1) What are the stability properties of the \((0, 0)\) solution of
\[
\begin{align*}
x' &= \alpha x + y^n \\
y' &= \alpha y - x^n
\end{align*}
\]
depending on the parameters \(\alpha \in \mathbb{R}\) and \(n \in \mathbb{N}\).

2) Show by an example that if \(f\) is \(C^1\) and \(f(0) = 0\), it is possible that \(\lim_{t \to +\infty} x(t) = 0\) for all solutions to \(x' = f(x)\) without the eigenvalues of \(Df(0)\) having negative real parts.

3) Consider
\[
\begin{align*}
x' &= 1 + y - x^2 - y^2 \\
y' &= 1 - x - x^2 - y^2
\end{align*}
\]
\[\text{(2)}\]

a/ Determine the critical points and characterise them
b/ Show that the system has a periodic solution
c/ Linearize the system near this periodic solution and determine the characteristic exponents.