EE324 Control Systems Lab

Problem Sheet 8

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1 Question 1

Code

```
s = poly(0, 's')
poles = [0.01, 0.05, 0.1, 0.5]
t = 0:0.01:20
i = 1
for pole = poles
    G = syslin('c', (s + 5*pole) / (s + pole))
    tf = (G) / (1 + G)
    resp = csim("step", t, tf)
    plot2d(t, resp, i)
    i = i + 1
end
legend(string(poles))
```

```
scf()
i = 1
for pole = poles
    G = syslin('c', (s + 5*pole) / (s + pole))
    tf = (G) / (1 + G)
    resp = csim("impuls", t, tf)
    plot2d(t, resp, i)
    i = i + 1
end
legend(string(poles))
```

1.1 Part A

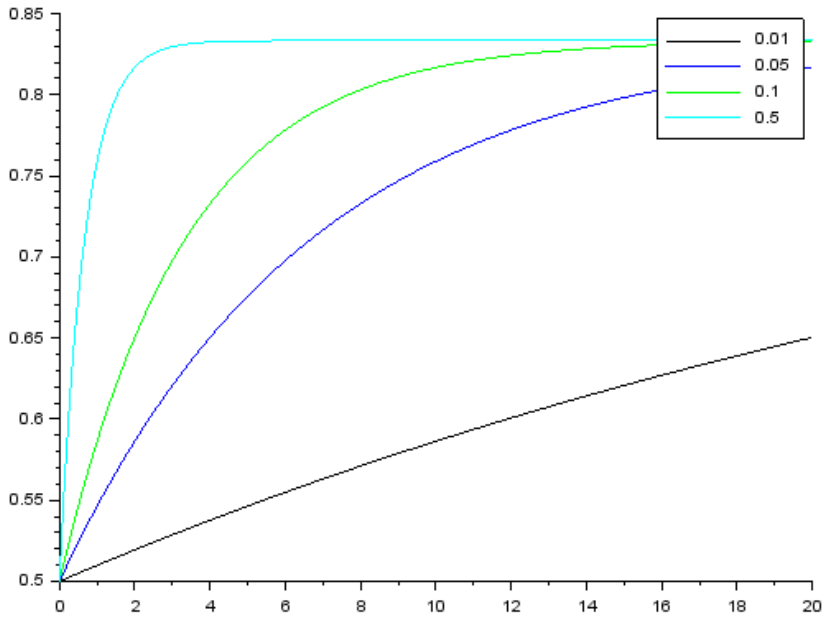

Figure 1: For step response, we see that as the pole moves farther away from origin, settling time decreases

1.2 Part B

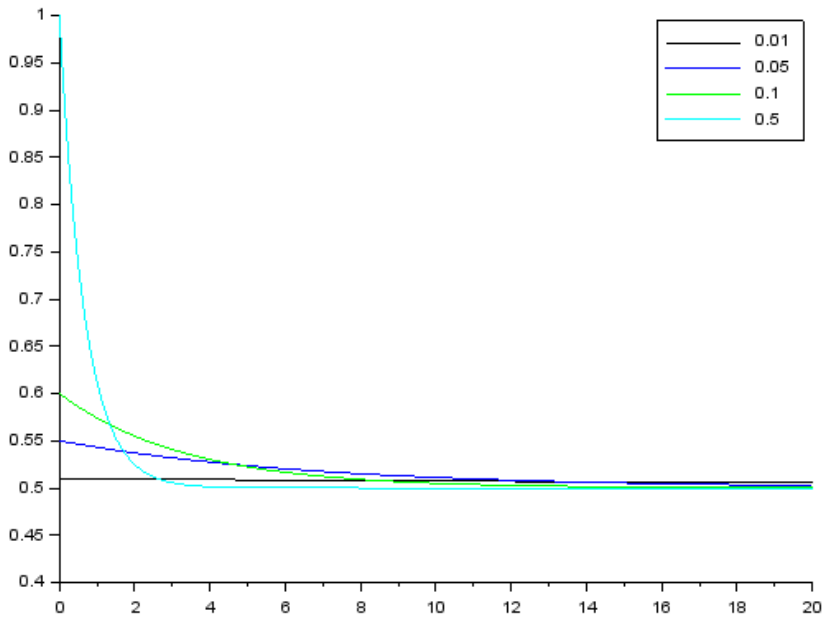

Figure 2: We see that as the pole moves farther away from origin, impulse response starts higher, and ends lower

2 Question 2

Code for all parts

```
s = poly(0, 's')


// part A
g = 1 / ((s + 1) * (s^2 + 1) * (s^2 + 4))
G = syslin("c", g)
evans(G)


// part B
scf()
s_ = s + 1
g = 1 / ((s_ + 1) * (s_^2 + 1) * (s_^2 + 4))
G = syslin("c", g)
bode(G)


// part C
// phase becomes -180 at w ~ 2
// so we add zeros after w = 2, say at w ~ 10
// now final phase is -450 deg
// we need to get it back upto -180 deg
/// so we need 4 zeros (since each zero contributes +90 deg)
scf()
G = G * (1 + s/10)^4
bode(G)
```

```
scf()
evans(G)
```

2.1 Part A

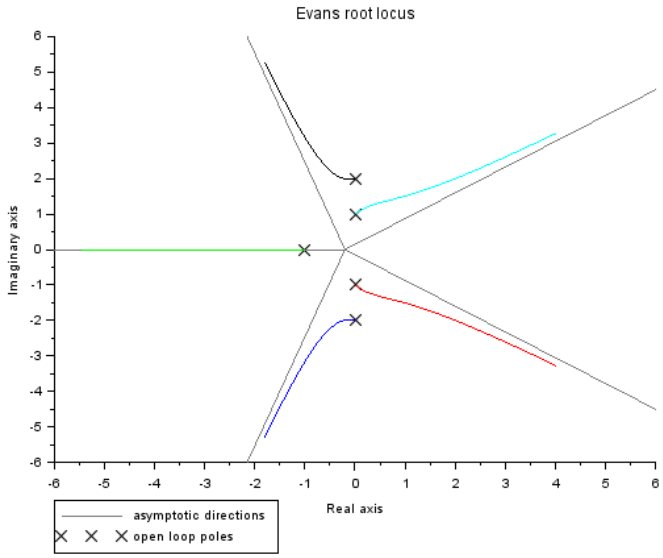

Figure 3: Root locus

2.2 Parts B, C, D

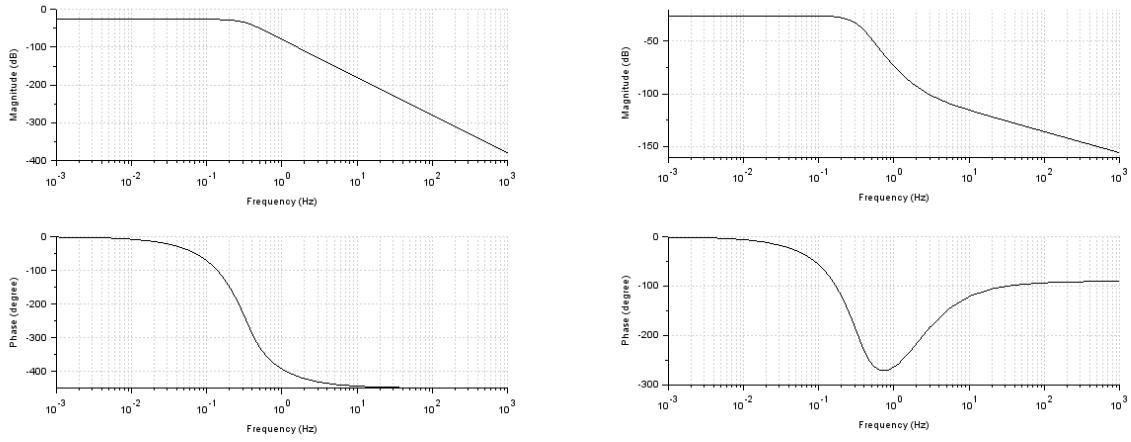

Figure 4: Bode plot without zeros, and with zeros

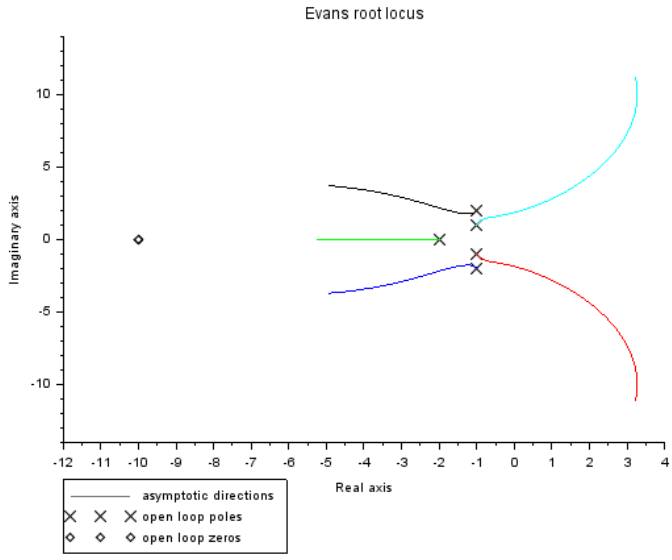

Figure 5: Final root locus

Calculation of the zeros is included in the code.

3 Question 3

3.1 Code and calculation

```
s = poly(0, 's')
// there is +40dB/dec slope starting at w=1 => single zero
// slope becomes 0 at w=5 => single pole
// slope becomes -20dB/dec at w=10 => single pole
// slope becomes -40dB/dec at w=100 => single pole
// initial value is -75dB = 0.00017782794100389227
g = 0.00017782794100389227 * (1 + s) / ((1 + s/5) * (1 + s/10) * (1 + s/100))
G = syslin("c", g)
bode(G)
```

3.2 Phase plot

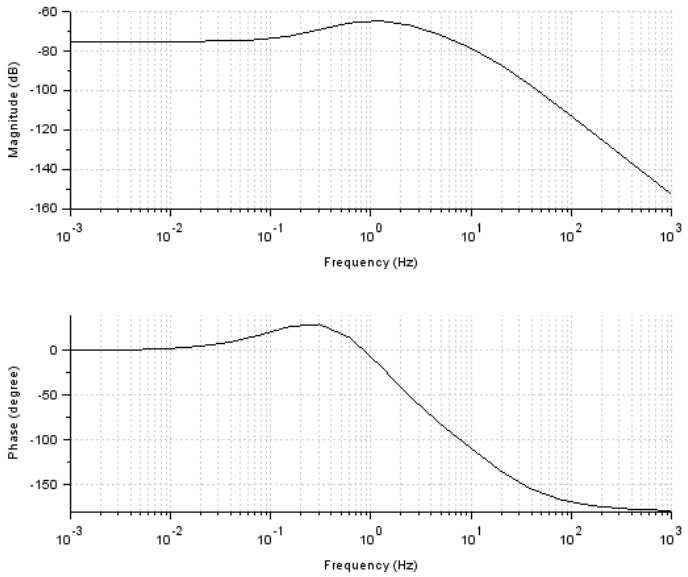

Figure 6: Magnitude and phase bode plot of the system