1. Consider the differential equation describing the motion of a pendulum:

\[ \frac{d^2 \theta}{dt^2} + \sin \theta = 0. \]

(a) (1 point) What is the order of this equation?

\[ \boxed{2} \]

(b) (1 point) Is this equation linear or nonlinear?

\[ \text{nonlinear} \]

(c) (1 point) Is the equation autonomous or nonautonomous?

\[ \text{autonomous} \]

(d) (1 point) Is this a scalar equation or a system?

\[ \text{scalar} \]

2. Consider the following differential equation:

\[ \frac{dy}{dt} + y = e^t \]

(a) (4 points) Find the general solution of this equation.

**Solution:** We use the integrating factor method. We first seek a factor \( \mu(t) \) so that \( \mu(t)y' + \mu(t)y = (\mu(t)y)' \). This means we would like \( \mu'(t) = \mu(t) \), so \( e^t \) will do.

We now multiply both sides by \( \mu(t) = e^t \) to obtain

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

and notice that the left side is the derivative of \( e^t y \). We may then integrate both sides to find that

\[ e^t y = \frac{1}{2} e^{2t} + C, \]

so that

\[ y = \frac{1}{2} e^t + Ce^{-t}. \]

(b) (2 points) Find the specific solution satisfying \( y(0) = 0 \).

**Solution:** We use our formula above and ask that \( y(0) = 0 \), so we want

\[ 0 = \frac{1}{2} e^0 + Ce^0 = \frac{1}{2} + C, \]
so $C = -1/2$. The specific solution is thus:

$$y = \frac{1}{2} (e^t - e^{-t}) .$$