Partial credit will be awarded for your answers, so it is to your advantage to explain your reasoning and what theorems you are using when you write your solutions. Please answer the questions in the space provided and show your computations.

Good luck!
1. Solve the following initial value problem

\[ ty' + (t + 1)y = 2te^{-t} \]
\[ y(0) = 1. \]
2. Consider the initial value problem

\[
\begin{align*}
\frac{dy}{dt} &= \frac{\ln t}{y^2 + 1} \\
y(1) &= 0
\end{align*}
\]

1. Find an interval where the solution the (above) initial value problem is certain to exist.

2. Solve analytically the ODE.
3. Consider the initial value problem

\[
\begin{align*}
\frac{dy}{dt} &= (y - 1)^3 \\
y(t_0) &= y_0 > 0
\end{align*}
\]

1. Find the equilibrium solutions and study their asymptotic stability.
2. Solve analytically the initial value problem for \( t_0 = 0 \) and \( y_0 = 0 \).