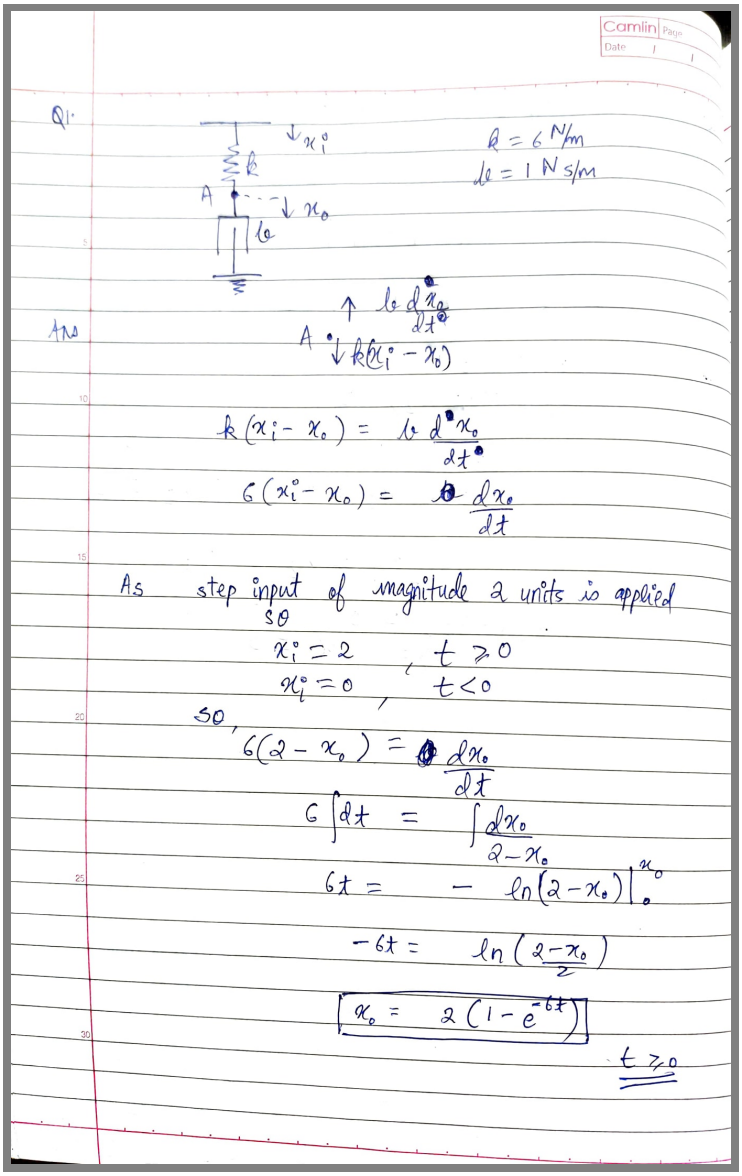
ControlSystems Lab4

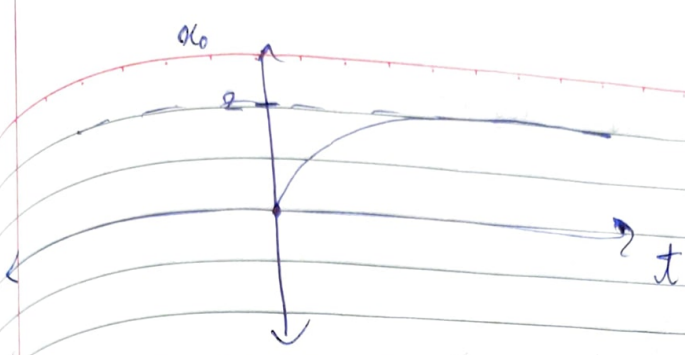
RollNo-190020021

Kushagra Khatwani

Answers-

Q1-





Time constant -

$$\tau = \frac{1}{\text{initial slope}} = \frac{1}{\frac{d}{dt}(x_o)|_{t=0}}$$

$$\tau = \frac{1}{6} \text{ sec}$$

Rise time -

$x_o(t_1) = 0.1$, $x_o(t_2) = 0.9$

$0.1 \times 2 = 2(1 - e^{-6t_1}) \Rightarrow e^{-6t_1} = 1.8$

$0.9 \times 2 = 2(1 - e^{-6t_2}) \Rightarrow e^{-6t_2} = 0.2$

$$e^{6(t_2 - t_1)} = 9$$

$$t_2 - t_1 = \frac{1}{6} \ln(9)$$

Rise time → $\boxed{t_2 - t_1 = 0.366}$

Settling time -

$x_o(T_s) = 0.98 = 1 - e^{-6T_s}$

$e^{-6T_s} = 0.02$

$$\boxed{T_s = \frac{3.91}{6} = 0.652 \text{ sec}}$$

steady state value -

$t \to \infty$

$x_0 \to 2$

so

$$\boxed{x_{S.T} = 2}$$

from ① -

$$6(x_i - x_0) = \frac{dx_0}{dt}$$

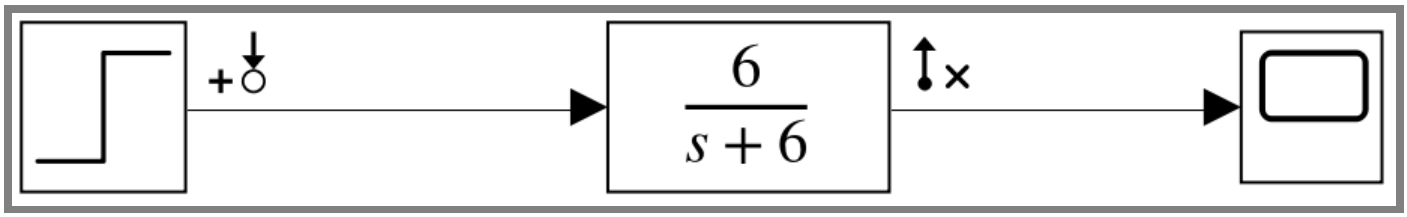
taking laplace transform -

$$6(X_i(f) - X_0(f)) = sX_0(f)$$

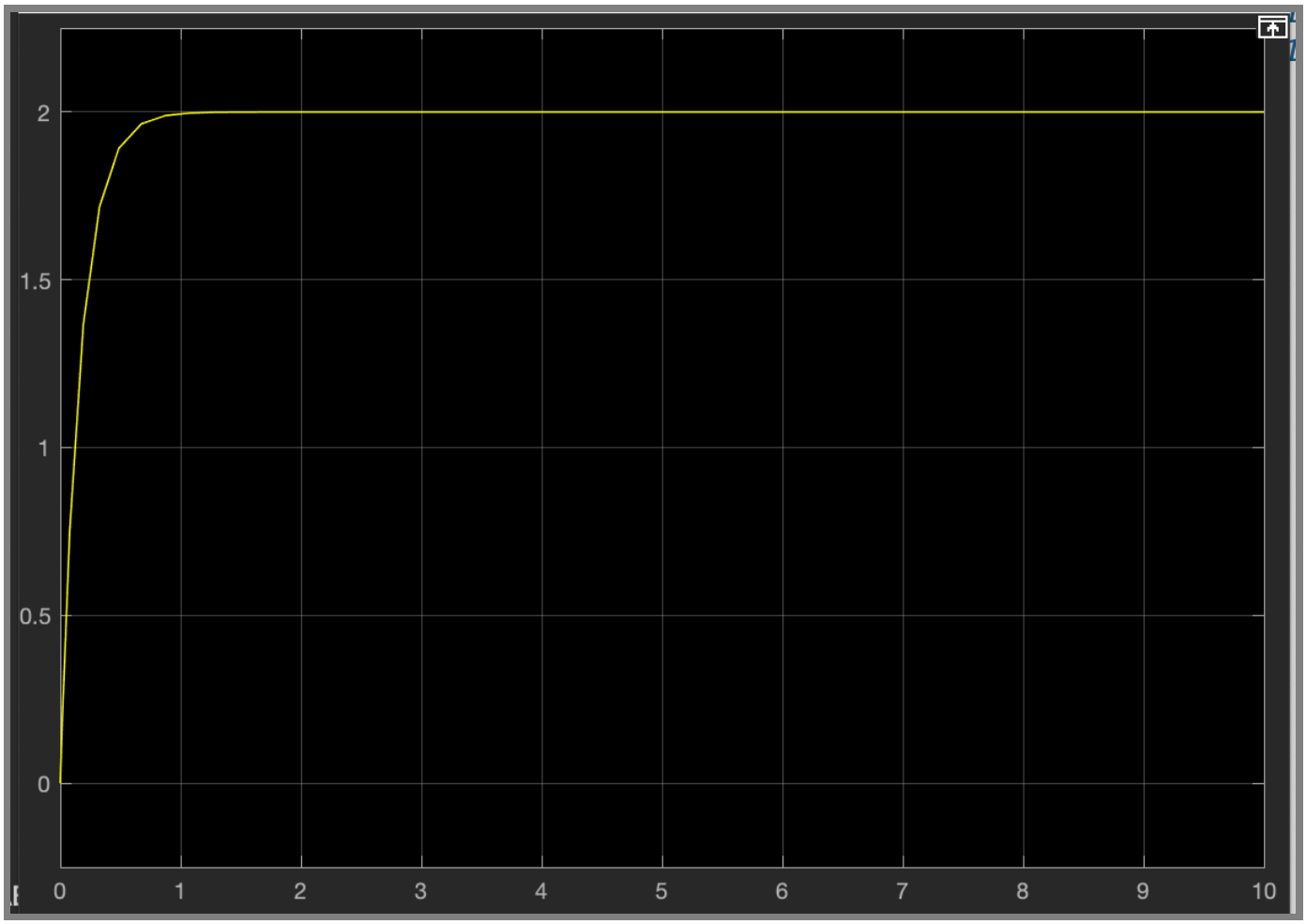
$$6X_i(f) = (s+6)X_0(f)$$

$$T(f) = \boxed{\frac{X_0(f)}{X_i(f)} = \frac{6}{s+6}}$$

Simulink Model-



Plot from scope-

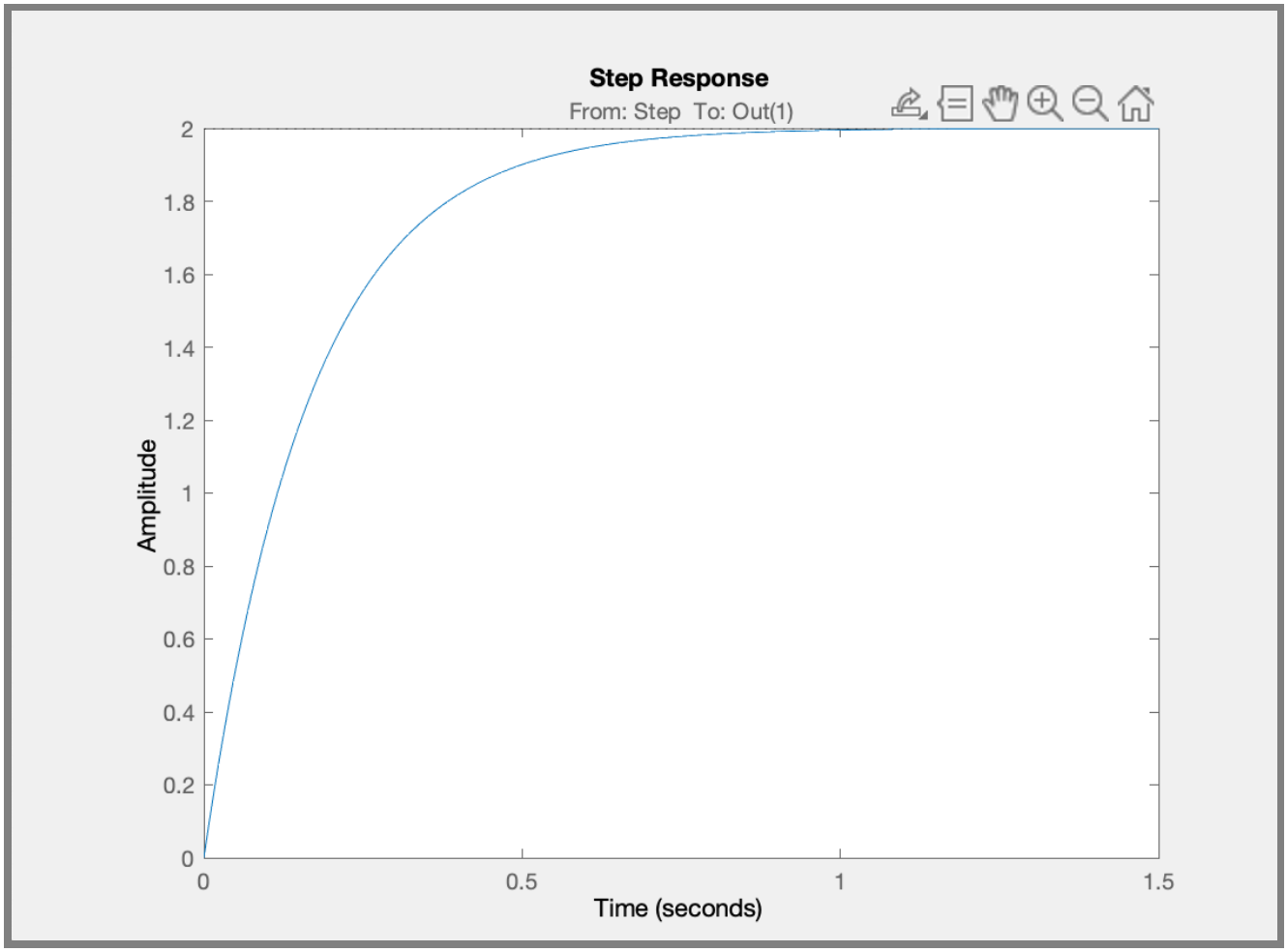


Time Domain Characterstics-

Code-

```
%% Exact linearization of the Simulink model untitled
%
% This MATLAB script is the command line equivalent of the exact
% linearization tab in linear analysis tool with current settings.
% It produces the exact same linearization results as hitting the Linearize button.

% MATLAB(R) file generated by MATLAB(R) 9.9 and Simulink Control Design (TM) 5.6.
%
% Generated on: 29-Jan-2021 15:36:52

%% Specify the model name
model = 'Lab4_Q1';

%% Specify the analysis I/Os
% Get the analysis I/Os from the model
io = getlinio(model);

%% Specify the operating point
% Use the model initial condition
op = operpoint(model);


%% Linearize the model
sys = linearize(model,io,op);

%% Plot the resulting linearization
stepinfo(2*sys)
step(2*sys)
```

Output-



Characterstics from plot-

RiseTime: 0.3662
SettlingTime: 0.6520
SettlingMin: 1.8090
SettlingMax: 1.9999
Overshoot: 0
Undershoot: 0
Peak: 1.9999
PeakTime: 1.7576
We can see that plots match and also time-domain characterstics calculated match.