ISTANBUL TECHNICAL UNIVERSITY

COMPUTER ENGINEERING DEPARTMENT

BLG 354E

SIGNALS AND SYSTEMS

FOR COMPUTER ENGINEERING
FINAL PROJECT REPORT

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Finding H(s)

From analyizing the given bode plot we can obtain the transfer function $H(s)$ as follows:

$$H(s) = \frac{Ks^3}{\left(1+\frac{s}{2\pi f_{cl}}\right)^3\left(1+\frac{s}{2\pi f_{cl}}\right)^3}$$

Here we can find K value by calculating the DC gain of the system. We can calculate the DC gain by drawing a parallel line to the +60dB/decade line from the point (1,0). We know that the gain is 0 throughout the passband. The distance between f_{cl} and 1 is $\log(1/f_{cl})$ decades. The line increases +60dB/decade since it is parallel. So we can calculate the DC gain as(I found this method from [1]):

$$\log\left(\frac{1}{2\pi f_{cl}}\right)\cdot 60\frac{\text{dB}}{\text{decade}} = 20\log(K)$$

$$(2\pi f_{cl})^{-3} = K$$

So the transfer function is as follows:

$$H(s) = \frac{(2\pi f_{cl})^{-3}s^3}{\left(1+\frac{s}{2\pi f_{cl}}\right)^3\left(1+\frac{s}{2\pi f_{cl}}\right)^3}$$

I used the following code piece to obtain the coefficients of the z transfer function

Listing 1: Code for calculating coefficients

```
import sympy as sp
s = sp.Symbol("s")
z = sp.Symbol("z")
w_cl = sp.Symbol("w_cl")
w_ch = sp.Symbol("w_ch")
T = sp.Symbol("T")

G_s = ((w_cl ** (-3) * s ** 3) / ((1+s/w_cl)**3 * (1+s/w_ch)**3))
G_s = G_s.subs(s, 2/T * (1 - z ** (-1)) / (1 + z ** (-1)))

print(sp.collect((sp.simplify(G_s).expand()), z))
```

I multiplied the output with $\frac{z^{-6}}{z^{-6}}$ to get H(z) in direct programming format. Since the period T and edge frequencies f_{cl} and f_{ch} are kept as variables the coefficients are too long to write to this page and you can see them on the codes.

Pseudocode

Listing 2: Pseudocode

```
ISR @Ts=1/f_s=1/44100Hz
X = READ(ADC)
A = X + (- a_1B - a_2C - a_3D - a_4E - a_5F - a_6G) / a_0
Y = (b_0A + b_2C + b_4E + b_6G) / a_0
G = F
G = F
F = E
E = D
D = C
C = B
B = A
```

References

[1]: http://web.mit.edu/2.010/www/2010SpPS10Soln.pdf