Contents

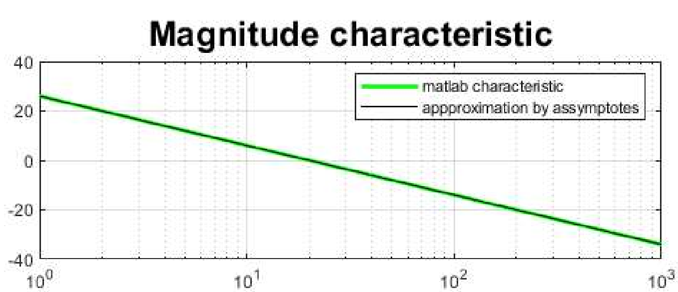

```
clear; clc; close all;

tau_m = 0.025; % time delay given in seconds
H = tf(20,[1 0],'IOdelay',tau_m);

w = logspace(0,3);
[m,f] = bode(H,w);
mm(1,:) = m(1,1,:);
ff(1,:) = f(1,1,:);
```

Ploting the magnitude characteristics:

is not changed with a time delay

```
subplot(2,1,1);
semilogx([1 10 20 1e2 1e3], [26 6 0 -14 -34], 'g', 'LineWidth',2);
grid;
hold;
semilogx(w,20*log10(mm),'k');
legend('matlab characteristic','appproximation by assymptotes');
title("Magnitude characteristic", 'FontSize',18);
hold
```

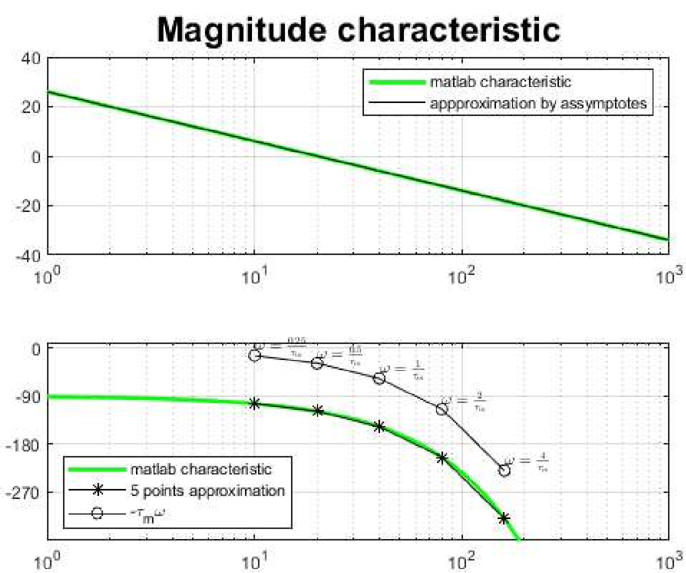
```
Current plot held
Current plot released
```



Ploting the phase characteristics:

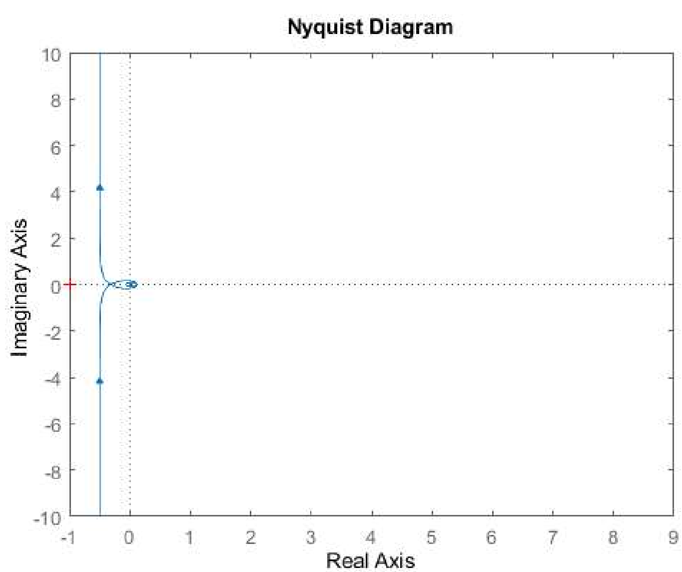
```
subplot(2,1,2);
semilogx(w,ff,'g', 'LineWidth',2);
hold
wtm = 1/tau_m; %frequency of interest for time delay
semilogx([0.25 0.5 1 2 4]*wtm, -90-180/pi*[0.25 0.5 1 2 4],'*k-');
semilogx([0.25 0.5 1 2 4]*wtm, -180/pi*[0.25 0.5 1 2 4],'ok-');
info={'$\omega=\frac{0.25}{\tau_m}$','$\omega=\frac{0.5}{\tau_m}$','$\omega=\frac{1}{\tau_m}$','$\omega=\frac{2}{\tau_m}$','$\omega=\frac{4}{\tau_m}$'};
text([0.25 0.5 1  2 4]*wtm, -57*[0.25 0.5 1 2 4] + 15, info,'color','k','interpreter','Latex','FontSize',8);
hold
legend('matlab characteristic','5 points approximation','-\tau_m\omega',   'Location','southwest')
axis([1,1e3,-360,10]);grid
set(gca,'YTick',[-270,-180,-90,0]);shg
```

```
Current plot held
Current plot released
```



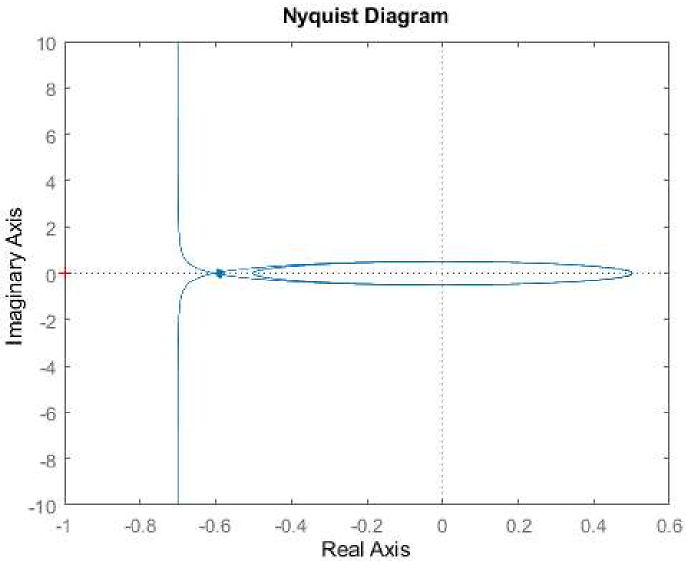
Ploting the nyquist for H

```
figure
nyquist(H)
```




```
k = 1;
tau_m = 0.2;
```

```
H =tf([-0.5 1]*k, [1 0],'IOdelay',tau_m);

wmin = -1;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)
shg;
```



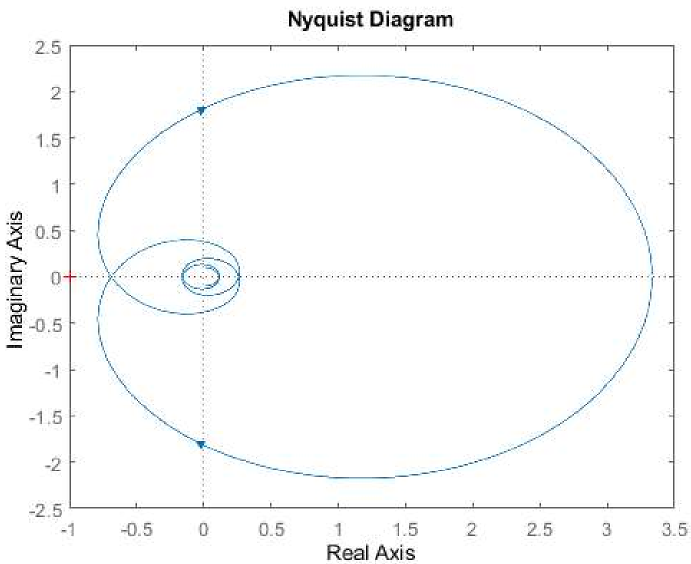
Designing a proportional controller for

obataining a closed loop stables ystem:

```
%Answer:
%We have to find the critical point(in which the nyquist plot crosses the real axes for the first time)
%If we need to choose k in such a way that if whe change k the critical
%point will be smaller than -1 radius, real{pc}*k should be < -1; where pc
%is the critical point, that means that k should be between 0 and
%1/real{pc} for a closed loop stbale system.
```

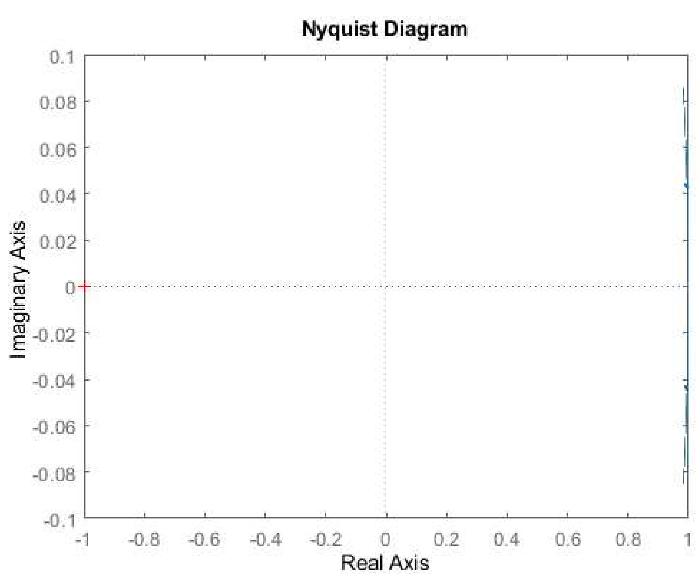
a)

```
tau_m = 1/8;

H =tf(10, [1 3],'IOdelay',tau_m);

wmin = -2;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)
shg;

% k should be between (0,1/5.09) to be (remain) closed loop stable;
```



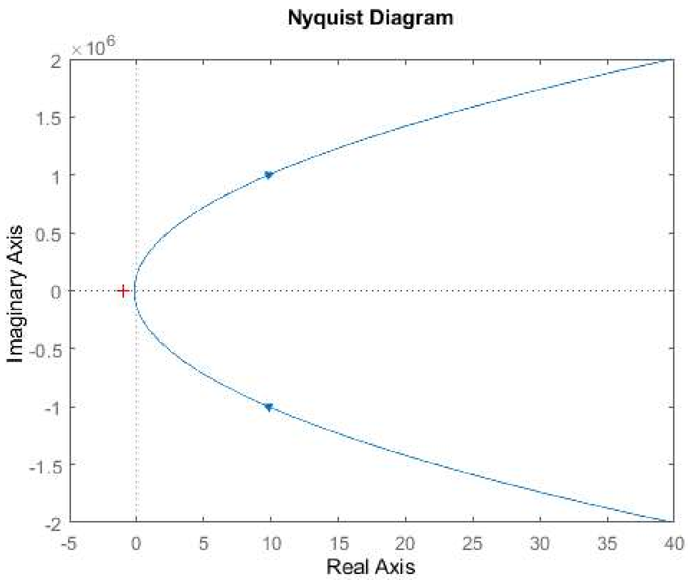
b)

```
k = 1/1.8;

H =tf([1 900]*k, [1 500]);

wmin = -2;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)

% k should be between[1.8, inf) to be (remain) closed loop stable;
```



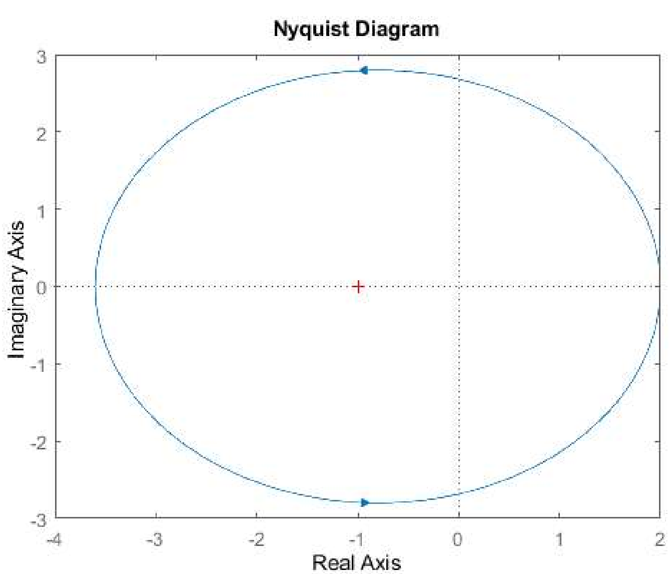
c)

```
k = 1e11;
H =tf([1 -9e-6]*k, [1 5e6]);

wmin = -2;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)

% k should be between(0, 1e12) to be (remain) closed loop stable;
```



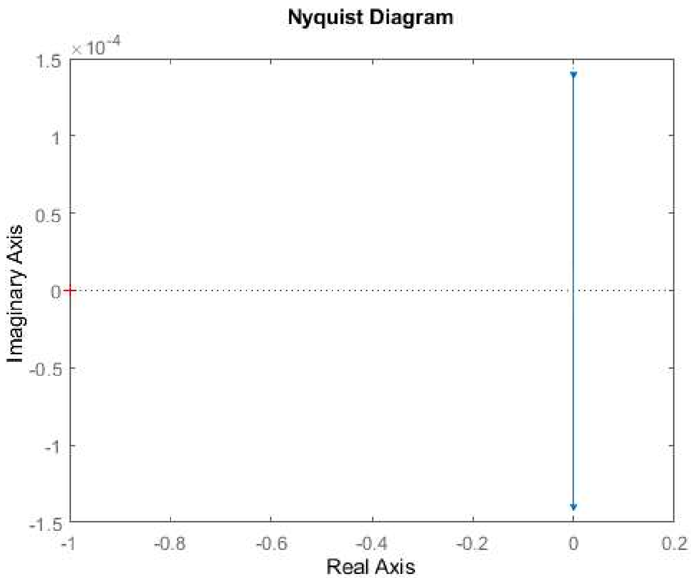
d)

```
k = 1/0.5;

H =tf([1 9]*k, [1 -5]);

wmin = -2;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)

% k should be between (1/1.8, inf) to be (remain) closed loop stable;
```



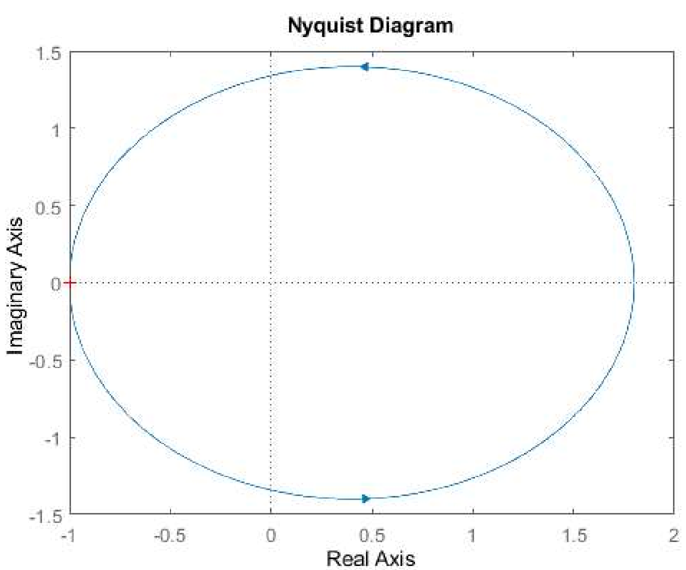
e)

```
k = 0.0001;

H =tf([-1 9]*k, [1 5]);

wmin = -2;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)

% k should be between (0, 1) to be (remain) closed loop stable;
```



f)

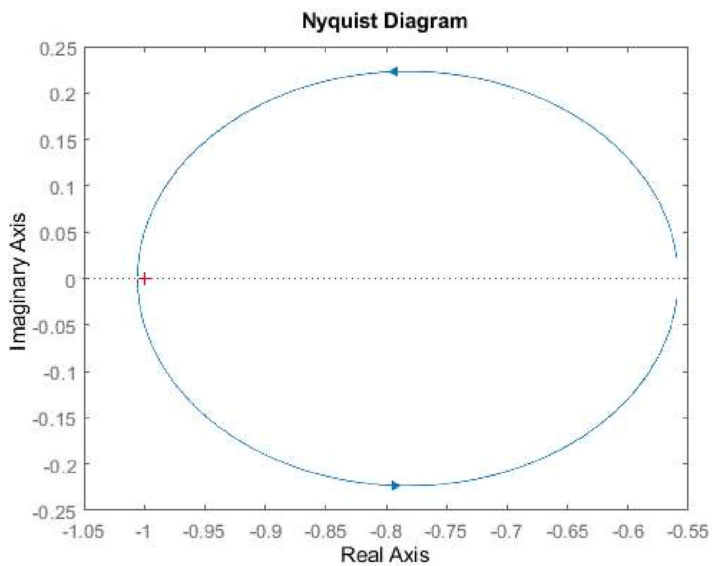
```
k = 1;

H =tf([1 9]*k, [-1 5]);

wmin = -2;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)

% k should be between (1, inf) to be (remain) closed loop stable;
```



g)

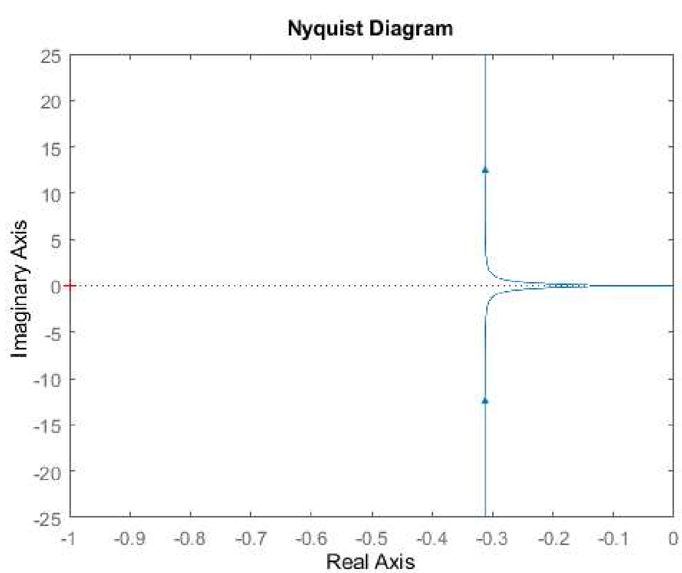
```
k = 1/1.79;

H =tf([-1 9]*k, [1 -5]);

wmin = -2;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)
```

```
% k should be between (1/1.8, 1) to be (remain) closed loop stable;
```



h)

```
k = 1;

H =tf((1)*k, conv([1 1 0], [1 4]));

wmin = -2;
wmax = 2;
w = logspace(wmin,wmax,1e4);
figure;
nyquist(H,w)

% k should be between (1, 20) to be (remain) closed loop stable;
```



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