1. [100 pts] The impulse response of a particular LTI system is $h(t) = e^{-t}u(t)$. Use convolution to find the output in response to the input signal $x(t) = u(t) - u(t - 1)$.

The grids below may be used for sketching signals. You are not required to use them.
2. [100 pts] In response to the input

\[ x(t) = 10 u(t - 2) \]

a certain LTI system produces the output

\[ y(t) = 5 e^{-4(t - 2)} u(t - 2) \]

(a) What is the step response, \( s(t) \), of this system?

(b) What is the impulse response, \( h(t) \), of this system?

(c) Is this system causal? Stable? Justify your answers.

(d) What is the response to \( x(t) = 5 \delta(t - 2) + 20 u(t - 4) \)?
3. [100 pts] A certain LTI system has the following system transfer function

\[ H(s) = 4 \frac{s + 1}{(s + 2)(s - 3)} \]

Find the forced (steady-state) response for all \( t > 0 \) to each of the following inputs:

(a) \( x(t) = 12 \ u(t) \)

(b) \( x(t) = 14 \ e^{-4t} u(t) \)

(c) \( x(t) = 100 \ e^{-t} u(t) \)

(d) \( x(t) = 10 \ \sin(2t + 45^\circ) \ u(t) \)
4. [100 pts] Consider the system whose output, $y(t)$, and input, $x(t)$, are related by the following differential equation:

$$\frac{d^2 y(t)}{dt^2} - \frac{d y(t)}{dt} - 6 y(t) = 4 \frac{d x(t)}{dt} + 4 x(t)$$

(a) Find the transfer function, $H(s)$, of this system.

(b) Find all modes of the system.

(c) Is this system stable? Justify your answer.

(d) Draw the Direct Form I realization of this system.