Lab5-Q2

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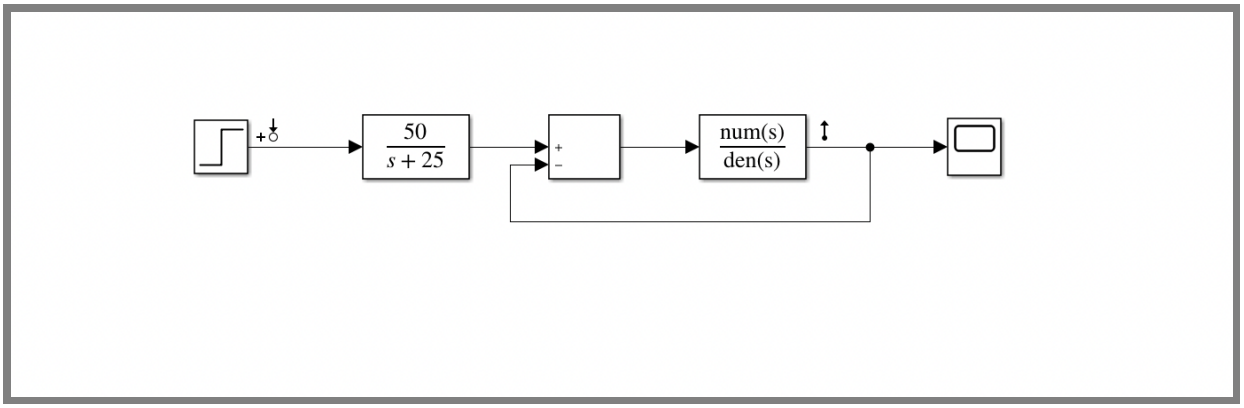
Answers-

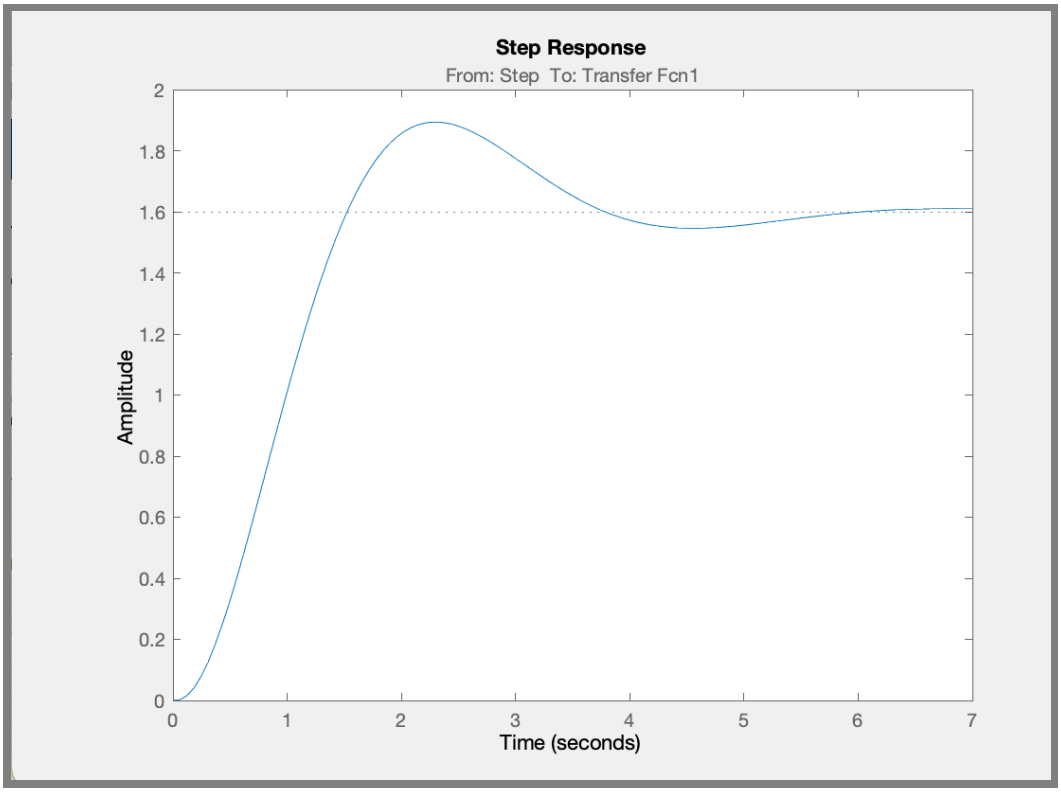
Q2

Simulink Model-



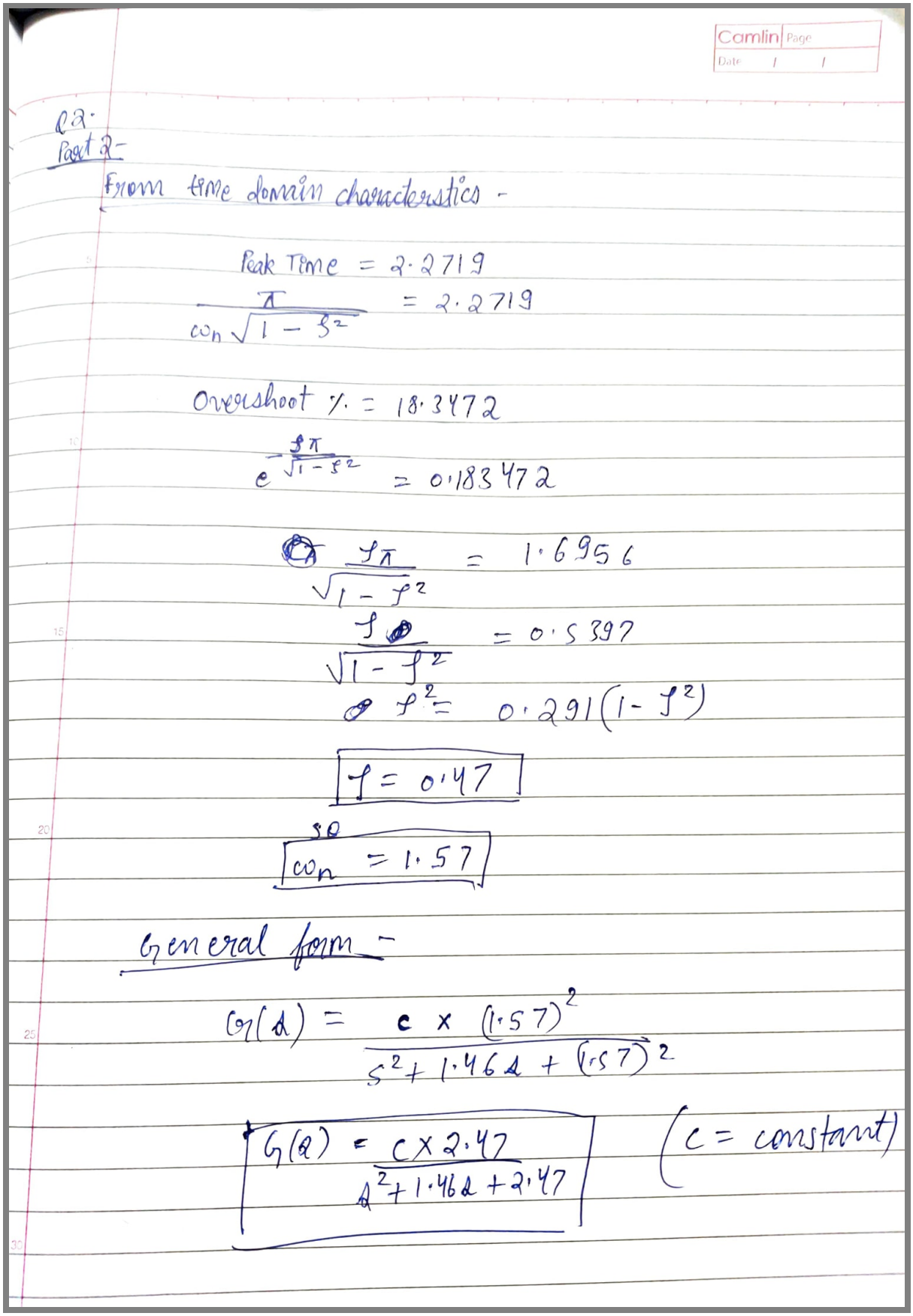
Code to get time domain characterstics and plot-

```
%% Exact linearization of the Simulink model Q2_simulink
%
% 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: 04-Feb-2021 22:27:46

%% Specify the model name
model = 'Q2_simulink';

%% 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(sys)
tf(sys)
step(sys)
```



Output-
RiseTime: 1.0092
SettlingTime: 5.2598
SettlingMin: 1.4989
SettlingMax: 1.8936
Overshoot: 18.3472
Undershoot: 0
Peak: 1.8936
PeakTime: 2.2719

Solve for transfer function using timedomain characterstics-



Q2.

Part 2-

From time domain characteristics -

$$\text{Peak Time} = 2.2719$$

$$\frac{\pi}{\omega_n \sqrt{1-\zeta^2}} = 2.2719$$

$$\text{Overshoot \%} = 18.3472$$

$$e^{\frac{\zeta\pi}{\sqrt{1-\zeta^2}}} = 0.183472$$

$$\frac{\zeta\pi}{\sqrt{1-\zeta^2}} = 1.6956$$

$$\frac{\zeta}{\sqrt{1-\zeta^2}} = 0.5397$$

$$\zeta^2 = 0.291(1-\zeta^2)$$

$$\boxed{\zeta = 0.47}$$

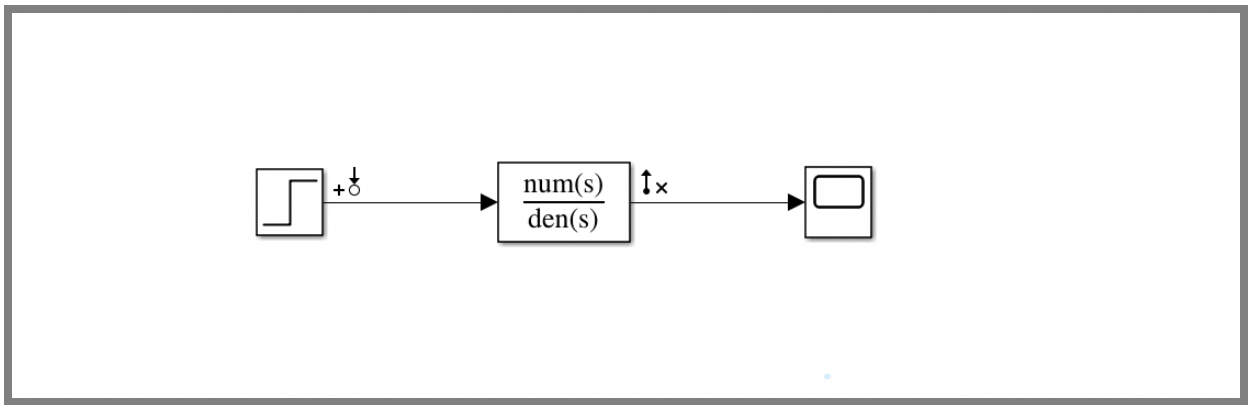
$$\boxed{\omega_n = 1.57}$$

General form -

$$G(s) = \frac{c \times (1.57)^2}{s^2 + 1.46s + (1.57)^2}$$

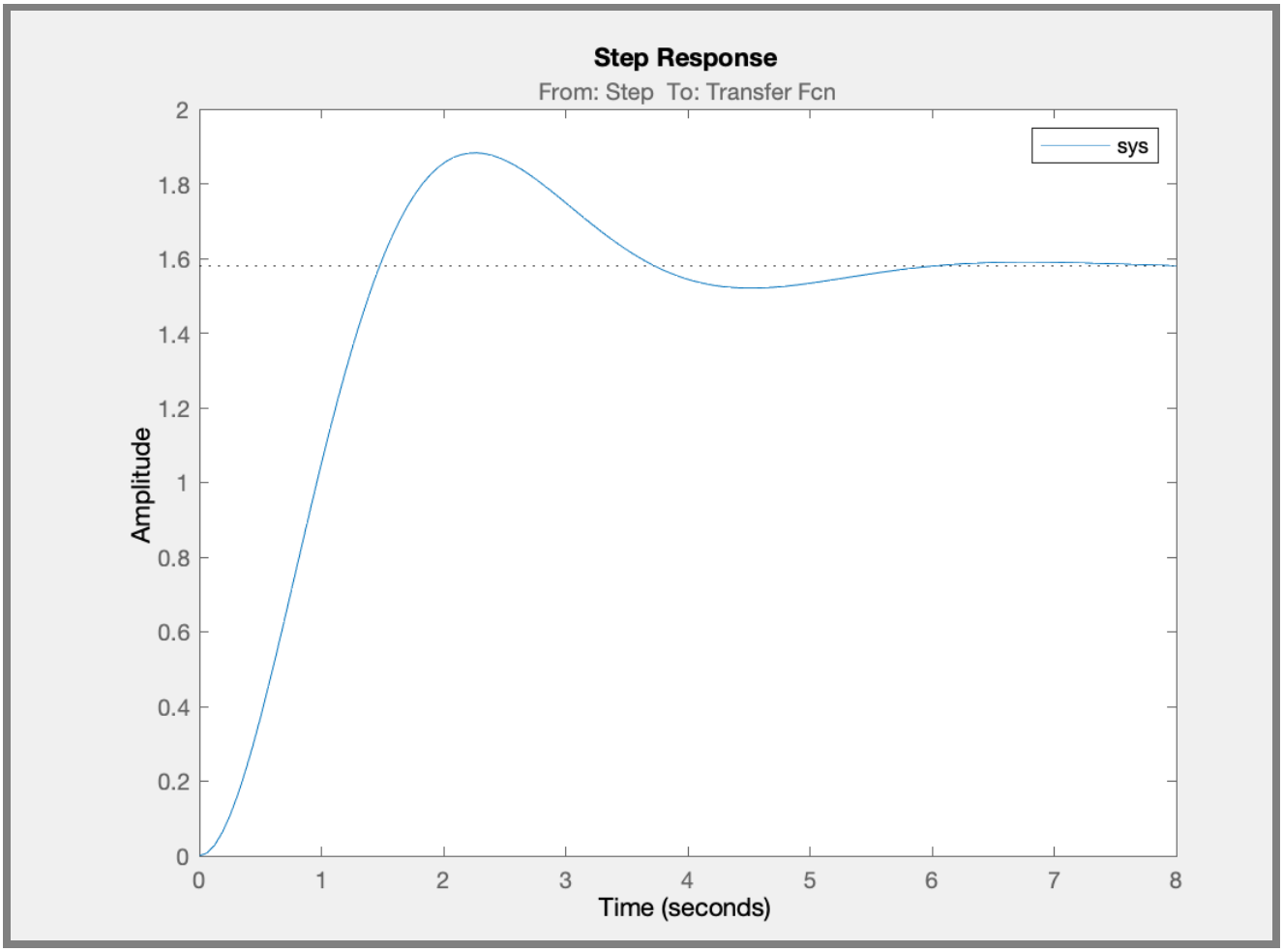
$$\boxed{G(s) = \frac{c \times 2.47}{s^2 + 1.46s + 2.47}} \quad (c = \text{constant})$$

Simlink model-



After finding the value of C using time domain characterstics of G(s)/c.

Plot-



We can see that both plots look similar hence second order approximation is valid.