Notes: Show your work. In other words, just writing the answer, even if correct, may not be sufficient for full credit. Scientific calculators are allowed, but no programmable and/or graphing calculators. And please put away your cell phones and other electronic devices, turned off or in airplane mode.

Your Name: ____________________________

Problem 1: out of 20
Problem 2: out of 20
Problem 3: out of 20
Problem 4: out of 20
Problem 5: out of 20

Total: out of 100

Good luck and have a great Memorial Day Weekend!
1. (20 points) In this problem, let the curve $C$ be the boundary of the square with vertices (-1,0), (0,1), (1,0) and (0,-1), oriented counterclockwise.

(a) (6 points) Evaluate \[ \int_{C} ds \]

(b) (7 points) Evaluate \[ \int_{C} -y \, dx + x \, dy \]

(c) (7 points) Evaluate \[ \int_{C} 2xy \, dx + x^2 \, dy \]
2. (20 points) Let $\vec{F} = (-y, x, z)$. Evaluate

$$\int_C \vec{F} \, d\vec{s}$$

where the curve $C$ is the quarter circle of radius $\sqrt{2}$ centered at the origin, starting at the point $P(1, 1, 0)$ and ending at the point $Q(0, 0, \sqrt{2})$. 
3. (20 points) Let \( \Phi(u, v) = (u \cos v, u \sin v, u^2) \) be a mapping from a subset \( D \subseteq \mathbb{R}^2 \) given by \( 0 \leq u \leq 3, 0 \leq v \leq 2\pi \) onto a surface \( S = \Phi(D) \) in \( \mathbb{R}^3 \).

(a) (5 points) Sketch or describe (identify) this surface.

(b) (15 points) Find the surface area of \( S \).
4. (20 points) Let the surface $S$ be the portion of the cone $z^2 = x^2 + y^2$ where $1 \leq z \leq 4$. Let $f(x, y, z) = y + z^3$. Evaluate
\[
\iint_S f \, dS
\]
5. (20 points) Let $\vec{F} = (x, -z, y)$ and $S$ be the closed upper hemisphere centered at the origin of radius 3, with the orientation given by the outer normal (i.e. pointing out of the hemisphere). In other words, $S$ is the surface enclosed by the portion of the sphere $x^2 + y^2 + z^2 = 9$ where $z \geq 0$ and the disk $x^2 + y^2 \leq 9$ where $z = 0$. Evaluate

$$\iint_S \vec{F} \cdot d\vec{S}$$