Directions: Show ALL work for credit; Give EXACT answers when possible; Start each problem on a SEPARATE page; Use only ONE side of each page; Be neat; Leave margins on the left and top for the STAPLE; Calculators can be used for graphing and calculating only; Nothing written on this page will be graded;

1. Sketch the region of integration for the integral below, then change the order of integration (do NOT evaluate) and then convert the double integral to polar coordinates (do NOT evaluate).

\[ \int_{0}^{3} \int_{-x}^{x} x^{2} + y^{2} \, dy \, dx \]

2. Let \( D = \{(x, y) | x^2 + y^2 \leq 1 \} \) be the unit disk, \( B = \{(x, y) \in D | y \leq 0 \} \) be the bottom half of \( D \), \( R = \{(x, y) \in D | x \geq 0 \} \) be the right half of \( D \), and \( Q = \{(x, y) \in D | y \leq 0, x \geq 0 \} \) the part of \( D \) in the fourth quadrant. Decide if the following double integrals are positive, negative or zero.

\[
\begin{align*}
A &= \iint_{D} y \, dA \\
B &= \iint_{B} x^3 \, dA \\
C &= \iint_{Q} xy \, dA \\
D &= \iint_{B} \sin x \, dA \\
E &= \iint_{D} 1 - x^2 - y^2 \, dA \\
F &= \iint_{B} -y \, dA \\
G &= \iint_{R} y^2 \, dA \\
H &= \iint_{R} -5x \, dA \\
I &= \iint_{R} \sin x \, dA \\
J &= \iint_{B} x - 0.005 \, dA
\end{align*}
\]

3. Write and evaluate a double integral which will give the volume under the parabolic cylinder \( z = 1 - x^2 \) and above the parabolic cylinder \( z = y^2 \). (See the graph below left)

4. Setup and evaluate a double integral which will compute the area of one loop of the lemniscate \( r^2 = 2 \cos 2\theta \) (see the graph above right).

5. Find the center of mass of a lamina with constant density \( \delta(x, y) = k \) that occupies the region under the curve \( y = \cos x \) from \( x = -\pi/2 \) to \( x = \pi/2 \).