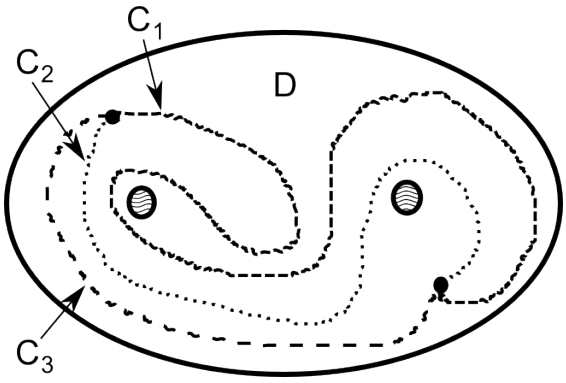
4. TRUE/FALSE (circle your answer, no justification needed)

   (a) [3 pts] If curl $\overrightarrow{\mathbf{F}} = 0$ throughout $D$, then $\int_{C_1} \overrightarrow{\mathbf{F}} \cdot d\overrightarrow{\mathbf{r}} = \int_{C_2} \overrightarrow{\mathbf{F}} \cdot d\overrightarrow{\mathbf{r}}$ in the picture below.

   $TRUE$ $FALSE$

   (b) [3 pts] If curl $\overrightarrow{\mathbf{F}} = 0$ throughout $D$, then $\int_{C_2} \overrightarrow{\mathbf{F}} \cdot d\overrightarrow{\mathbf{r}} = \int_{C_3} \overrightarrow{\mathbf{F}} \cdot d\overrightarrow{\mathbf{r}}$ in the picture below.

   $TRUE$ $FALSE$



5. Let $\overrightarrow{\mathbf{A}}(x, y, z) = \langle e^z, e^z, e^z \rangle$ and let $\overrightarrow{\mathbf{B}}(x, y, z) = \langle e^z, e^z, e^z(1 + x + y + z) \rangle$.

   (a) [6 pts] Is $\overrightarrow{\mathbf{A}}$ conservative or not? If not, justify. If so, find a potential function.

   (b) [6 pts] Is $\overrightarrow{\mathbf{B}}$ conservative or not? If not, justify. If so, find a potential function.

(c) [3 pts] Let $\mathcal{C}_1$ be the unit circle centered at the origin. Choose one of the following to compute:

$$\oint_{\mathcal{C}_1} \overrightarrow{\mathbf{A}} \cdot d\overrightarrow{\mathbf{r}} \quad \text{OR} \quad \oint_{\mathcal{C}_1} \overrightarrow{\mathbf{B}} \cdot d\overrightarrow{\mathbf{r}}$$

(d) [5 pts] Let $\mathcal{C}_2$ be the line segment from point $P = (0, 1, -1)$ to $Q = (5, 4, 0)$. Choose one of the following to compute:

$$\int_{\mathcal{C}_2} \overrightarrow{\mathbf{A}} \cdot d\overrightarrow{\mathbf{r}} \quad \text{OR} \quad \int_{\mathcal{C}_2} \overrightarrow{\mathbf{B}} \cdot d\overrightarrow{\mathbf{r}}$$

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