1. Textbook, Chapter 1, #1.2. Always assume \( x(t) = 0 \), for \( t < 0 \).

2. Consider the differential equation:
   \[
   \frac{dy(t)}{dt} = t \frac{dx(t)}{dt} + x(t), \quad t \geq 0; \quad y(0) = 1, x(0) = 0.
   \]
   (a) solve for \( y(t) \) in terms of \( x(t) \);
   (b) Is the system described by this input-output relationship linear? Is it causal? Is it time-invariant? Explain your answers.

3. Consider the differential equation:
   \[
   \frac{dy(t)}{dt} + y(t) = \frac{dx(t)}{dt} - x(t), \quad t \geq 0; \quad y(0) = 0, x(0) = 0.
   \]
   (a) Solve for \( y(t) \) in terms of \( x(t) \).
   (b) Find \( y(t) \) when \( x(t) = t, \ t \geq 0, x(t) = 0, t \leq 0 \).

4. Consider the following input-output relationship:
   \[
   y(t) = \int_{-\infty}^{\infty} e^{-\sigma} x(t-\sigma) \, d\sigma, \quad -\infty < t < \infty.
   \]
   (a) Is the system time-invariant?
   (b) Find the output \( y(t) \) when the input to the system is \( x(t) = |t|, \ -\infty < t < \infty \).

5. For each of the following systems, state whether the system is linear, causal, and time-invariant. Construct a counter-example for each property you claim the system does not have.
   (a) \( y(t) = [x(t)]^3 \);
   (b) \( y(t) = tx(t) \);
   (c) \( y(t) = x(t^2) \).

Try to use MATLAB to demonstrate the counter-examples. Remember that the command \texttt{t=linspace(-5,5,101)} creates a vector of 101 linearly spaced elements between \(-5\) and \(5\). The command \texttt{t=[-5:0.1:5]} has the same effect. You can use these commands to generate a time-vector. The vector \texttt{x=sin(t)}, for instance, generates a vector of the same length as \( t \), in our example, a 101-element vector. For this question, generate your own time-vector, \( t \), and your own amplitude vectors \( x(t) \) and \( y(t) \). (the elements of all these vectors have to be aligned with each other!) You can visualize your results by using the commands \texttt{plot(t,x)} and \texttt{plot(t,y)} (provided that the vectors have equal lengths). Use \texttt{axis} to control the axes limits, \texttt{title}, \texttt{xlabel} and \texttt{ylabel} to generate labels. You can also use \texttt{subplot} to break up the plot in different parts. (Also remember that typing \texttt{help command_name} on the command line will give you help on the specific MATLAB command.)