Problem 1: Show that the equation \( xu_y - yu_x = x^2 + y^2 \) has no continuous solutions in any neighborhood of (0,0). (Hint: convert to polar coordinates.)

Problem 2: Carry out explicitly the reduction of the Cauchy problem for the equation \( u_t + u^T \nabla u = f \) in 2 spatial dimensions with \( u = (u_1, u_2) \) to a first order system needed in the proof of Cauchy-Kowalevski theorem, assuming \( u(x_1, x_2, 0) = g(x_1, x_2) \).

Problem 3: Show that the function

\[
 u(x_1, x_2) = \begin{cases} 
 \frac{1}{2} & \text{for } |x_1 - \xi_1| < \xi_2 - x_2 \\
 0 & \text{otherwise}
\end{cases}
\]

Is a fundamental solution for \( L = \frac{\partial^2}{\partial x_2^2} - \frac{\partial^2}{\partial x_1^2} \) with pole \((\xi_1, \xi_2)\).

Problem 4: Verify:

\[
 \int_\Omega \left( v \Delta^2 u - u \Delta^2 v \right) dx = \int_\Omega \left( v \frac{d\Delta u}{dn} - \Delta u \frac{dv}{dn} - u \frac{d\Delta v}{dn} + \Delta v \frac{du}{dn} \right) dS
\]