Control Systems LAB Digital Assignment 4

Submitted by:

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School of Electrical Engineering

Faculty: **Professor Dhanamjayalu C**

Course: **EEE-3001**

Course Name: **Control Systems Lab**

Lab Slot: **L45 + L46**

Study of First Order System

Exp No: 4

Date: 23-02-2022

AIM

1. To obtain the time and frequency response for a step input of a First order electrical system and correlate experimental results with theoretical.

APPARATUS REQUIRED

S.No.	Name of the apparatus / equipment	Specification / Range	Quantity
1	Resistance	10 k	1
2	Capacitance	0.01µf	1
3	Function generator	-----	1
4	Cathode ray oscilloscope	-------	1

THEORY

1. A first Order system whose input –output relationship is given by

   C(s) / R(s) = 1/(1+sT)

   Here we are analyzing the output of the system for a step input R(s) = 1/s Therefore . C(s) = 1/1+sT [R(s)]

   Taking inverse laplace transform of C(s), we get C(t) = 1 – for t0

   From the equation we can see that c(t) = 0 initialy (i.e., at t=0) and finally becomes unity (i.e., at t At t=T, c(t) = 1 – = 0.632. There fore one of the important characteristics of such curve is that t=T sec. system response is 63.2

   Smaller the time constant T, faster the system response dc/dt = 1/T at t=0 , dc/dt = 1/T

   Another important characteristics of the exponential response curve are that at t = 0. Slope of the tangent line is 1/t.

2. Frequency Response A sinusoidal transfer function may be represented by two separate plots, one giving the magnitude versus frequency and the others phase angle in degree versus frequency. A bode diagram consists of two graph , plot of magnitude of sinusoidal transfer function and other is a plot of phase angle both drawn to logarithmic scale. The standard representation of logarithmic magnitude of G (jw) is 20 log G (jw) where the base of the logarithm is 10. The unit is decibel.

   The main advantage of using a semi log sheet and using logarithmic plot is that multiplication of magnitudes can be converted to addition. The experimental

determination of transfer function can be made simple if frequency response datas are represented in the bode diagram.

PROCEDURE

1. Connections are made as shown in figure 1.
2. Keep the appropriate value for resistance and capacitance using respectively
3. A step input (square pulse of very low frequency i.e. large time period)) is given at input and output is observed across the capacitor using CRO.
4. Output shows a damped oscillation before it comes to steady state. Maximum overshoot or peak overshoot is noted.
5. A graph is plotted showing the variation of output voltage with time.
6. To get frequency response a sinusoidal signal is given as input and output (peak to peak value) is noted.
7. The input voltage is kept constant and output is noted for different frequency. Also the phase angle is noted, the output waveforms are noted using CRO.
8. The magnitude in decibel and phase angle in degree is plotted as a function of frequency ran/sec. In the semilog graph sheet.

CIRCUIT DIAGRAM

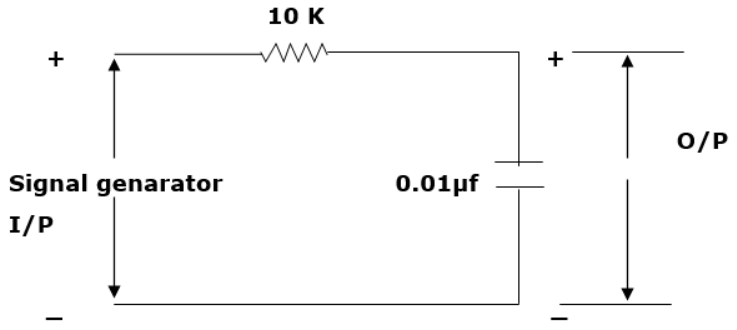
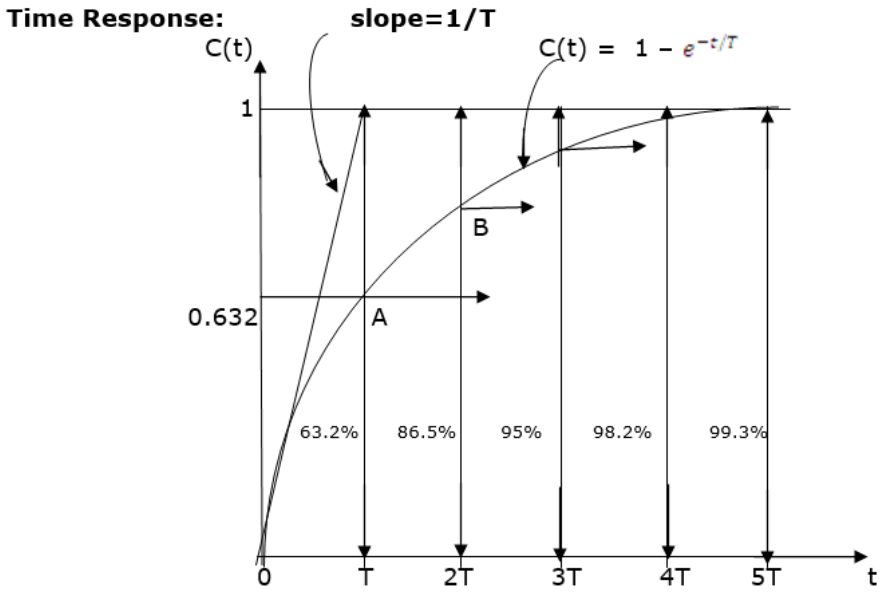


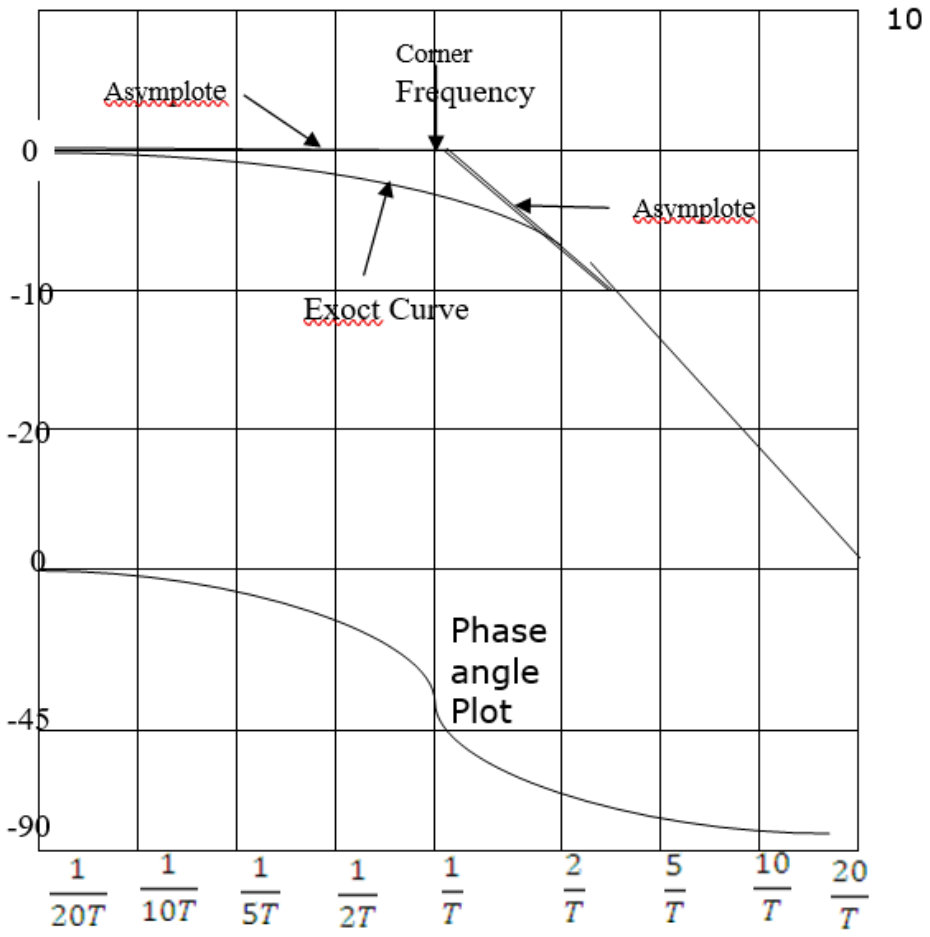
Fig. 1. Circuit Diagram for First order System

TIME RESPONSE



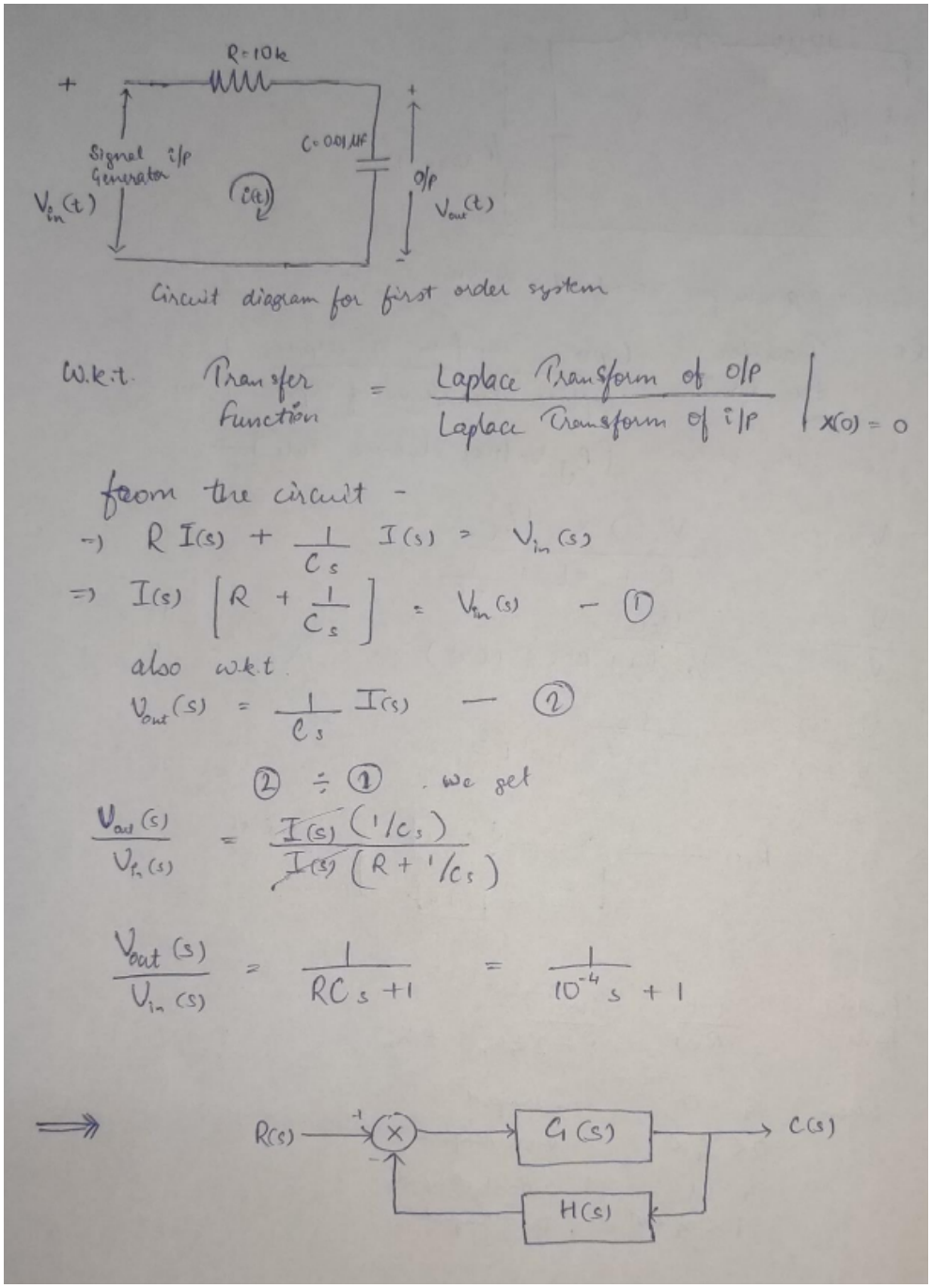
Time (Step) response of the first order system for unit step input.

FREQUENCY RESPONSE



Frequency Response of the First order system

MODEL CALCULATION



Circuit diagram for first order system

W.k.t. Transfer function = $\frac{\text{Laplace Transform of o/p}}{\text{Laplace Transform of i/p}} \Big|_{x(0)=0}$

from the circuit -

$\Rightarrow R\,I(s) + \frac{1}{Cs} I(s) = V_{in}(s)$

$\Rightarrow I(s)\left[R + \frac{1}{Cs}\right] = V_{in}(s) \quad - (1)$

also w.k.t

$V_{out}(s) = \frac{1}{Cs} I(s) \quad - (2)$

(2) ÷ (1) we get

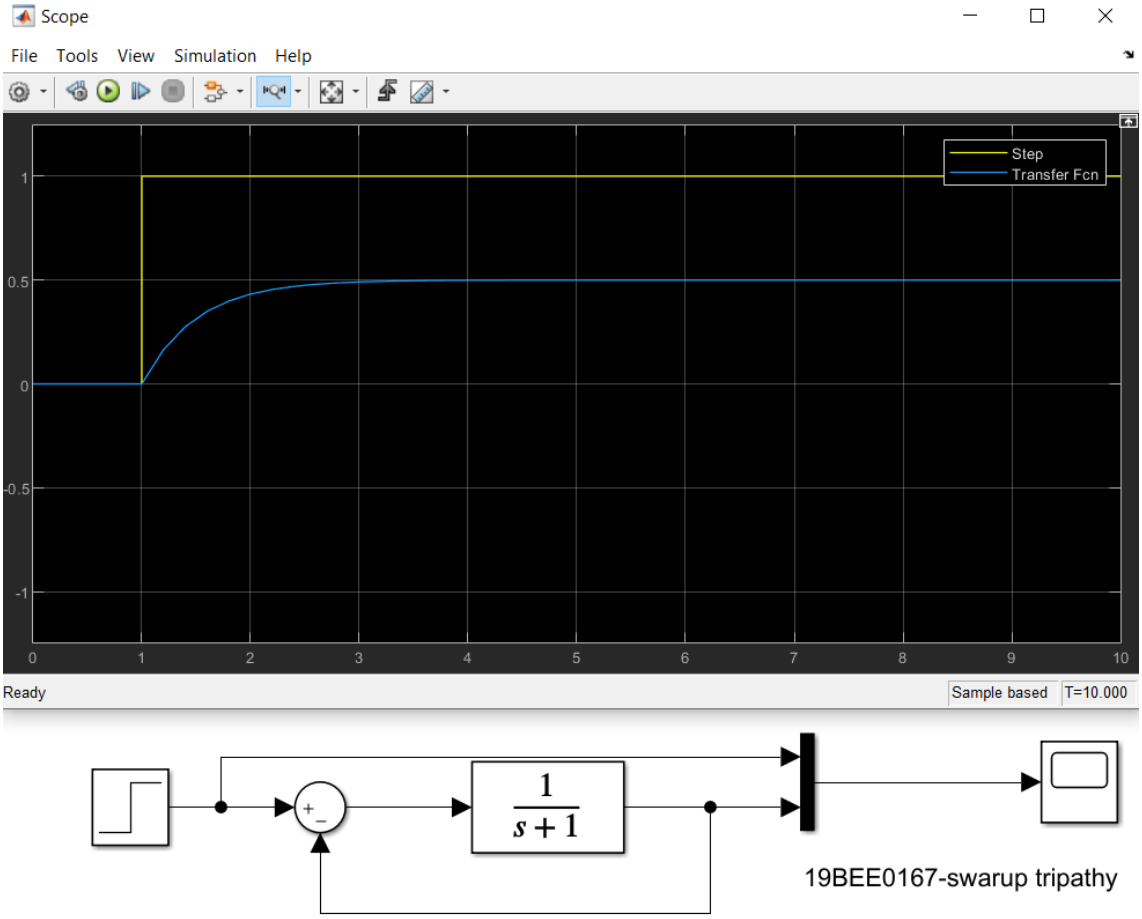
$$\frac{V_{out}(s)}{V_{in}(s)} = \frac{I(s)\,(1/Cs)}{I(s)\,(R + 1/Cs)}$$

$$\frac{V_{out}(s)}{V_{in}(s)} = \frac{1}{RCs+1} = \frac{1}{10^{-4}s + 1}$$

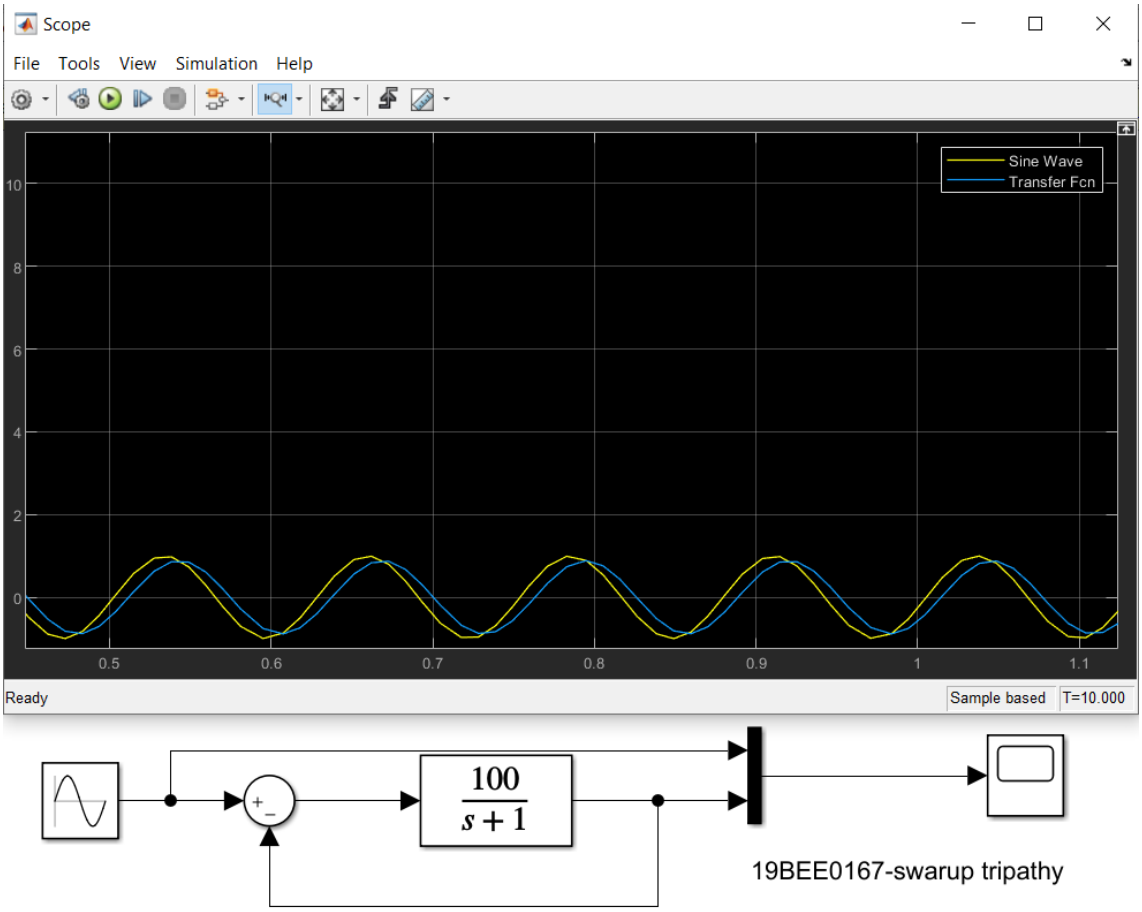
$\Longrightarrow$

RESULT

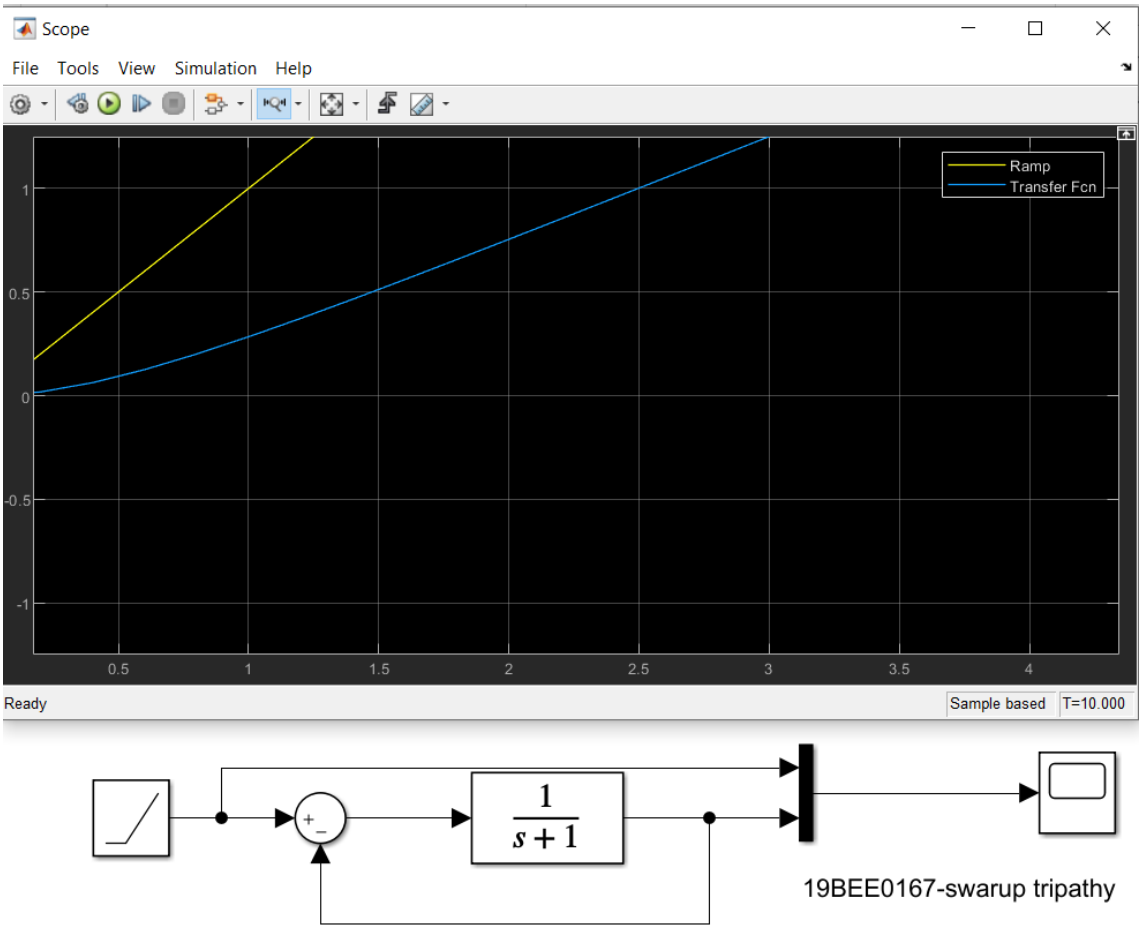
1. UNIT STEP INPUT



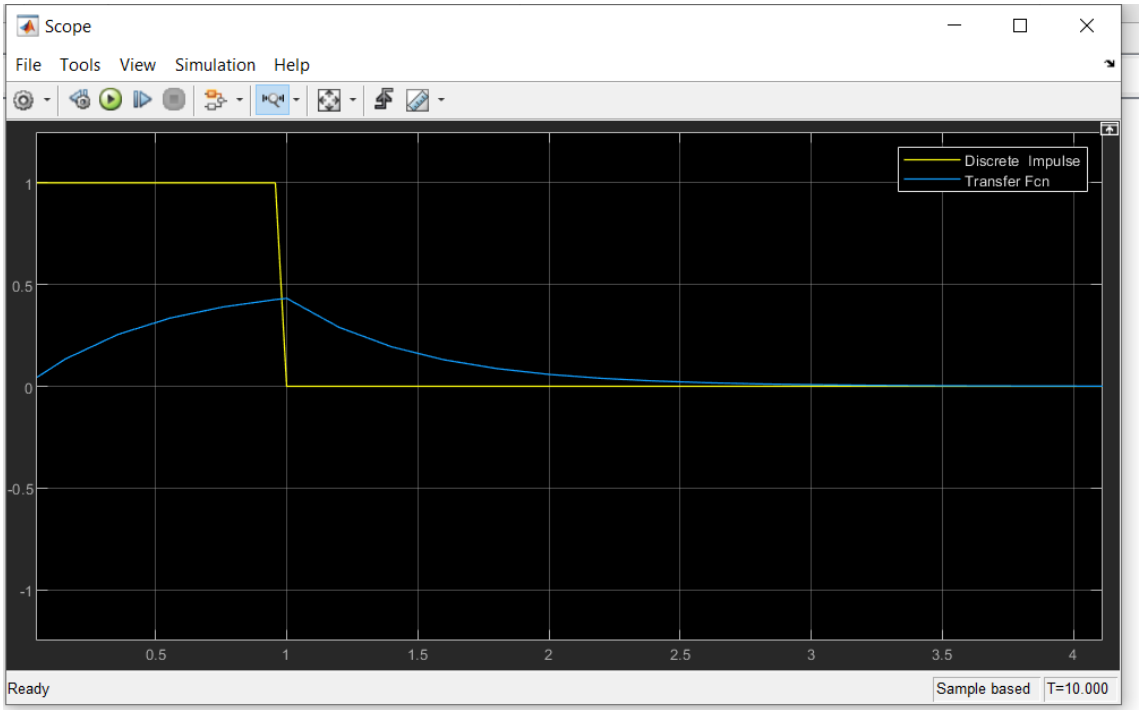
2. SINUSOIDAL INPUT

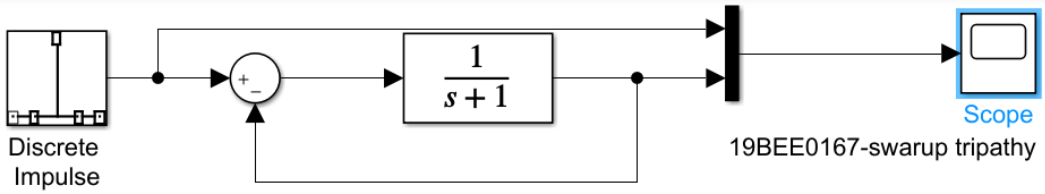


3. UNIT RAMP INPUT



4. UNIT IMPULSE INPUT


Scope
File Tools View Simulation Help
Discrete Impulse
Transfer Fcn
1
0.5
0
-0.5
-1
0.5 1 1.5 2 2.5 3 3.5 4
Ready
Sample based
T=10.000


1
s + 1
Discrete
Impulse
Scope
19BEE0167-swarup tripathy