Robotics and Intelligent Systems (RIS) LAB 2

Lab 1 (Tasks 1.1 - 1.3)

Submitted By
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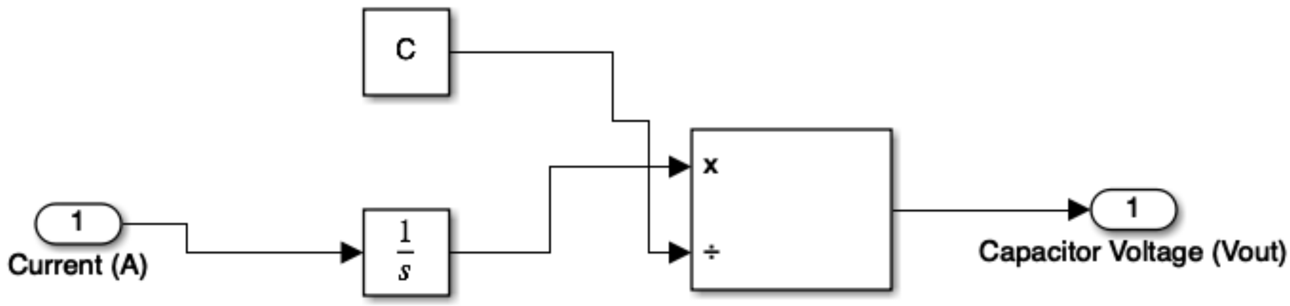
Task 1.1. Explain why Fig. 1.4 represents the model of a capacitor by writing down the equation it implements.



From Volta's law of capacitance, we know,

$$C = \frac{Q}{V}$$

here, C= Capacitance, Q=Current, V= Voltage

$$V = \frac{Q}{C}$$

$$V = \frac{1}{C} * \int I$$

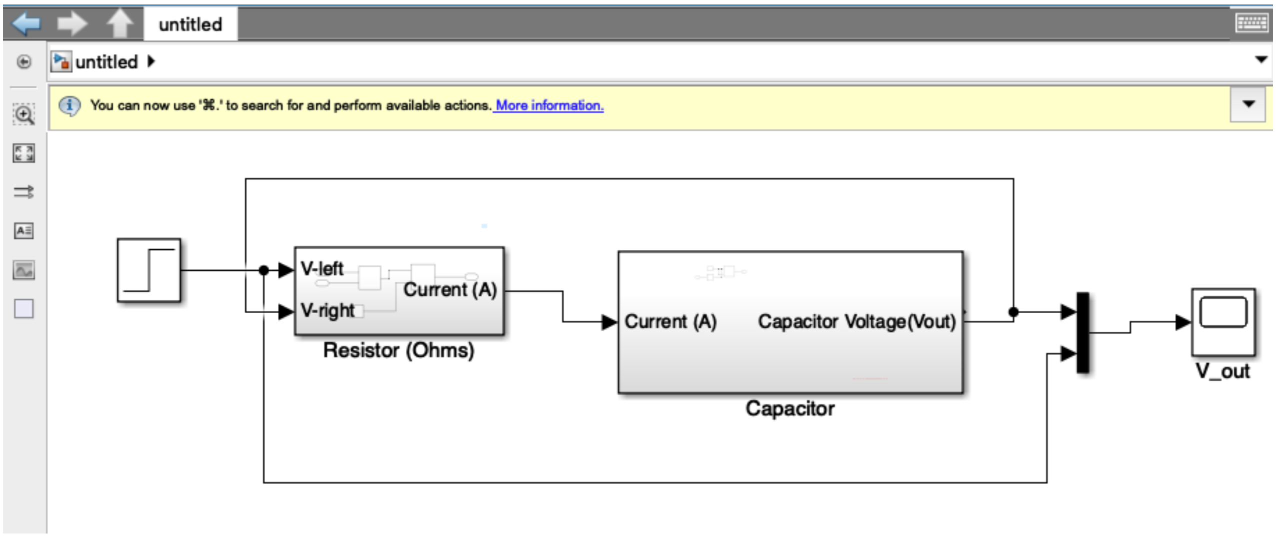
$$I = C * \frac{dV}{dt}$$

Task 1.2. Proceed as follows:

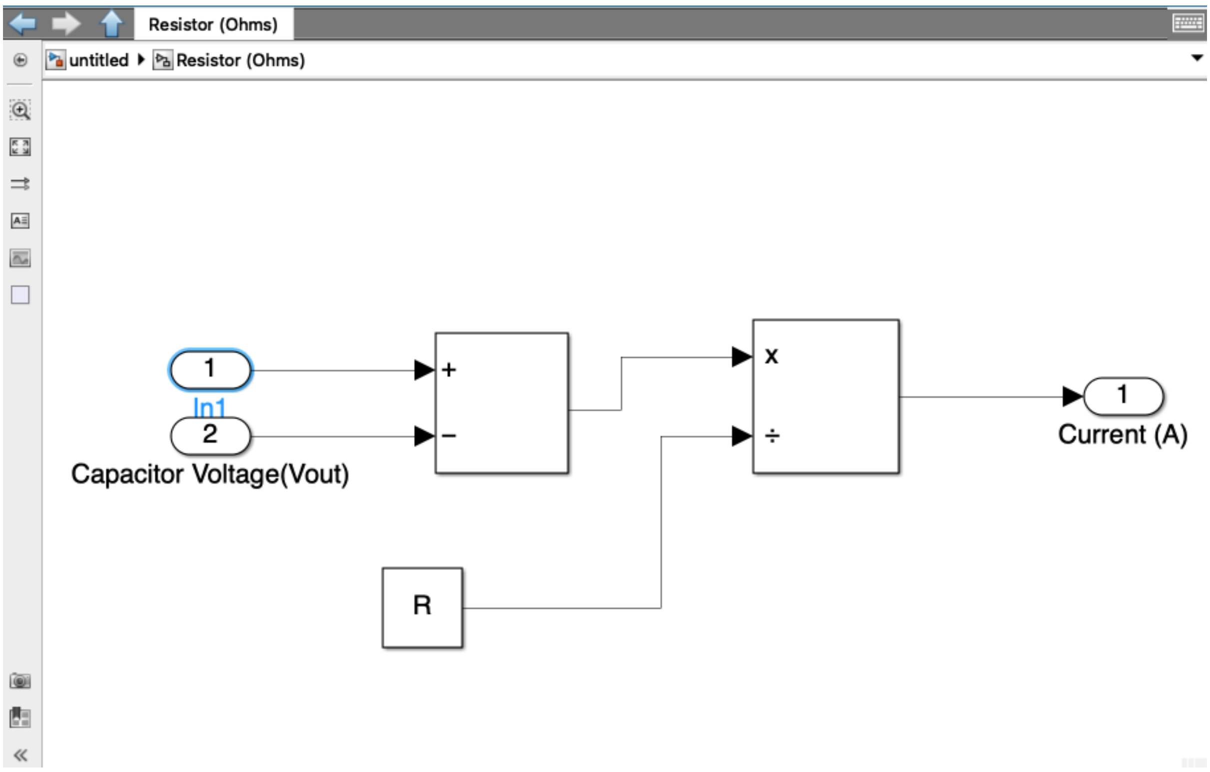
The RC Model: We join together the resistor and capacitor subsystems from 1.3 and 1.4 in the lab manual to one that looks like in figure 1.5.

You may have to delete the automatically created i/o ports of the subsystems and replace them with appropriate connections.

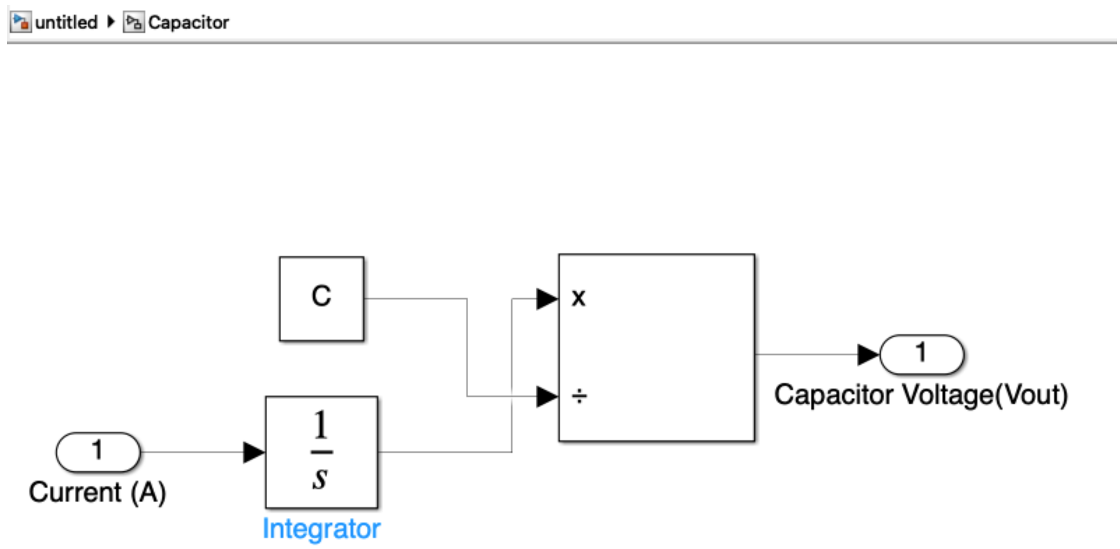
Fig 1.5 RC Model:



The resistor subsystem:

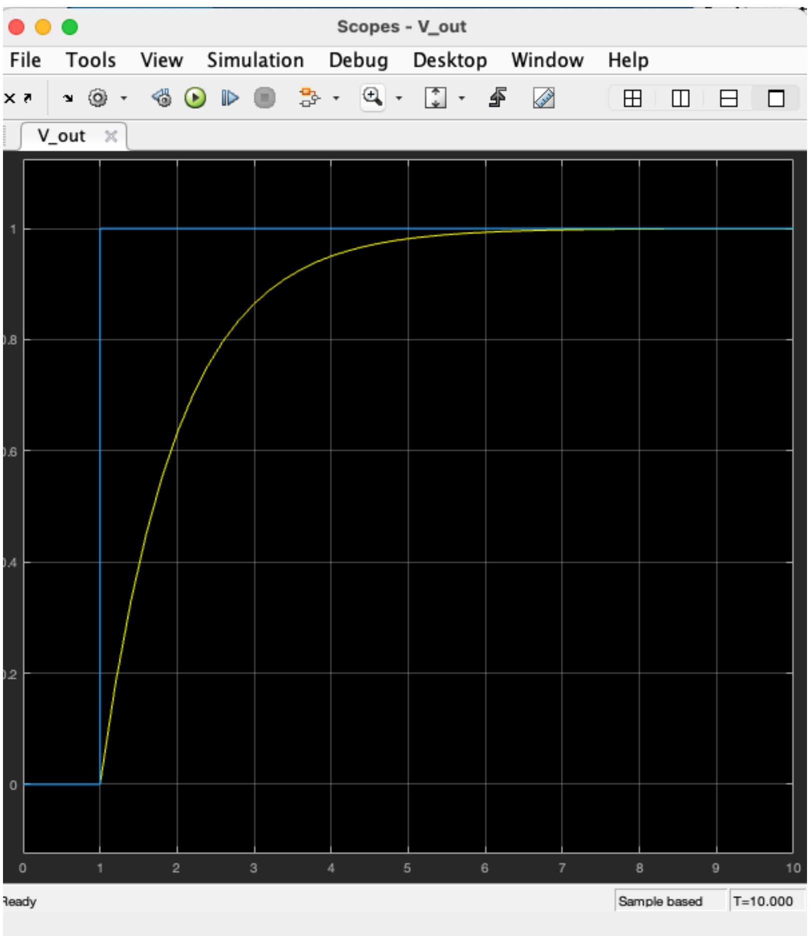


The capacitor subsystem:



- *What is the time-constant of this system? How can you see it in the plot? Change the simulation-time (in input field in the tool-ribbon) from the default 10.0 seconds to 5 times this time-constant.*

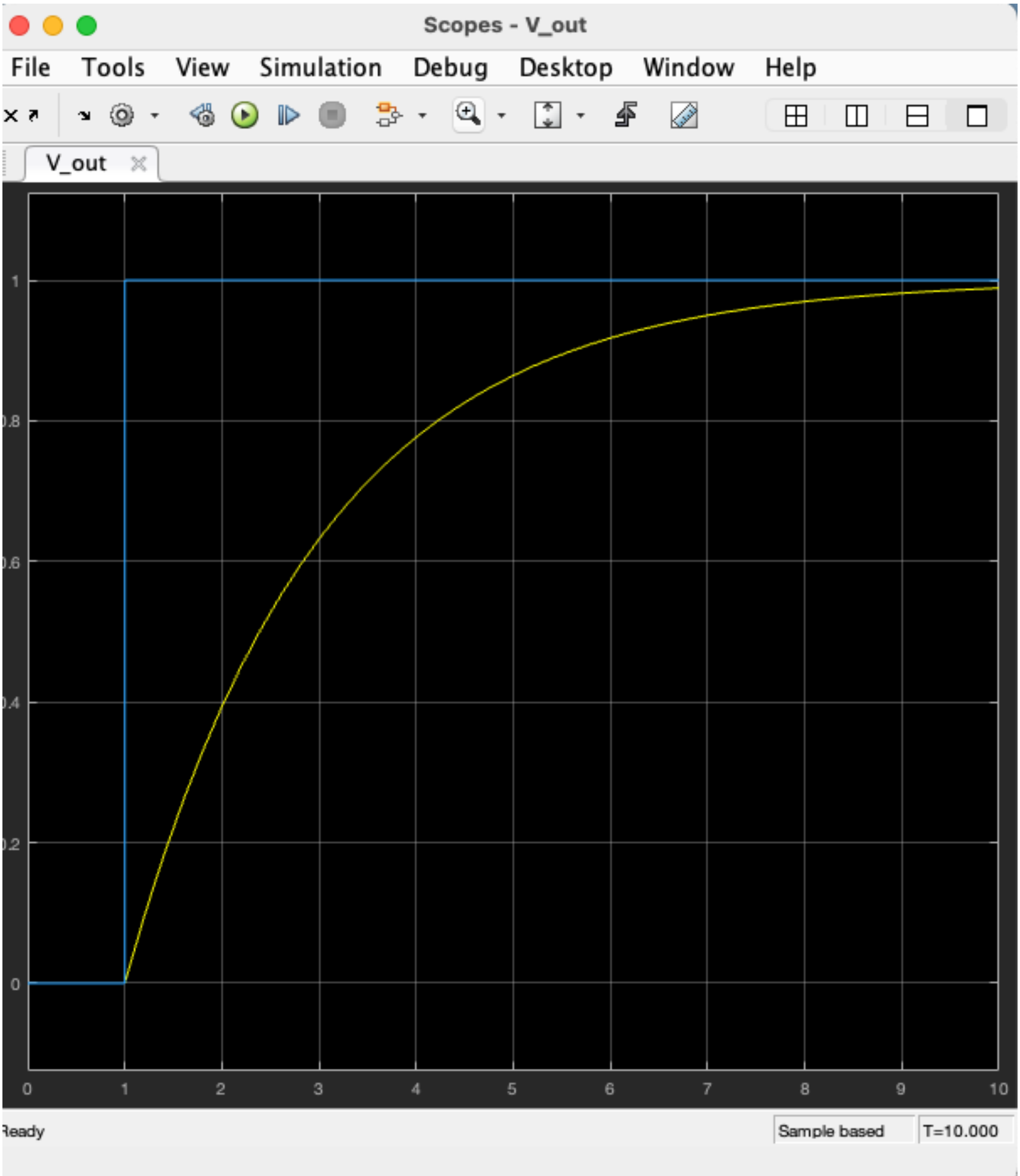
-> In the main model, R was set to R=1e6 and C was set to C=1e-6 i.e., the values of constants R and C in the resistor and capacitor subsystems.



From the plot, in the interval of 1 second and 2 second, the value reaches around 0.625.

– Run the system by pressing Ctrl+T or by clicking the run-button. Look at the output by double-clicking the scope.
- Now change the variables R and C in the workspace and re-run the simulation. Does the scope display change as expected?

-> The value of C was changed to 2e-6 and the following change was observed in the plot:



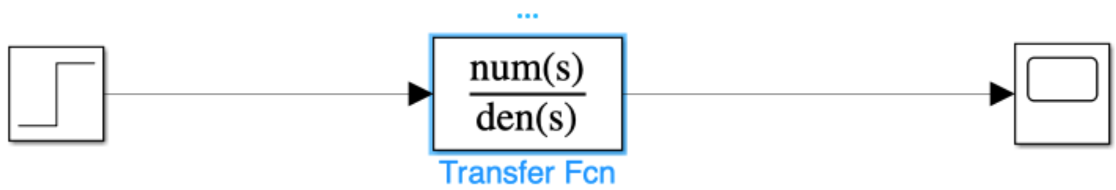
Task 1.3. Answer the following:

1. How many seconds does it take for the initial transient to die off in the output response?

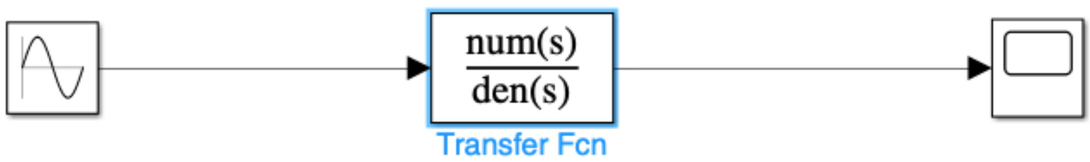
-> The numerator and denominator of the expression

$$H(s) = \frac{1}{RCs + 1}$$

was entered in the transfer-function block, taking some suitable values of R and C from the previous task. A step-function input was connected, and the output was visualized in a scope. The new model created looked like the one below:

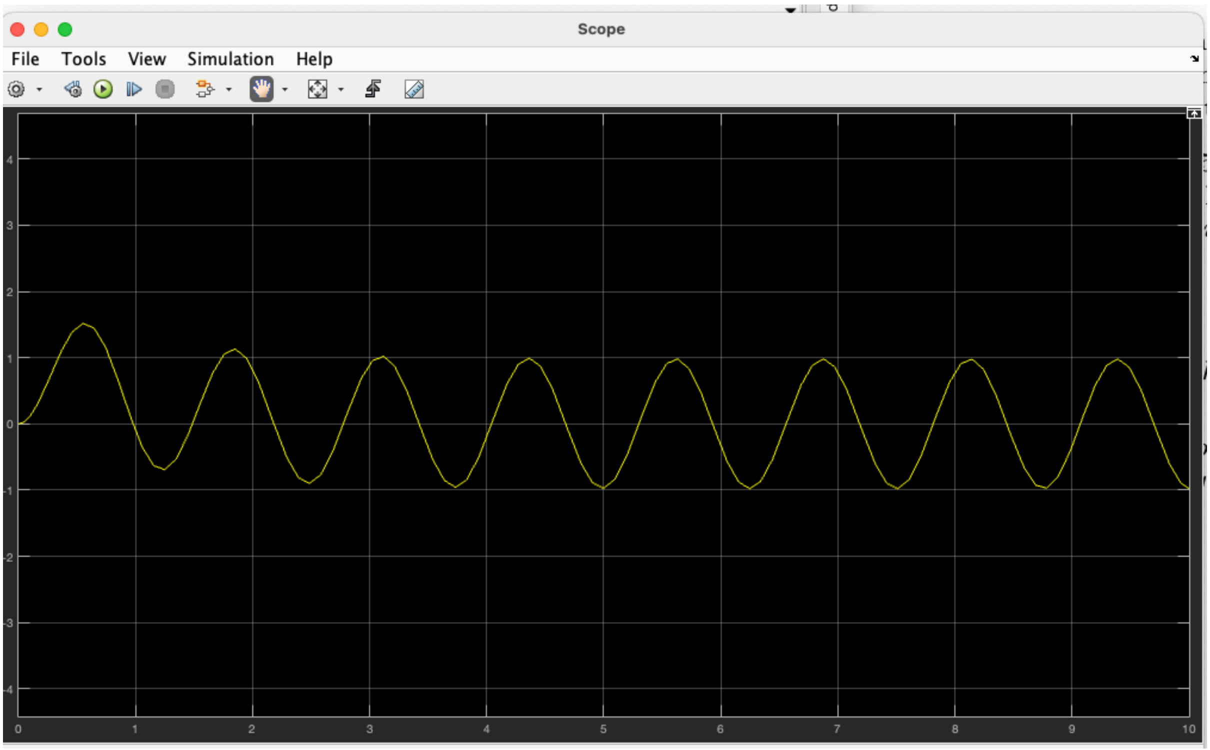


Then, a sinusoidal input of 5V amplitude and of frequency 1Hz was input:



The following plot was obtained from the scope:

(The frequency had to be tweaked a little bit to fit the sinusoidal waves within the time of 10 second. Additionally, the curves did not appear as smooth, so the relative-tolerance was set to 1e-6)



It can be observed that the wave stabilized after around 3.5 seconds so therefore, it takes 3.5 seconds for the initial transient to die off in the output response.

2. What is the expected gain-ratio (ratio of output to input amplitudes) from theory? You can find this by replacing s by jω in the transfer-function and evaluating |H(jω)|.

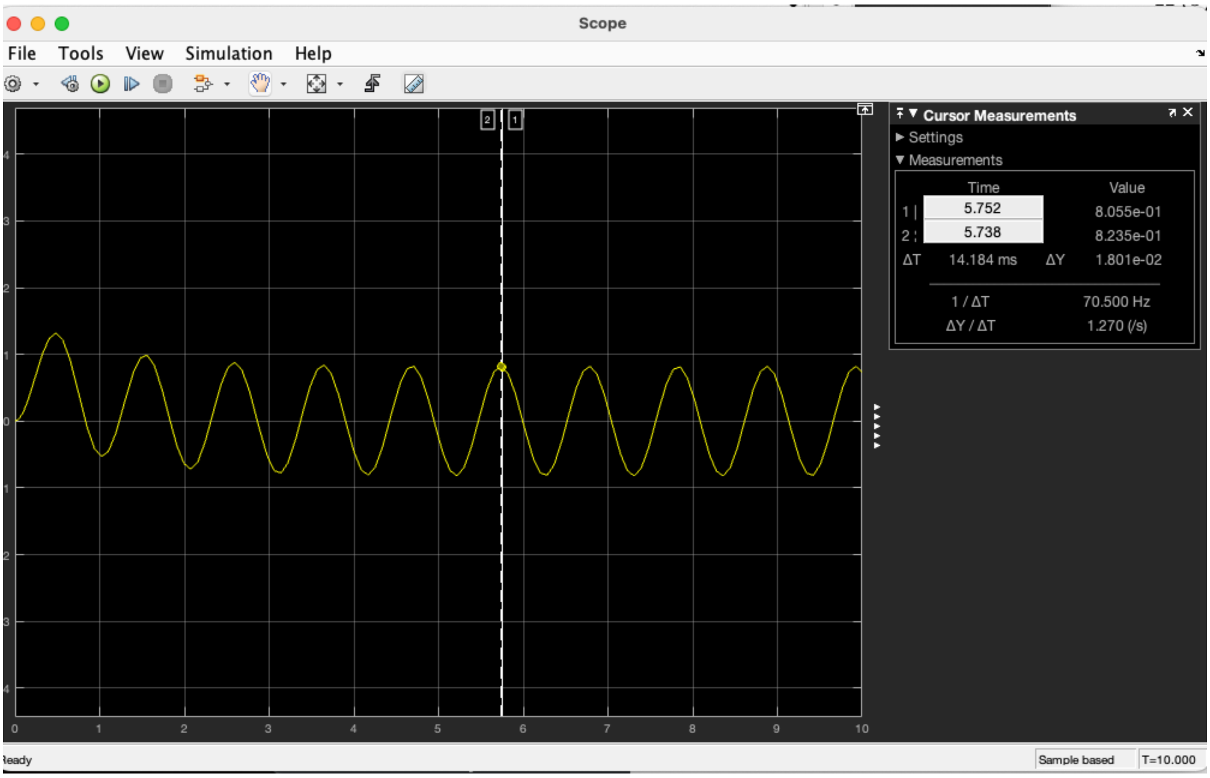
->

$$H(jw) = \frac{1}{(R * C * 2 * (\pi) * i) + 1}$$

$$= \frac{1}{10^6 * 10^{-6} * 2 * \pi * 0.8235 + 1}$$

$$|H(jw)| = 0.1617$$

3. Zoom in the scope to find the amplitude ratio of the output wave to the input wave. Is it as expected?



From the plot above, the amplitude is 8.235e-01. So, dividing 0.8235 by amplitude 5, we get 0.1647 which is pretty close to the theoretical value obtained earlier.