

LEVEL 5 ASSESSMENT SPECIFICATION

Student name:	George Bellmaine	Student ID number:	
Programme:	HND/HNC Electrical/Electronic Engineering, HNC Instrumentation Engineering & HNC Power System Engineering		
Module:	Electrical Principles, Methods and Simulation		
Module code:	PSDE5009	Contribution to Overall Module Assessment (%):	50%
Lecturer:	Jason Pointer	Internal Verifier:	Steve Roberts
Assignment Title:	Control Systems	Word count (or equivalent):	2000
Submission deadline:	16/05/19	Return date of provisional marks & written feedback:	
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

1. Analyse and evaluate electrical circuits, electronic systems and **control systems**.
2. Simulate standard electrical circuits, electronic systems and **control systems**.

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills	0	0
2. Knowledge and Understanding Skills	30	14.8
Achieved 40% for Task 1. Achieved 70% for Task 2. Achieved 48% for Task 3. Achieved 45% for Task 4. Achieved 44% for Task 5. Knowledge is reasonably detailed and accurate in most parts. Show some good understanding of some concepts and principles covered by this assignment but not all of the elements were covered for some of the task.		
3. Cognitive and Intellectual Skills	10	0
Have made no attempt to comment upon the results in the required tasks.		
4. Practical Application Skills	50	25.5
Achieved 45% for Task 1. Achieved 75% for Task 2. Achieved 55% for Task 3. Achieved 40% for Task 4. Achieved 40% for Task 5. A good and appropriate application of established methods in the use of Matlab, Multisim and Simulink but in places not all of the required work was produced.		
5. Transferable Skills for Life and Professional Practice	10	4.5
Mostly ordered presentation and structure but in places does lack some coherence. Must state the requirements of all tasks.		

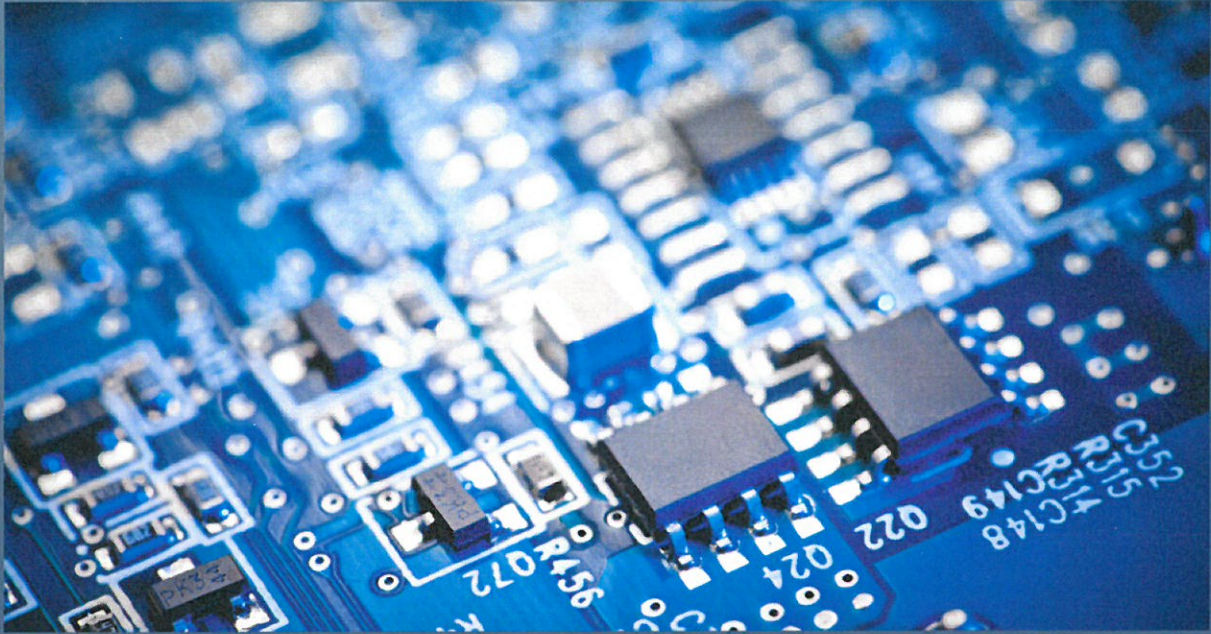
Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to 1 week late (40% Max)

Over 1 week late (0%)

45%



ASSIGNMENT 2

ELECTRICAL PRINCIPLES, METHODS AND SIMULATION

HNC - INSTRUMENTATION AND CONTROL, YEAR 2
GEORGE BELLMAINE

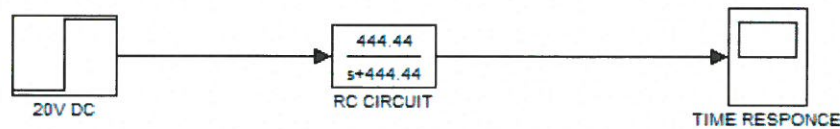
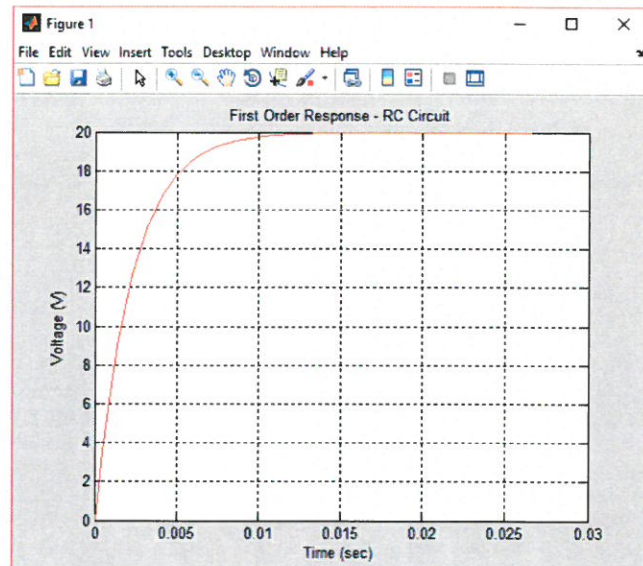
Task 1

- You have not derive the equation.*
- This shows the similarity between the MatLab and the Simulink on the plot although they look slightly different this is due to the time scale.

```

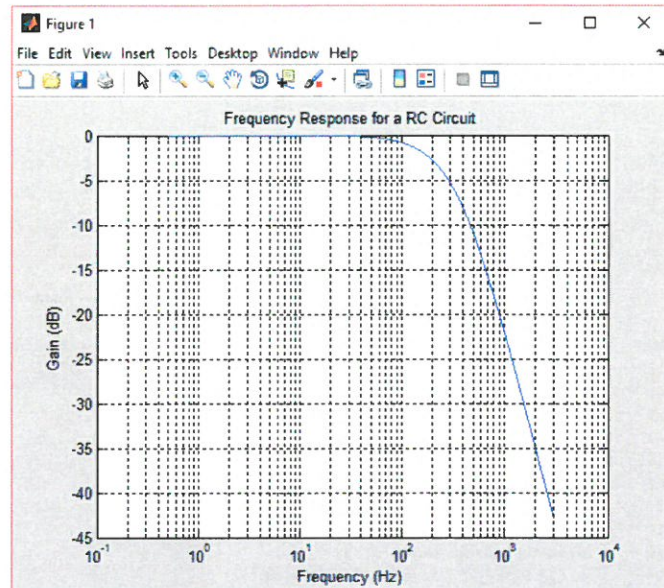
1 %George Bellmaine ass 2 task 1
2
3 % First order response of a RC circuit.
4
5 % Set value for Resistor, capacitor and voltage
6 R = 1.5*10^3; C = 1.5*10^-6; V = 20;
7
8 Tc=R*C; % Calculate time constant
9 t=0; % Set initial conditions
10 Vout=0;
11
12 % Determine the output voltage for value of time, t.
13 for k=1:60
14 t(k)=(k-1)*Tc/5;
15 Vout(k)=V*(1-exp(-t(k)/Tc));
16 end;
17
18 % Display the Vout against time
19 plot(t,Vout,'r-');
20 title('First Order Response - RC Circuit')
21 xlabel('Time (sec)')
22 ylabel('Voltage (V)')
23 grid
24

```



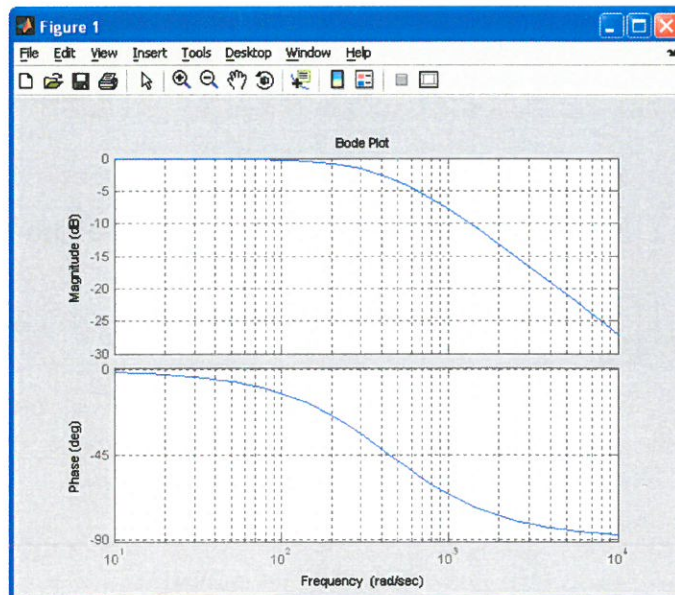
c. This print screen shows the frequency response when a sin wave is applied.

```
1 % George Bellmaine Task 1c
2 R = 1.5*10^3; C = 1.5*10^-6;
3 f=0; % initial conditions
4
5 % Time constant
6 Tc=R*C;
7
8 fx=0:0.5:3000;
9 z=length(fx);
10 % For loop
11 for x=1:z
12     f=f+0.1;
13
14     % Angular velocity
15     w(x)=2*pi*f;
16
17     % Time response
18     G(x)=20*log(1/(sqrt(1+w(x)^2*Tc^2)));
19 end
20
21 % The frequency Response
22 semilogx(fx,G)
23 xlabel('Frequency (Hz)')
24 ylabel('Gain (dB)')
25 title('Frequency Response for a RC Circuit')
26 grid
27
```



d. The print screen shows the bode plot in MatLab.

```
1 %George bellmaine task 1d
2 % Producing frequency response using Bode Plot
3
4 % Create Transfer Function
5 G=tf([1],[0.00225,1]);
6
7 % Bode Plot
8 bode(G)
9 grid
10 title('Bode Plot')
```



Need to compare this with Multisim results using the Bode plotter.

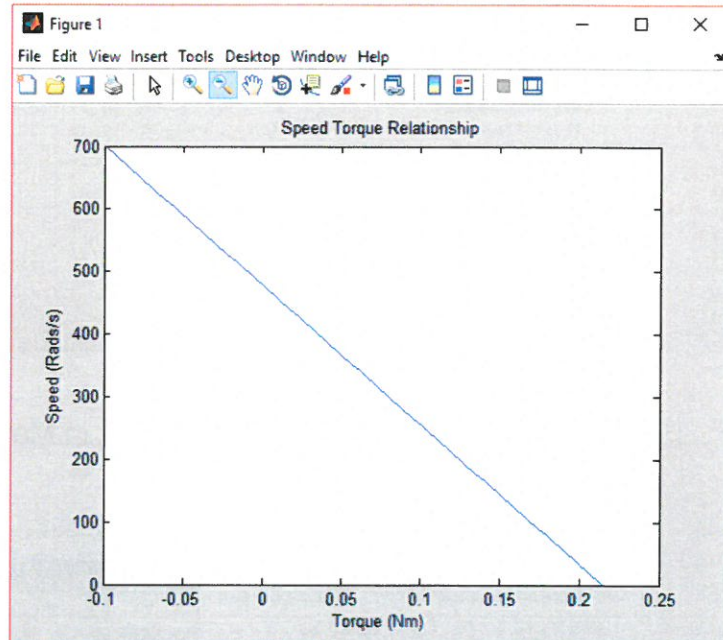
Task 2

a. This shows the torque to speed plotted on MatLab.

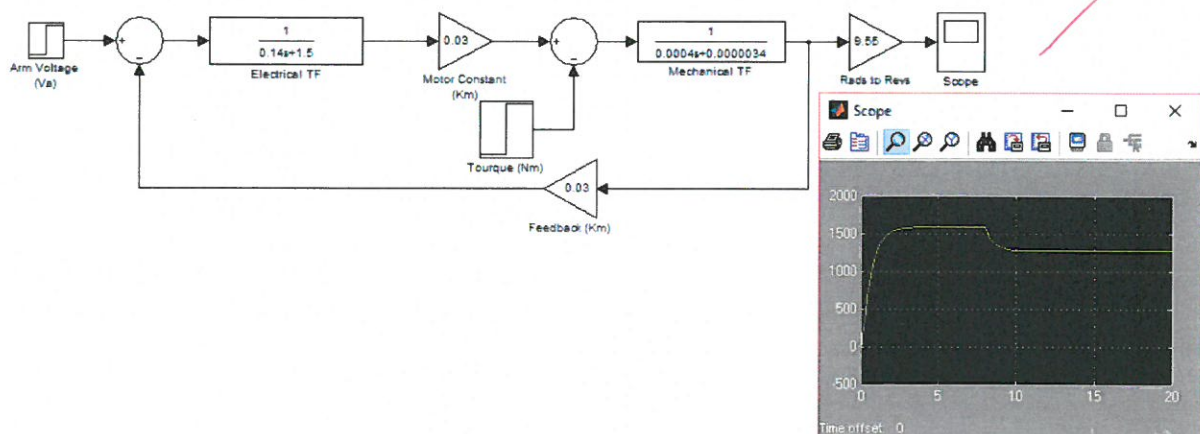
```

1 % George Bellmaine Task 2
2 % DC Motor Calculation
3 Ra=1.4; Va=12; Ts=0.215; % Motor parameters
4
5 km=(Ts*Ra)/Va; % Calculation of Motor constant
6
7 % Max Speed
8 MaxW=Va/km;
9
10 % Speed Range
11 W=0:2:700;
12 T=km*(Va-km*W)/Ra;
13
14 % Display of results
15 disp('The Motor Constant, km')
16 disp(km)
17 plot(T,W,'b-')
18 xlabel('Torque (Nm)')
19 ylabel('Speed (Rads/s)')
20 title('Speed Torque Relationship')
21

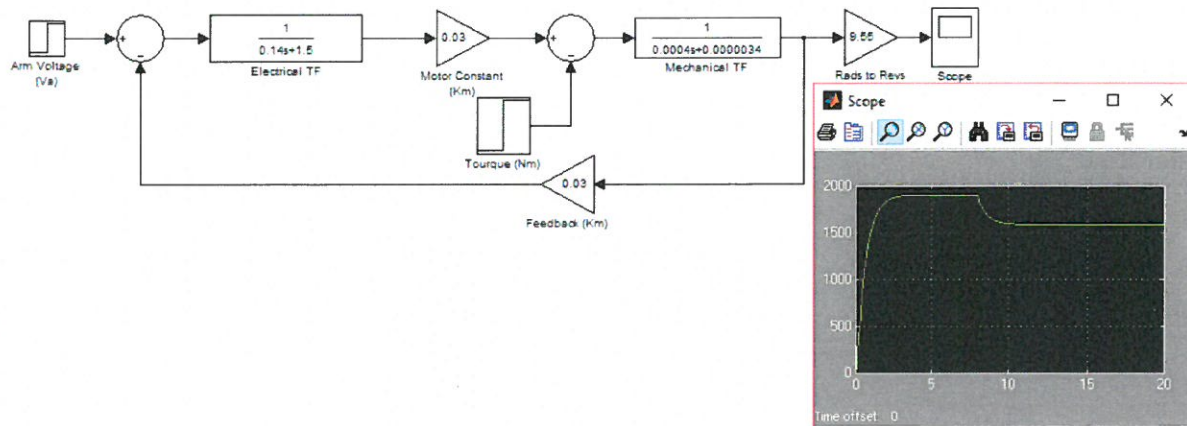
```



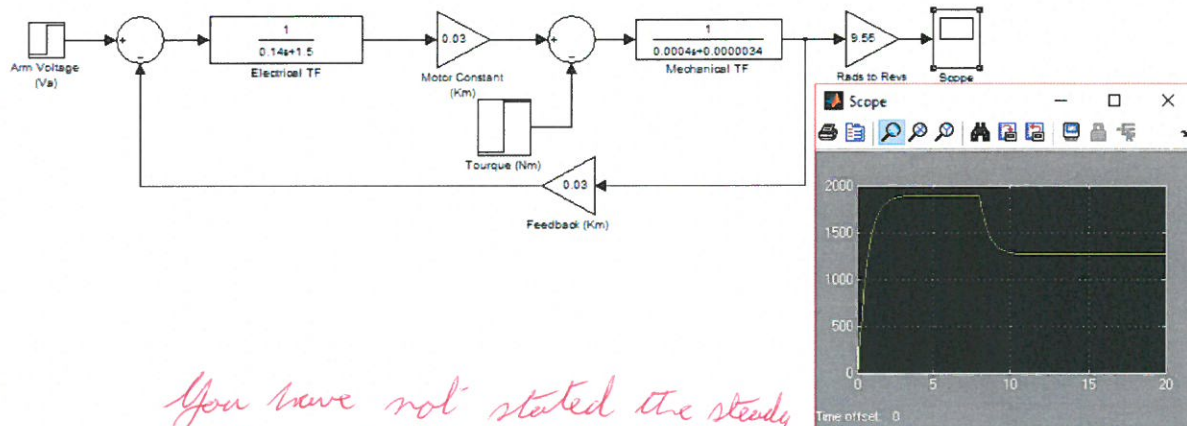
b. This shows the Simulink with plot of the speed of the motor (Part C).



d. 0.02Nm



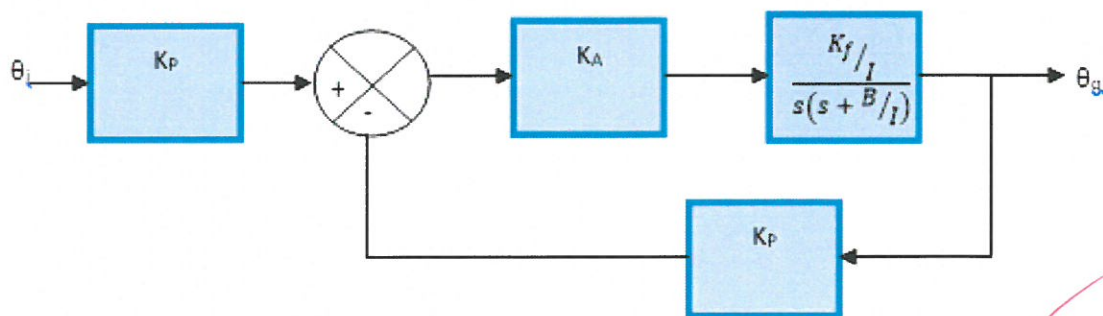
0.04Nm



You have not stated the steady state value for speed.

Task 3

a.



b. Standard equation for negative feedback system. $\frac{\theta_o}{\theta_i} = \frac{G(s)}{1+G(s)H(s)}$

$$G(s) = K_A \times \frac{K_f/I}{s(s + B/I)}$$

$$H(s) = K_P$$

Transfer function

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{K_P \times \frac{K_A K_F/I}{s(s + B/I)}}{1 + K_P \times \frac{K_A K_F/I}{s(s + B/I)}}$$

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{\frac{K_P K_A K_F/I}{s^2 + Bs/I}}{1 + \frac{K_P K_A K_F/I}{s^2 + Bs/I}}$$

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{\frac{(s^2 + Bs/I) \times K_P K_A K_F/I}{s^2 + Bs/I}}{(s^2 + Bs/I) \times 1 + \frac{(s^2 + Bs/I) \times K_P K_A K_F/I}{s^2 + Bs/I}}$$

$$= \frac{\frac{K_P K_A K_F}{I}}{s^2 + \frac{Bs}{I} + \frac{K_P K_A K_F}{I}}$$

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{\frac{K_P K_A K_F}{I}}{s^2 + \frac{Bs}{I} + \frac{K_P K_A K_F}{I}}$$

C.

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{\frac{K_P K_A K_F}{I}}{s^2 + \frac{Bs}{I} + \frac{K_P K_A K_F}{I}}$$

$$\frac{\theta_o(s)}{\theta_i(s)} = k_{ss} \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{\frac{5 \times 1 \times 8 \times 10^{-3}}{2 \times 10^{-4}}}{s^2 + \frac{Bs}{2 \times 10^{-4}} + \frac{5 \times 1 \times 8 \times 10^{-3}}{2 \times 10^{-4}}} = \frac{200}{s^2 + 5000Bs + 200}$$

$$\omega_n^2 = 200$$

So Steady state value = $k_{ss} = 1$

$$\text{Natural frequency} = \omega_n = \sqrt{200} = 14.14 \text{ rad/sec}$$

$$2\zeta\omega_n = 5000B$$

for critically damping $\zeta = 1$

$$\text{So } 2 \times 1 \times 14.14 = 5000B$$

$$B = \frac{28.28}{5000} = 5.656 \times 10^{-3} \text{ N/ms}^{-1}$$

To determine the poles for critically damped

$$(s^2 + 2\omega_n s + \omega_n^2) = 0$$

$$s = -\omega_n, -\omega_n = -14.14$$

No damping = make the $B=0$

Under damped = between 0 and 5.656,

$$B = 2.5 \times 10^{-3}$$

$$B/I = 2.5 \times 10^{-3} / 2 \times 10^{-4} = 12.5$$

Over damped = Over 5.656,

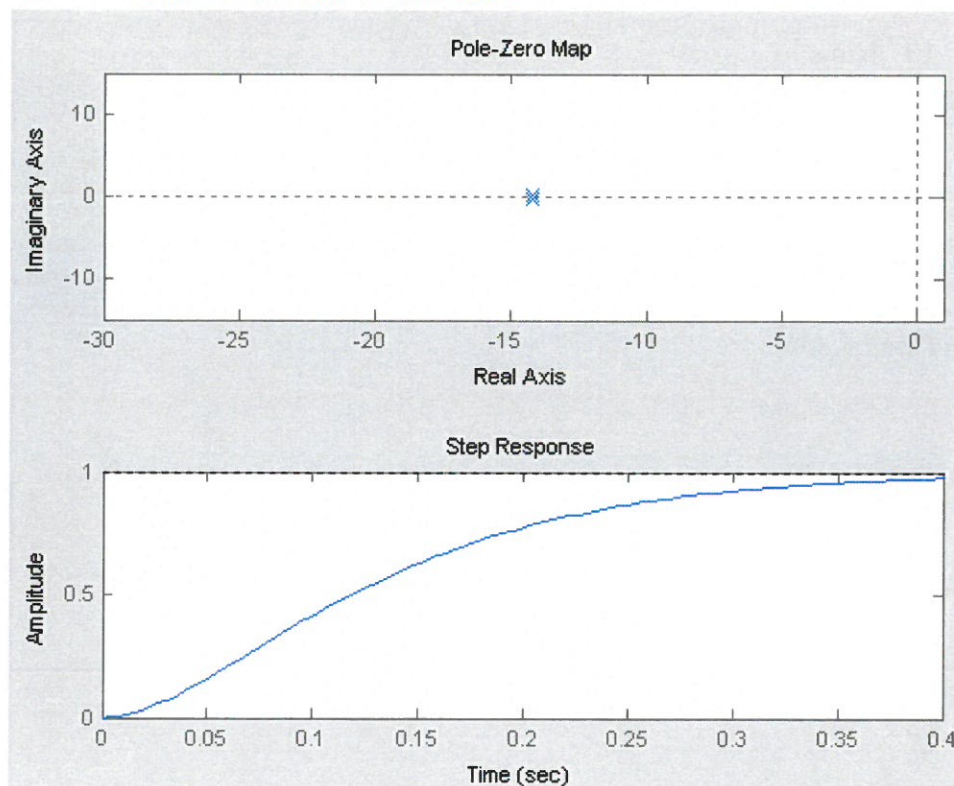
$$B = 15 \times 10^{-3}$$

$$B/I = 15 \times 10^{-3} / 2 \times 10^{-4} = 75$$

```

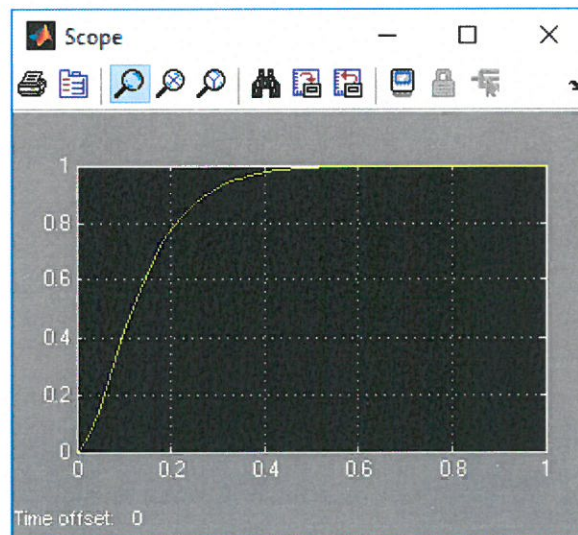
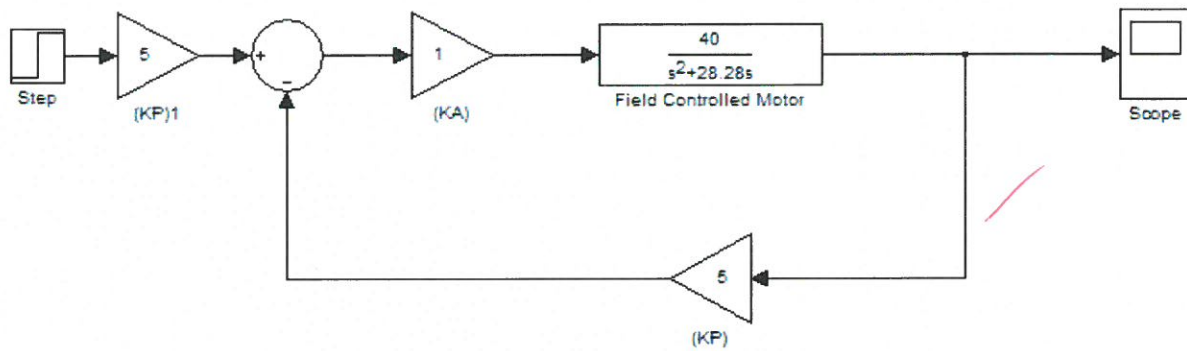
1  % George Bellmaine task 3
2
3  % Create the numerator
4 - num=[200];
5
6  % Create the denominator
7 - den=[1 28.28 200];
8
9  % Transfer Function
10 - sys=tf(num,den)
11
12 % Poles
13 - pole(sys)
14
15 % Plotting the Poles
16 - subplot(211), pzmap(sys)
17 - axis([-30 1 -15 15])
18
19 % Plotting the response for an unit step
20 - subplot(212), step(sys)

```



The screen shots and calculations show how I got the correct values for my MatLab which worked perfectly because it shows the plot.

d.



The response in MatLab is slightly different to the result in Simulink due to the scale on the graph but they are Identical at 0.4.

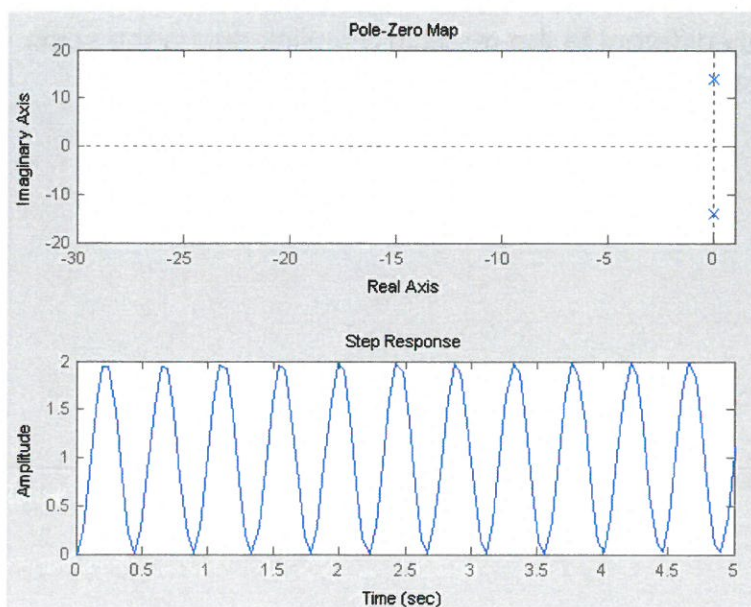
e. The equation for this task is

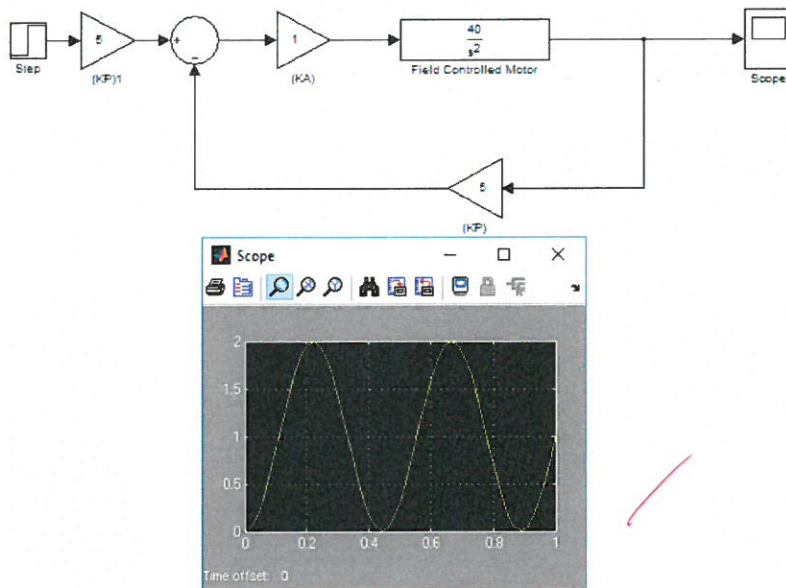
```

1      % George Bellmaine task 3
2
3      B=input('enter friction,B')
4      %calculate B/I
5      GB= B/(2*10^-4);
6
7      % Create the numerator
8      num=[200];
9
10     % Create the denominator
11     den=[1 GB 200];
12
13     % Transfer Function
14     sys=tf(num,den)
15
16     % Poles
17     pole(sys)
18
19     % Plotting the Poles
20     subplot(211), pzmap(sys)
21     axis([-100 1 -20 20])
22
23     % Plotting the response for an unit step
24     subplot(212), step(sys)

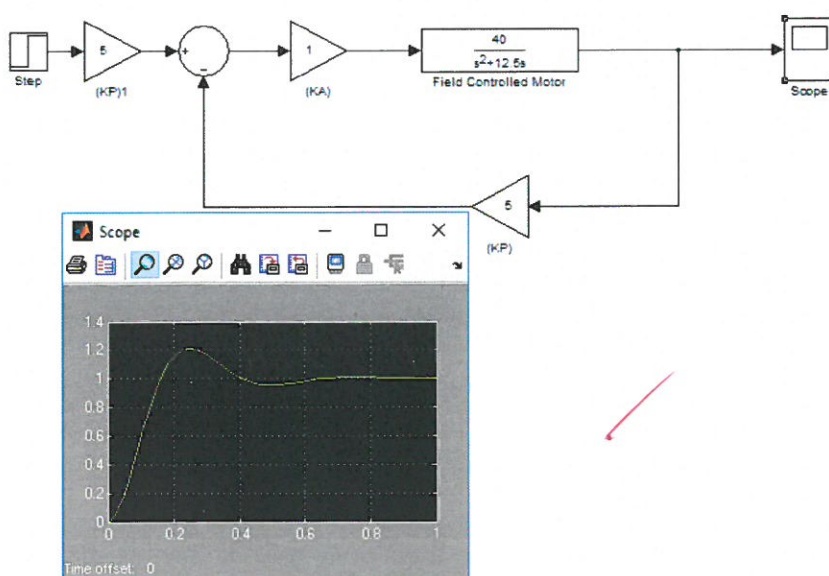
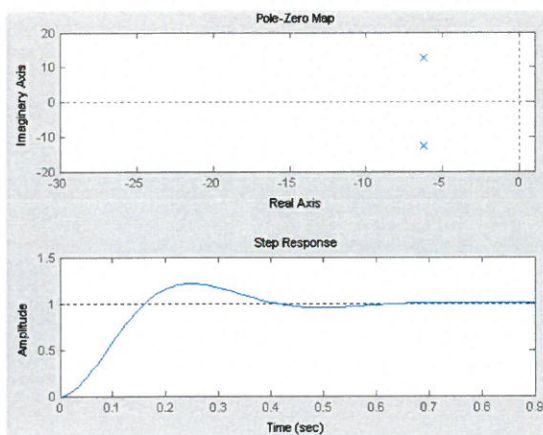
```

No damping results

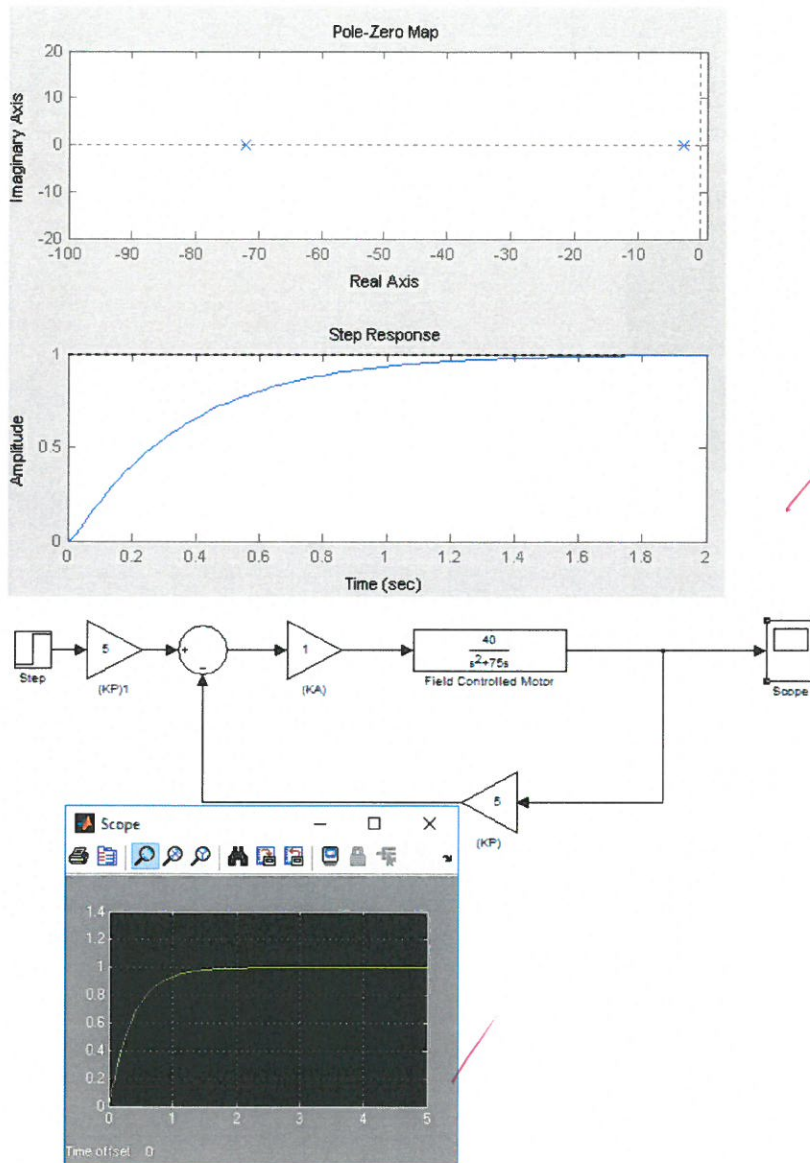




Under damped

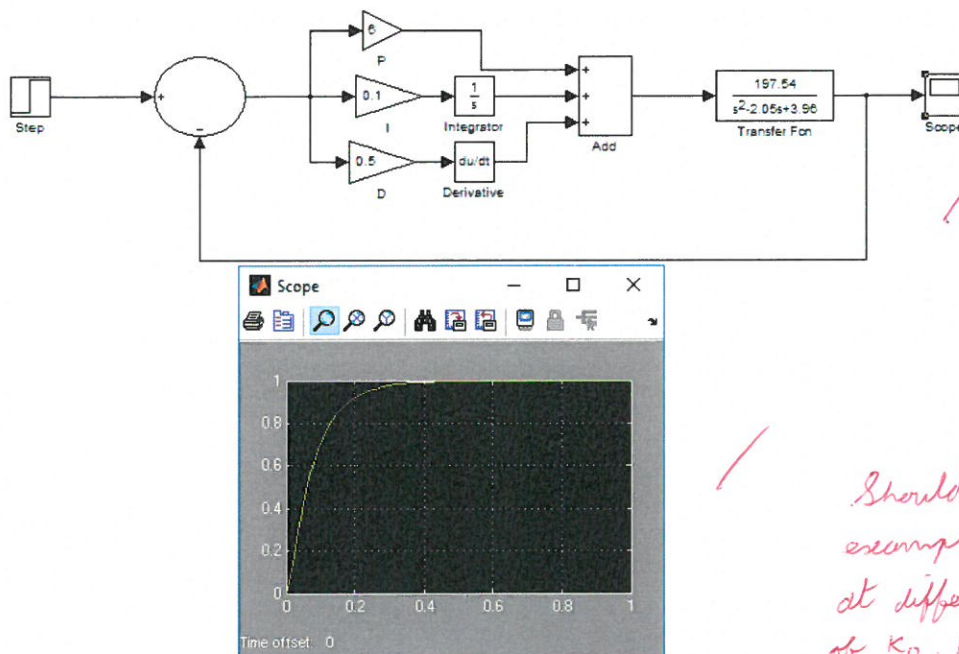


Over damped



Have not modified the program to calculate Rise time, Peak time, overshoot and settling time.
 Also have not investigated the proportional controller.

Task 4



Should included more examples of turning at different values of K_P , K_D and K_I .

Task 4 shows my PID control with the parameters at the correct rate so that it hits the max before 1 second and is less than 0.18 seconds.

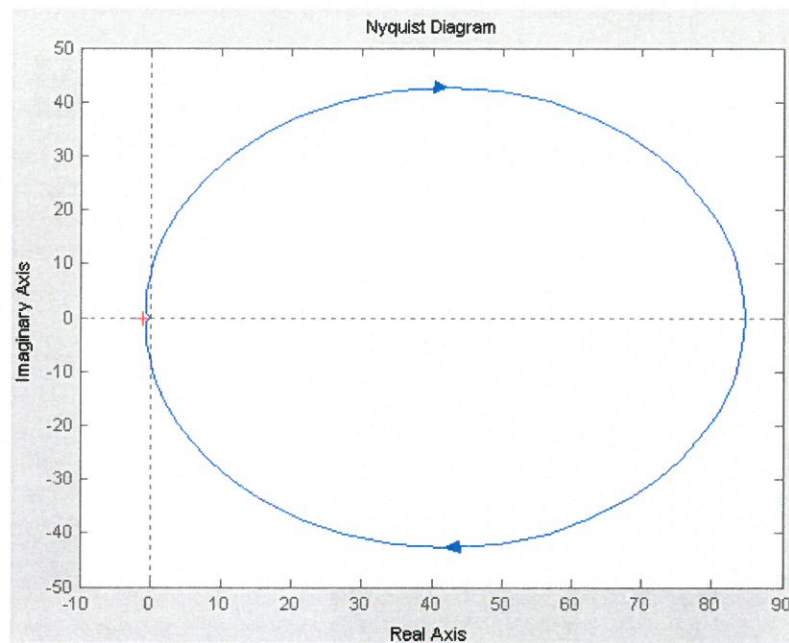
Task 5

$$a) G_c(s) = \frac{0.03868s^3 - 5.369s^2 - 97.34s + 13450}{s^3 + 169.8s^2 + 1730s + 159 + 0.03868s^3 - 5.369s^2 - 97.34s + 13450}$$

$$G_c(s) = \frac{0.03868s^3 - 5.369s^2 - 97.34s + 13450}{1.03868s^3 + 164.431s^2 + 1632.66s + 13609}$$

above are the equations I used to add into my MatLab code.

```
1 %George Bellmaine ASS 2 task 5 pt1
2
3 - num=[0.03868 -5.369 -97.34 13450];
4 - den=[1 169.8 1730 159];
5
6 - CRIG=tf([num],[den]) % Create the transfer function
7
8 - nyquist(CRIG) % Plot the Nyquist response
```

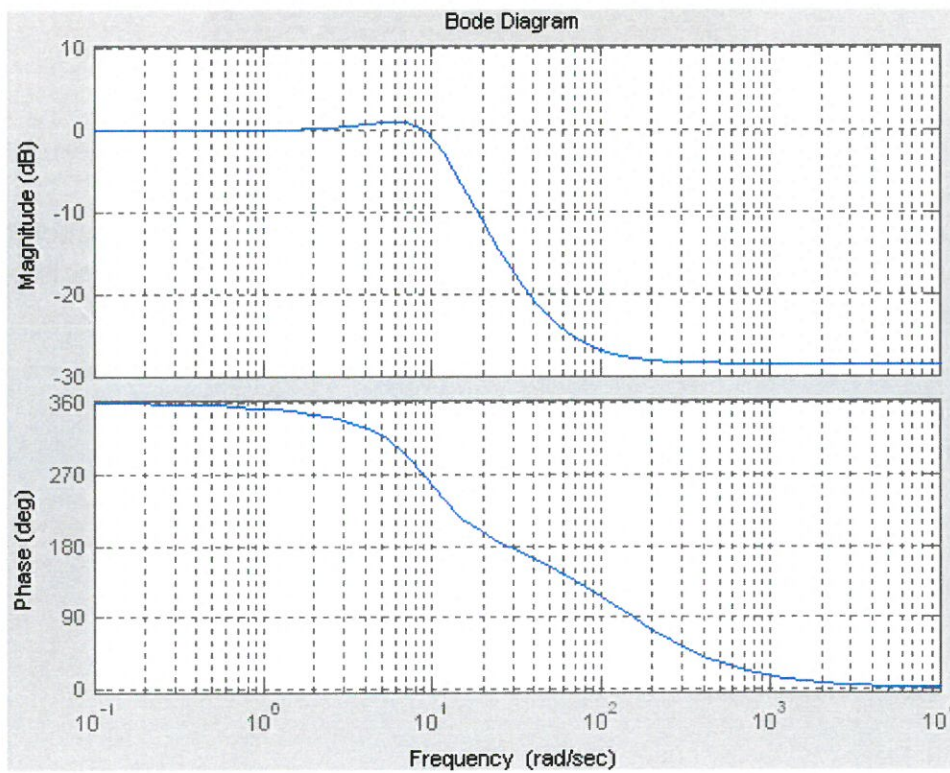
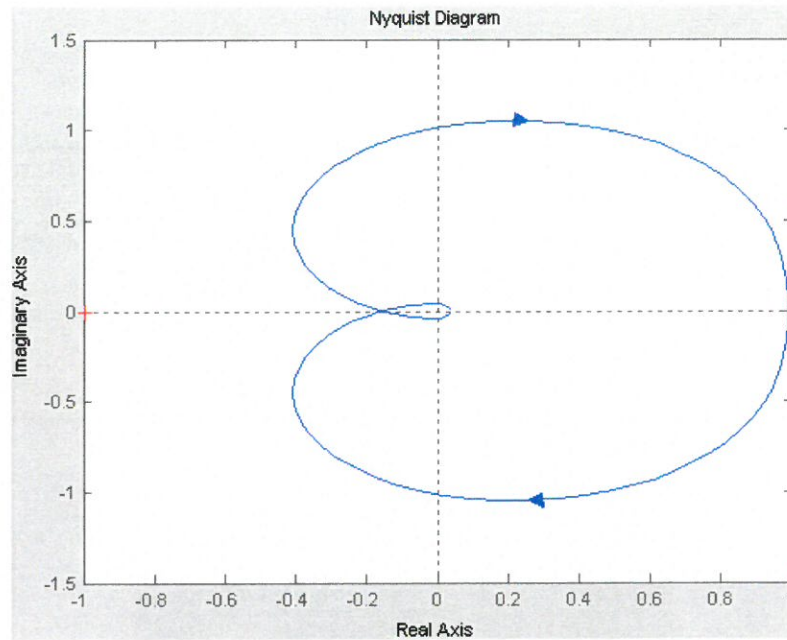


b)

```

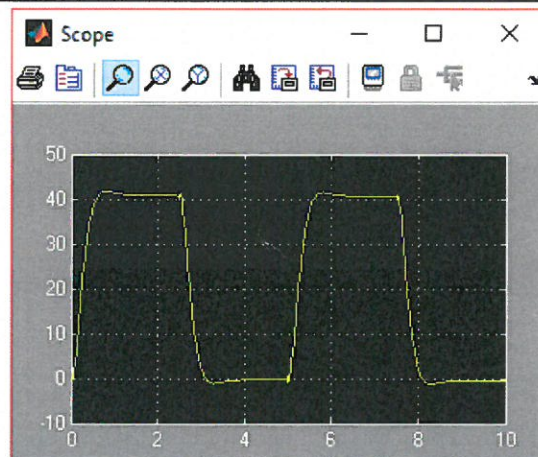
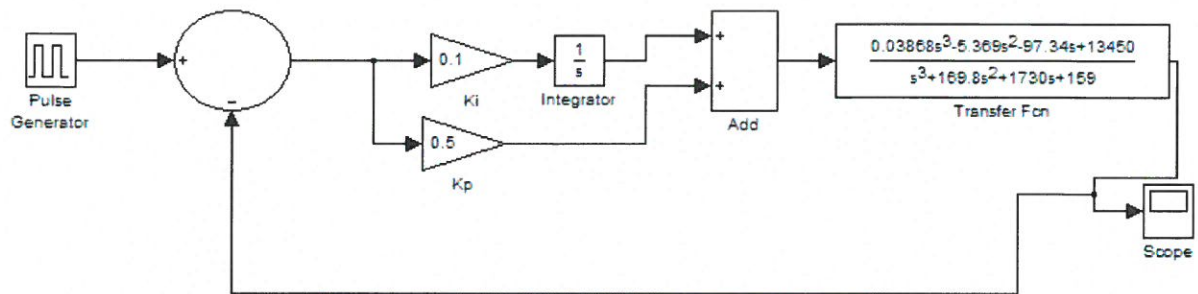
1      %George Bellmaine Ass 2 task 5 pt2/3
2
3 -    num=[0.03868 -5.369 -97.34 13450];
4 -    den=[1.03868 164.431 1632.66 13609];
5
6 -    CRIG=tf([num],[den])      % Create the transfer function
7
8 -    nyquist(CRIG)             % Plot the Nyquist response
9 -    pause
10 -    bode(CRIG)               % Plot the Bode plot
11 -    grid

```



You not completed the requirement of the task.

d)



The whole method for trying to tune this was by first working on the proportional number, which was rather straightforward, and then I fine-tuned the whole controller by changing the integral. This then resulted in the plot shown above.

Have shown no results to show what happens when K_i and K_p are changed.