

Solution to ECE 315 Test #4 F03

1. (4 pts) If a DT system is described by the difference equation,

$$3y[n] + 4y[n-1] - 10y[n-2] = x[n],$$

and it is excited by a DT unit impulse occurring at time, $n = 0$, find the numerical values of $y[-1]$, $y[0]$, $y[1]$ and $y[2]$.

The easiest way to find these numerical values is by iteration. The response is zero for all negative time so $y[-1] = 0$. Then

n	x[n]	y[n-2]	y[n-1]	y[n]
0	1	0	0	1/3
1	0	0	1/3	-4/9
2	0	1/3	-4/9	46/27

$y[-1] = 0$ $y[0] = 1/3$ $y[1] = -4/9 = -0.4444\dots$ $y[2] = 46/27 = 1.704$

2. (5 pts) For the difference equation, $10y[n] - 9y[n-1] = \delta[n]$, find the numerical values of $y[30]$ and $y[300]$.

In this case, iteration is impractical because of the large values of n . Therefore we need a closed-form solution.

$$\begin{aligned} \alpha = 0.9 &\Rightarrow y[n] = K(0.9)^n u[n] \\ y[0] = \frac{1}{10} &\Rightarrow K = \frac{1}{10} \Rightarrow y[n] = \frac{1}{10}(0.9)^n u[n] \\ y[30] &= \frac{1}{10}(0.9)^{30} = 0.00424 \\ y[300] &= \frac{1}{10}(0.9)^{300} = 1.874 \times 10^{-15} \end{aligned}$$

3. (2 pts) If a CT system is described by the differential equation,

$$3y''(t) - y'(t) + 7y(t) = x(t),$$

and the excitation, $x(t)$, is a unit impulse at time, $t = 0$, could the solution, $y(t)$, contain an impulse at time, $t = 0$? No

If $y(t)$ had an impulse, the left side of the equation would have the first and second derivatives of an impulse and those functions do not appear on the right side of the equation.

Could the solution, $y(t)$, be discontinuous at time, $t = 0$? No

If $y(t)$ were discontinuous at $t = 0$, the left side of the equation would have the first and second derivatives of a discontinuity (which are an impulse and the derivative of an impulse) and the derivative of an impulse does not appear on the right side of the equation.

4. (2 pts) If a CT system is described by the differential equation,

$$y'(t) + 7y(t) = x(t),$$

and the excitation, $x(t)$, is a unit impulse at time, $t = 0$, could the solution, $y(t)$, contain an impulse at time, $t = 0$? No

If $y(t)$ had an impulse, the left side of the equation would have the first derivative of an impulse and that function does not appear on the right side of the equation.

Could the solution, $y(t)$, be discontinuous at time, $t = 0$? Yes

If $y(t)$ were discontinuous at $t = 0$, the left side of the equation would have the first derivative of a discontinuity (which is an impulse) and an impulse does appear on the right side of the equation.