September 26, 2021 Prepared for ELE 302 TAs

EXPERIMENT #2

Finding Step Response Parameters

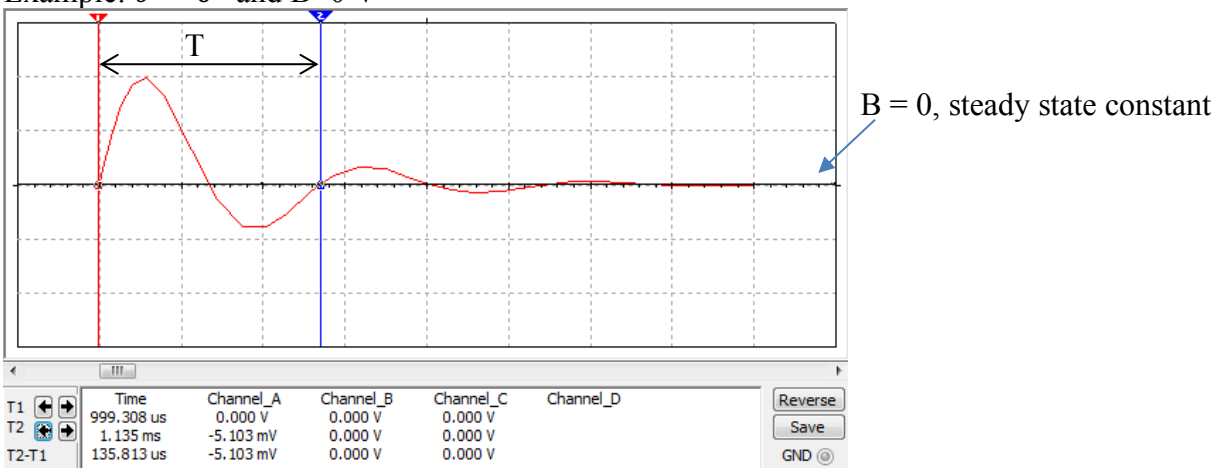
This handout is to be shared with the students to find parameters in Experiment 3

2nd Order Circuits with a Sinusoidal Output

Output voltage as the form of $v_o(t) = Ae^{-\sigma t}\sin(\omega t + \theta) + B$

1. Determine the period (T) using crossing points with B

Example: $\theta = 0^o$ and B=0 V



T = T2 – T1 = 135.812 µs, $\omega = \frac{2\pi}{T} = 46{,}263$ rad/s

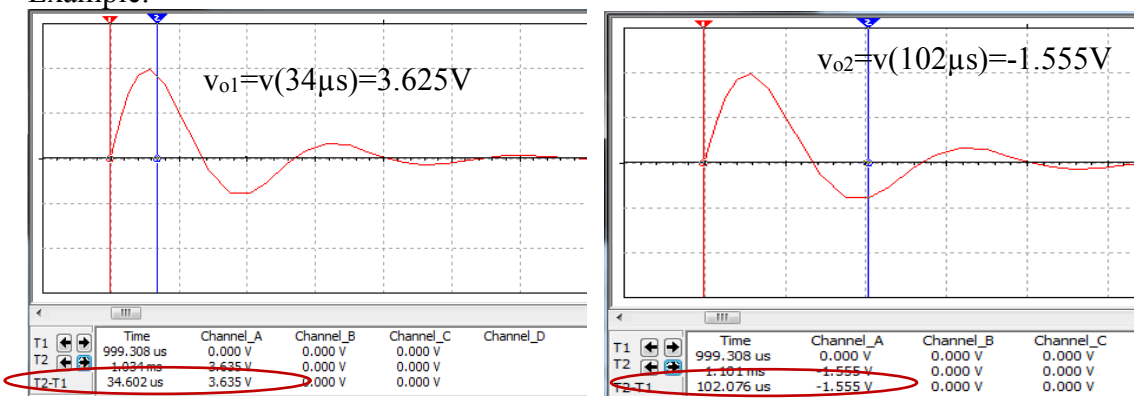
2. Measure voltage at quarter and 3-quarter cycle to determine σ and A

Quarter cycle: $v_{o1} = v_o\left(\frac{T}{4}\right) = Ae^{-\sigma t}\sin\left(\frac{\pi}{2}\right) = Ae^{-\frac{\sigma T}{4}}$

3-quarter cycle: $v_{o2} = v_o\left(\frac{3T}{4}\right) = Ae^{-\sigma t}\sin\left(\frac{3\pi}{4}\right) = -Ae^{-\frac{3\sigma T}{4}}$

Exponential decay: $\sigma = \frac{2}{T}\ln\left(-\frac{v_{o1}}{v_{o2}}\right)$ (1)

Example:



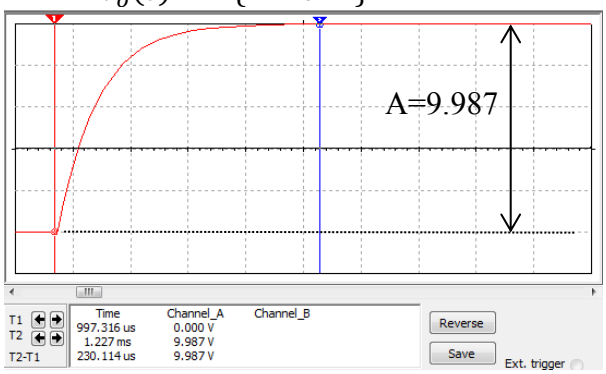
Using Equation (1), $\sigma = 12{,}463$

1st Order Circuits with an Exponential Output

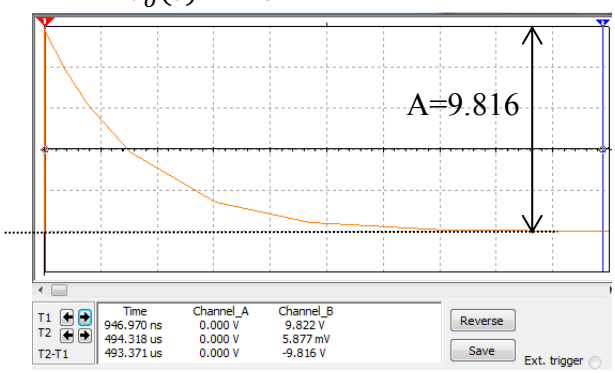
There are two possible outputs: $v_o(t) = A\{1 - e^{-\frac{t}{\tau}}\}$ or $v_o(t) = Ae^{-\frac{t}{\tau}}$

1. Find A

$v_o(t) = A\{1 - e^{-\frac{t}{\tau}}\}$



$v_o(t) = Ae^{-\frac{t}{\tau}}$



2. Calculate the voltage at $t = \tau$

$v_o(t = \tau) = A\{1 - e^{-1}\} = 0.63A = 6.31\text{V}$ $\quad v_o(t = \tau) = Ae^{-1} = 0.37A = 3.61\text{ V}$

3. Find when the voltage reaches the calculated value to get τ.
   (NOTE: There is limitation on the resolution. Use the closest value with the cursor arrows.)