Department of Electrical and Electronic Engineering Faculty of Engineering

Electrical Energy Conditioning and Control

(EEEE2045 UNUK) (FYR1 22-23)

Control Coursework

Author:
George Downing

Student Number:
20273662

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1 Aim of the Lab

2 Approach

git source Control using github full repo available report written in latex installation of matlab's control sandbox integration of matlab's scripts withing latex to produce graphs running of matlab's scripts from terminal to produce output tex files. whens matlabs script is run latex document updated with latest plots

3 Results and Discussion

3.1 Exercise 1

$$G_p(s) = \frac{a}{s+20} \tag{1}$$

$$\lim_{s \to 0} \left(G_p(s)\right) \tag{2}$$

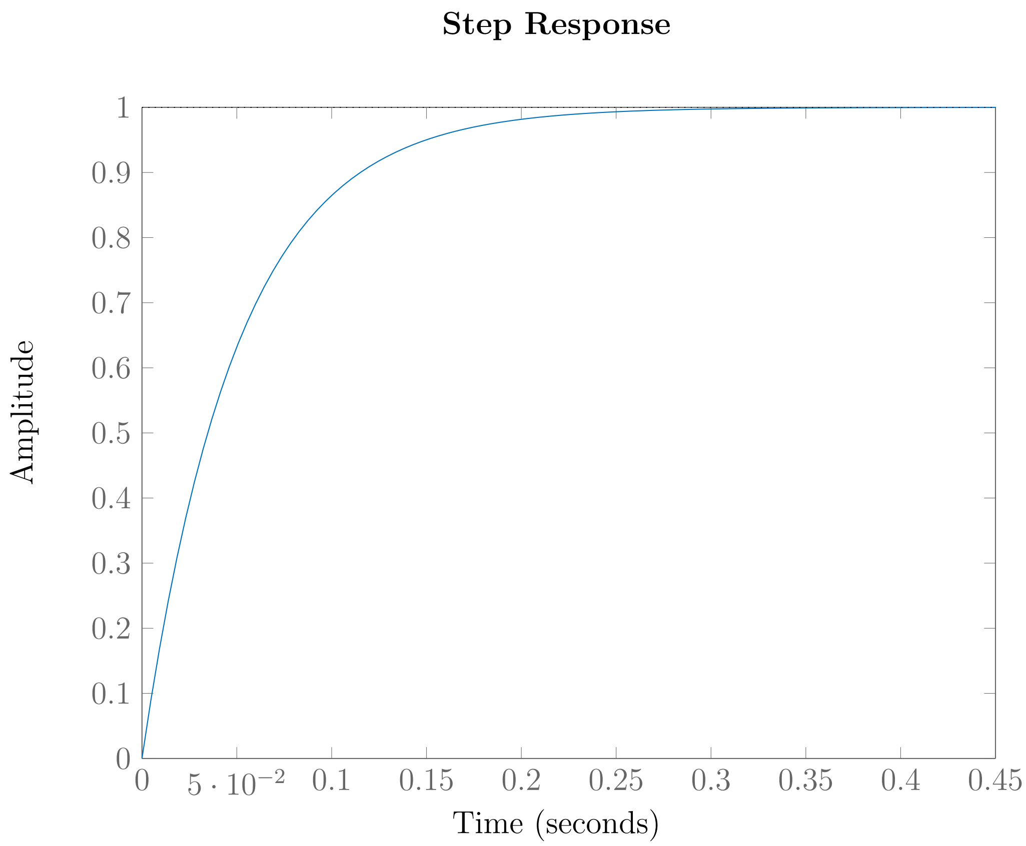

Figure 1: Graph showing step response of plant. This graph was automatically generated from code using matlab (Appendix A.1)

The plant transfer function for a simple first order system is given by (1) where a is the gain of the system and s is the Laplace variable. Steady state is achieved when s approaches 0 as described by (2). Therefore the steady state gain of the system is $a/20$.

When $a = 10$ the steady state gain is $\frac{10}{20}$ which is 0.5.

Unity gain is achieved when the gain is equal to 1 at steady state. Hence the gain of the system is equal to 1 when $a = 20$. The step response of such system is shown in Figure 1.

The time constant is the time taken for the system to reach $1 - e^{-1}$ or approximately 63.2% of its final value. The time constant is equal to the reciprocal of the denominator at steady state. Hence the time constant is equal to 0.05 at all values of a.

3.2 Exercise 2

$$G_p(s) = \frac{a}{s + a} \tag{3}$$

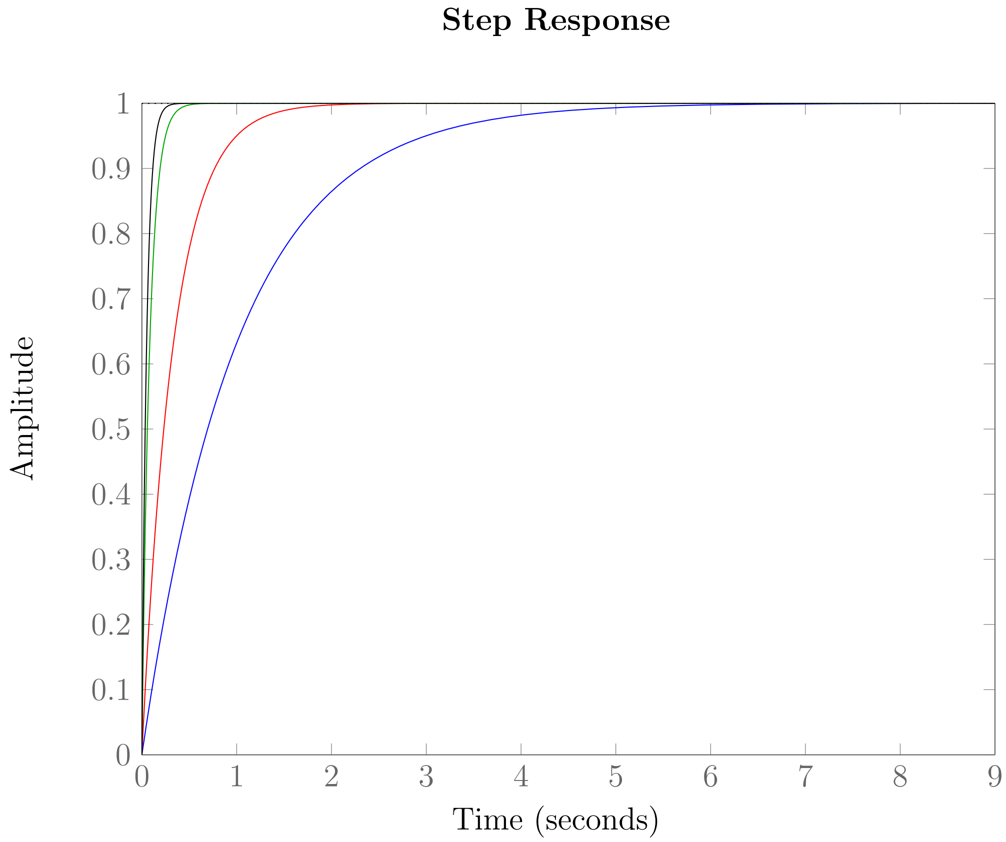

Figure 2: Graph showing step response of the transfer function shown in (3) where a = 1 (blue), 3 (red), 12 (green) and 20 (black). This graph was automatically generated from code using matlab (Appendix A.2)

a[arb]	Time Constant[s]
1	1
3	0.333
12	0.0883
20	0.05

Table 1: Table to show the time constant of the system for different values of a

Figure 2. shows the step response of the system for different values of a. The steady state gain of the system is a/a which is equal to 1 for all values of a. The time constant of the system is shown in Table 1. The time constant is equal to the reciprocal of the denominator at steady state. Hence the time constant is equal to $1/a$ at all values of a.

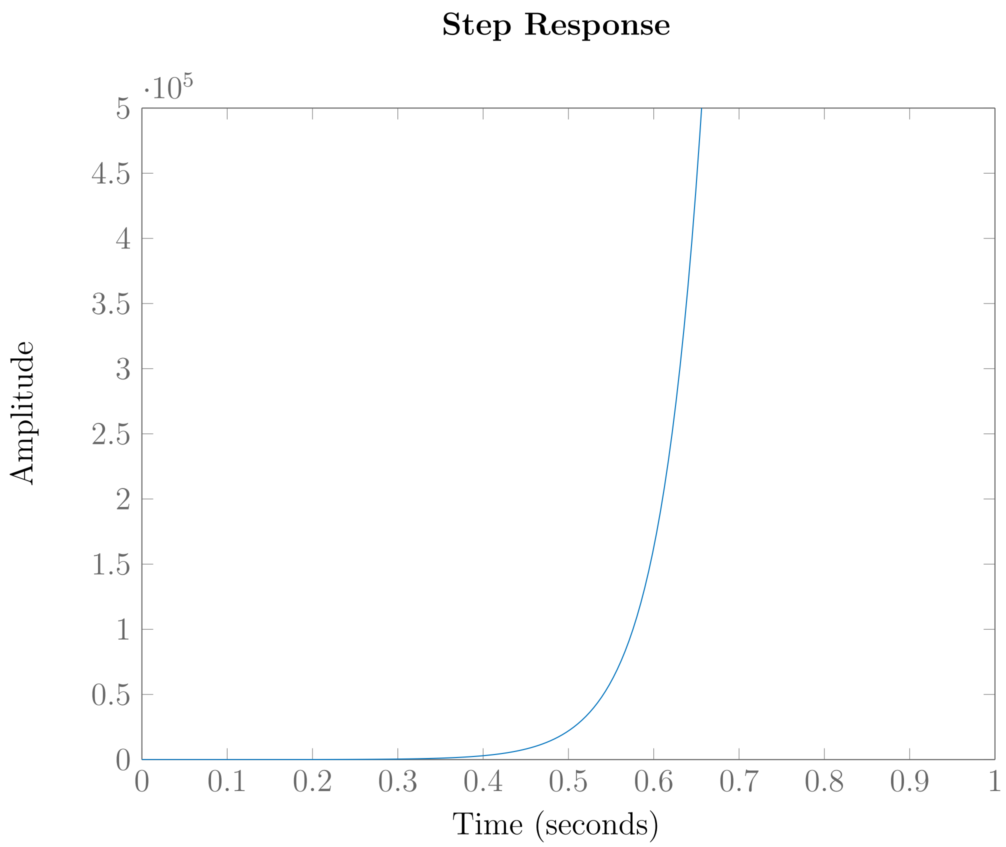

Figure 3: Graph showing the step response of the transfer function shown in (4).This graph was automatically generated from code using matlab (Appendix A.2)

$$G_p(s) = \frac{a}{s-a} \tag{4}$$

Figure 3. shows the step response of the transfer function shown in (4). where the plant has a positive pole the system is unstable and will not converge to a steady state. the rate of change of the system is increasing and will continue to increase until the system is destroyed.

3.3 Exercise 3

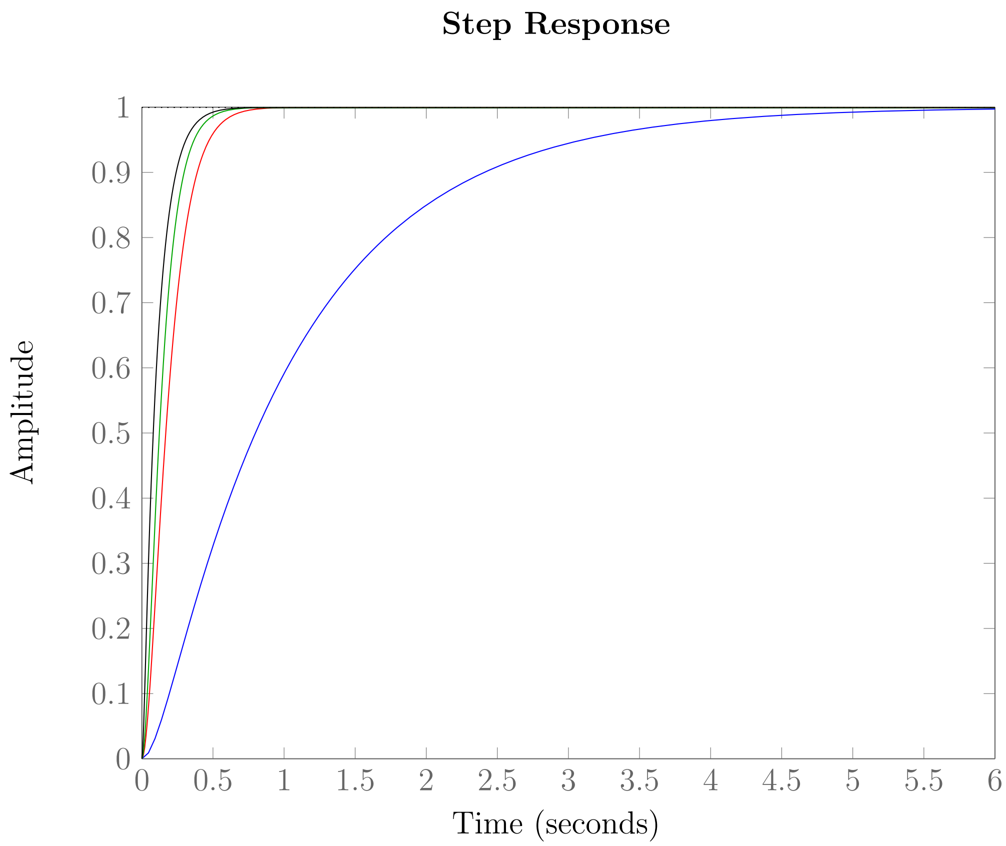

Figure 4: This graph was automatically generated from code using matlab (Appendix A.3)

3.4 Exercise 4a

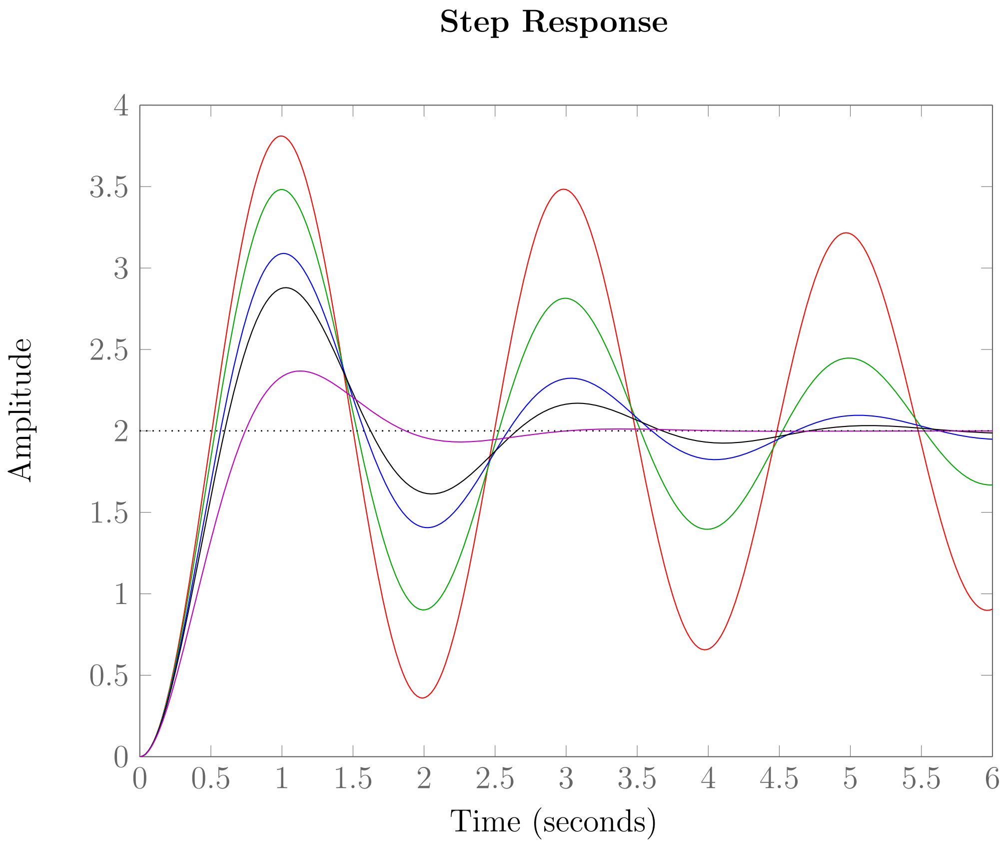

Figure 5: This graph was automatically generated from code using matlab (Appendix A.4)

3.5 Exercise 4b

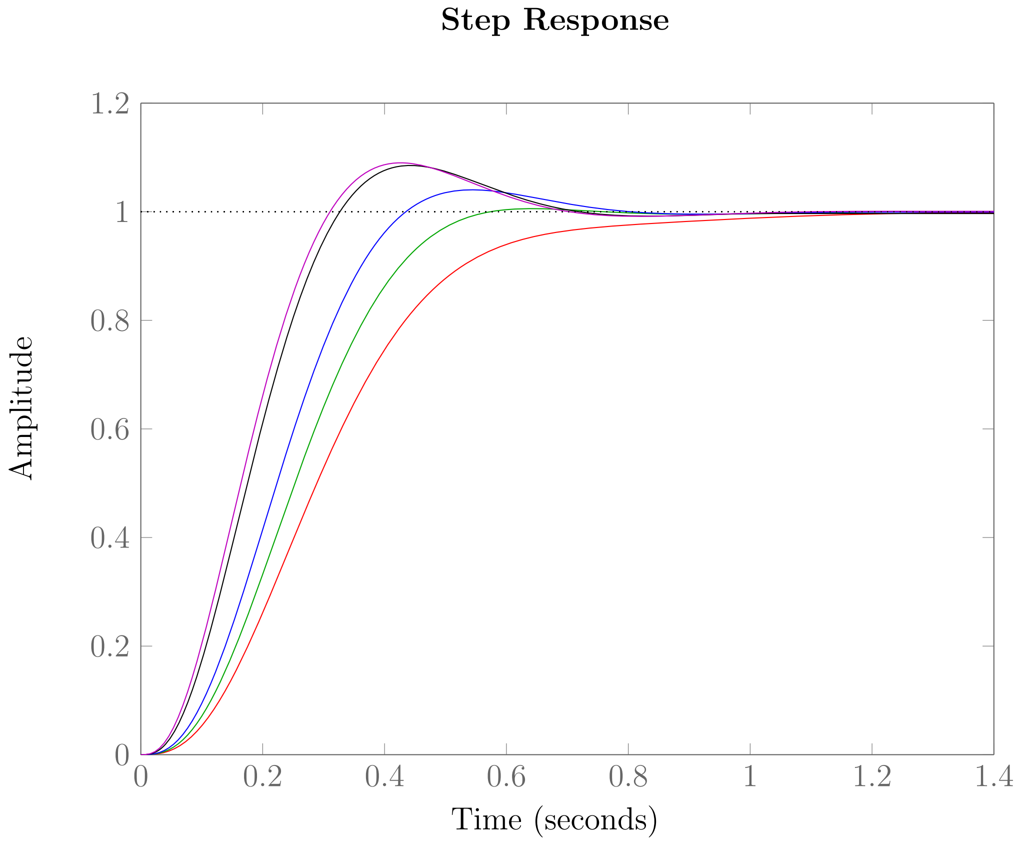

Figure 6: This graph was automatically generated from code using matlab (Appendix A.5)

3.6 Exercise 5

4 Design Questions and Solutions

5 Summary and Conclusions

References

Appendices

A Matlab Code

A.1 Ex1: (3.1)

```
Gp=tf([20],[1 20]) % plant transfer function
step(Gp) % Plot the unity step response

cleanfigure %cleanfigure
matlab2tikz('Output/ex1.tex'); % convert to tex
```

A.2 Ex2: (3.2)

```
figure; %new figure
hold on;

Gp=tf([1],[1 1])% plant transfer function
step(Gp,'b')     % Plot the unity step response

Gp=tf([3],[1 3])% plant transfer function
step(Gp,'r')     % Plot the unity step response

Gp=tf([12],[1 12])  % plant transfer function
step(Gp,'g')        % Plot the unity step response

Gp=tf([20],[1 20])  % plant transfer function
step(Gp,'k')        % Plot the unity step response

cleanfigure;     %clean figure
matlab2tikz('Output/ex2.tex'); %convert to tex

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

figure; %new figure

Gp=tf([20],[1 -20]) % plant transfer function
step(Gp)            % Plot the unity step response

axis([0 1 0 500000]);    % change axis

cleanfigure;     %clean figure
```

```
matlab2tikz('Output/ex2_2.tex'); %convert to tex
```

A.3 Ex3: (3.3)

```
figure; % new figure
hold on;

PlotPlantResponse(1,'b'); %plot response of dampend plant
PlotPlantResponse(10,'r'); %plot response of dampend plant
PlotPlantResponse(20,'g'); %plot response of dampend plant
PlotPlantResponse(100,'k'); %plot response of dampend plant


cleanfigure % clean figure
matlab2tikz('Output/ex3.tex');  % convert to tex

function [] = PlotPlantResponse(a,colour)
    Gp=tf([10],[1 10])
    Temp=tf([a], [1 a]) % this is a/(s+a) for a=1
    G=Gp*Temp % Multiply them both together
    step(G,colour) % Plot the unity step response
end
```

A.4 Ex4a: (3.4)

```
figure; % new figure
hold on;

PlotPlantResponse(0.2,'r'); %plot response of dampend plant
PlotPlantResponse(0.6,'g'); %plot response of dampend plant
PlotPlantResponse(1.2,'b'); %plot response of dampend plant
PlotPlantResponse(1.6,'k'); %plot response of dampend plant
PlotPlantResponse(3.0,'m'); %plot response of dampend plant

cleanfigure %cleanfigure
matlab2tikz('Output/ex4a.tex'); %convert to tex

function [] = PlotPlantResponse(a,colour)
time=0:0.01:6;
Gp=tf([20],[1 a, 10]); % plant transfer function
step(Gp, time, colour); % Plot the unity step response
```

```
end
```

A.5 Ex4b: (3.5)

```
figure; % new figure
hold on;

PlotPlantResponse(5,'r'); %plot response of dampend plant
PlotPlantResponse(7,'g'); %plot response of dampend plant
PlotPlantResponse(10,'b'); %plot response of dampend plant
PlotPlantResponse(25,'k'); %plot response of dampend plant
PlotPlantResponse(35,'m'); %plot response of dampend plant

cleanfigure % clean figure
matlab2tikz('Output/ex4b.tex');  % convert to tex

function [] = PlotPlantResponse(a,colour)
    Gp = tf([100],[1 12 100]);
    Temp=tf([a], [1 a]) % this is a/(s+a) for a=1
    G=Gp*Temp % Multiply them both together
    step(G,colour); % Plot the unity step response
end
```