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 and then change the order of integration of 
\[ \int_0^1 \int_{\sqrt{y}}^1 f(x, y) \, dx \, dy \]

2. Let \( A(0,0), B(5,0) \) and \( C(3,4) \). Find the coordinates of the point \( P \) in the \( xy \)-plane so the sum of the distance squares \( \|PA\|^2 + \|PB\|^2 + \|PC\|^2 \) is minimum.

3. The regions pictured below are inside the unit circle, decide if the following double integrals are positive, negative or zero.
\[
\begin{align*}
A &= \iint_D x^2 + y^2 \, dA \quad B = \iint_T 5y \, dA \\
F &= \iint_T -\sin(x) \, dA \\
G &= \iint_T -\cos(x) \, dA \\
C &= \iint_T 5x \, dA \\
H &= \iint_T y^3 - y \, dA \\
D &= \iint_R 5x \, dA \\
E &= \iint_Q 0 \, dA \\
I &= \iint_R y^3 - y \, dA \\
J &= \iint_R x + y^2 \, dA
\end{align*}
\]

4. Use your TI-89 to find all the critical points of the function \( f(x, y) = 8y^3 + 12x^2 - 24xy \), then show how you would obtain these critical points by hand. Classify these local extrema by filling out a table like the one below, with a separate line for each critical point.

<table>
<thead>
<tr>
<th>( x, y )</th>
<th>( f_{xx} )</th>
<th>( f_{xy} )</th>
<th>( f_{yy} )</th>
<th>big D</th>
<th>Classification</th>
</tr>
</thead>
</table>

5. Use Lagrange multipliers to find the maximum and minimum VALUES of \( f(x, y) = x^2 - y \) subject to the constraint that \( x^2 + y^2 = 4 \).