1. Find the general solution for the first-order linear differential equation.

\[ y' + 2ty = e^{-t^2} \cos(t) \]

This requires an integrating factor \( \mu(t) \), which will turn the left side of the equation into the result of a product rule. In this case, \( \mu(t) = e^{\int 2t \, dt} = e^{t^2} \). Multiplying through, we get:

\[ e^{t^2} y' + 2te^{t^2}y = e^{t^2} e^{-t^2} \cos(t) = \cos(t) \]

Recognizing that the left side of the equation is the derivative of \( e^{t^2} y \), we get:

\[ e^{t^2} y = \int \cos(t) \, dt = \sin(t) + C \]

\[ y = e^{-t^2} \sin(t) + Ce^{-t^2} \]

2. Use separation of variables to find the solution for the separable differential equation.

\[ \frac{dy}{dx} = (x - 1)e^y, \quad y(0) = 0 \]

Of course, there are many different valid notations used for solving the equation, but I will proceed using the traditional one, indicating a reversal of the chain rule:

\[ e^{-y} \frac{dy}{dx} = x - 1 \]

The left side is the implicit derivative with respect to \( x \) of a function of \( y \), which explains the next steps:

\[ \int e^{-y} \frac{dy}{dx} \, dx = \int x - 1 \, dx \]

\[ -e^{-y} = \frac{1}{2} x^2 - x + C \]

This is an implicit function, and in this form, if we like, we can solve for the constant of integration using \( y(0) = 0 \):

\[ -e^{0} = 1 = \frac{1}{2} \cdot 0^2 - 0 + C, \quad \text{so} \quad C = 1 \]

Now, to solve for \( y \):

\[ e^{-y} = -\frac{1}{2} x^2 + x - 1 \]

\[ -y = \ln \left( -\frac{1}{2} x^2 + x - 1 \right) \]

\[ y = -\ln \left( -\frac{1}{2} x^2 + x - 1 \right), \quad \text{or, if you like,} \quad y = \ln \left( \frac{1}{x - \frac{1}{2} x^2 - 1} \right) \]