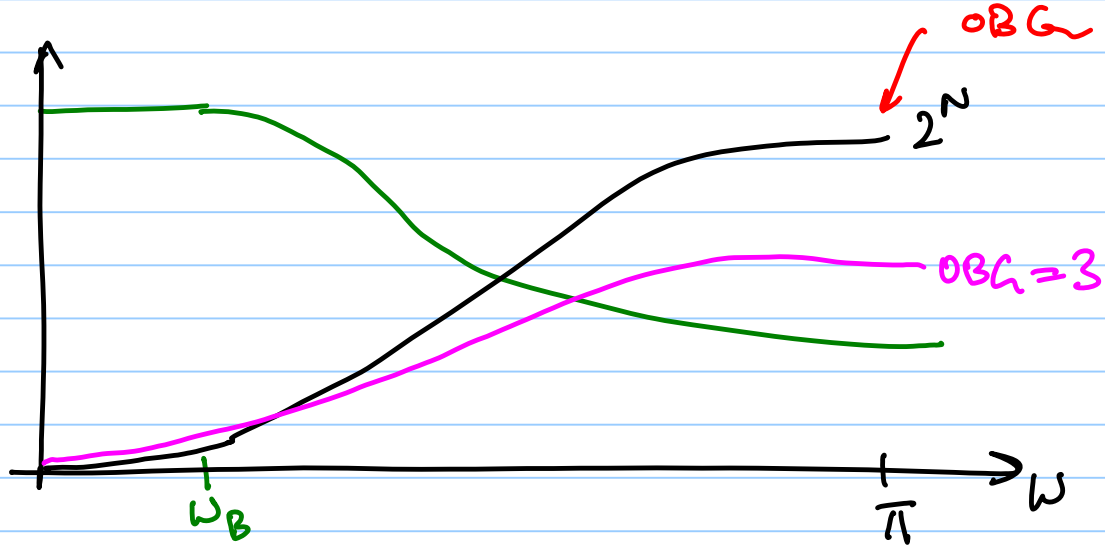
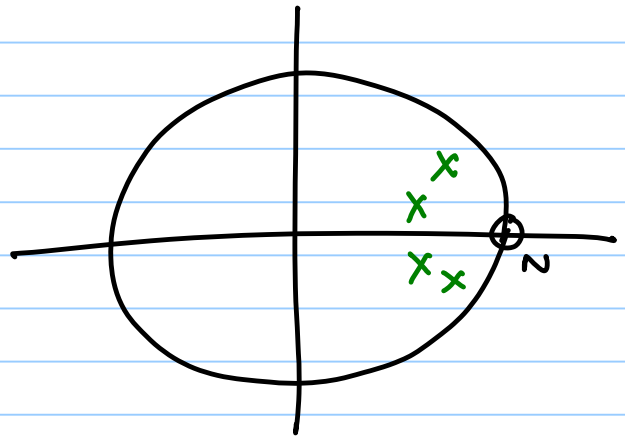
ECE 615 - Lecture 16

Note Title 3/3/2016



$$NTF(z) = (1-z^{-1})^N$$

$$OBG = 2^N$$



OBG ↓ $\Rightarrow$ better stability

MSA (u_{max}) ↑

* Need to systematically synthesize the NTF for the modulator

Recall the realizability condition (delay-free l.-f)

$$h[0] = NTF(z=\infty) = 1$$

If $NTF(z) = \dfrac{(1-z^{-1})^4}{a_0 + a_1 z^{-1} + \cdots + a_4 z^{-4}} = \dfrac{N(z)}{D(z)}$

N^γ is HPF

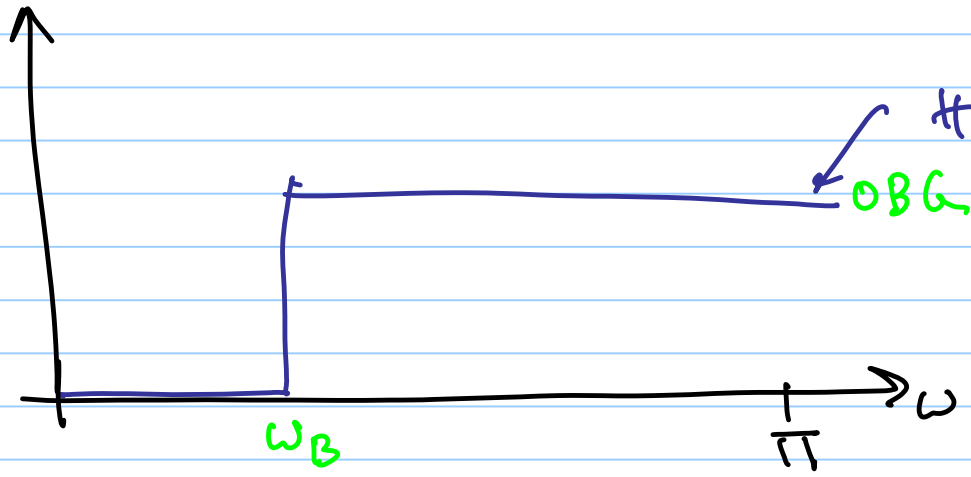
D^γ low pass response

$\Rightarrow a_0 = 1$ or $D(z=\infty) = 1$

$$OBG = \frac{2^N}{D(-1)} \leftarrow |D(e^{j\omega})|_{\omega=\pi}$$

Which pole configuration to use? $\Rightarrow D(z) = ?$

Filter "Approximation Problem":



Approximate the ideal brickwall HPF with a polynomial response.

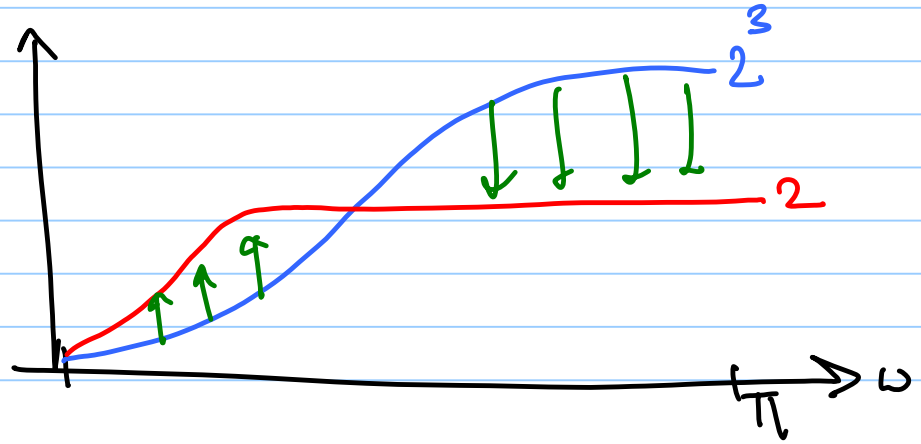
Many responses are possible!

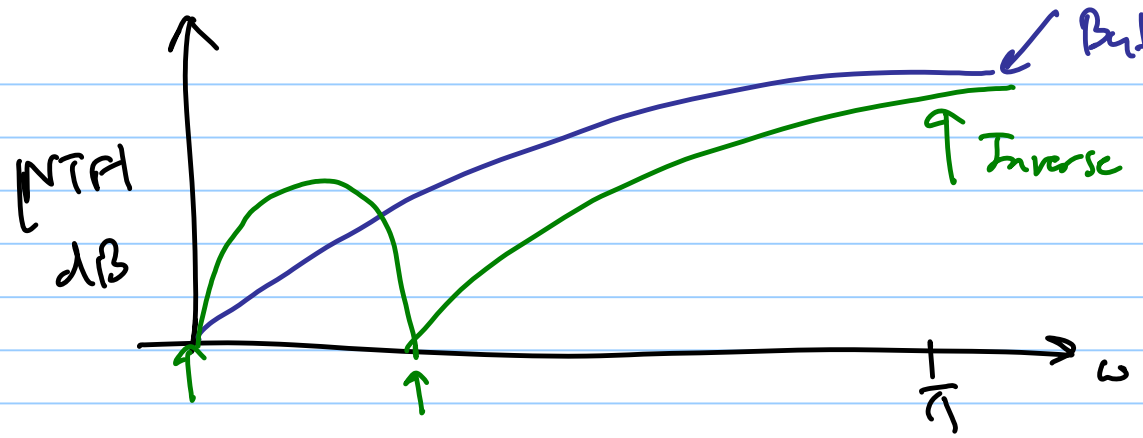
① Butterworth

② Inverse Chebyshev

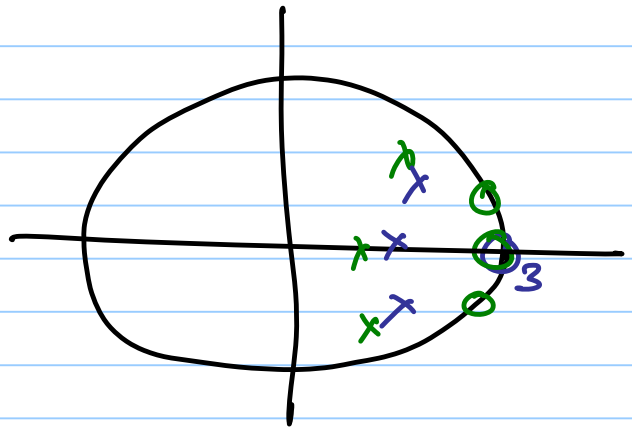
③ Maximally flat all pole transfer function

④ Elliptic response





N=3



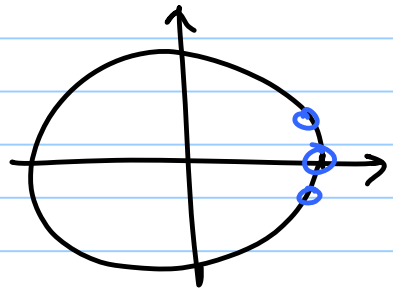
Butterworth Example:

See the slides

Iterating upon w_{3dB} of the realizable Butterworth NTF to meet the SQNR spec while keeping MSA at a reasonable value (> 75%)

NTF zero Optimization:

Textbook pgs 107-111

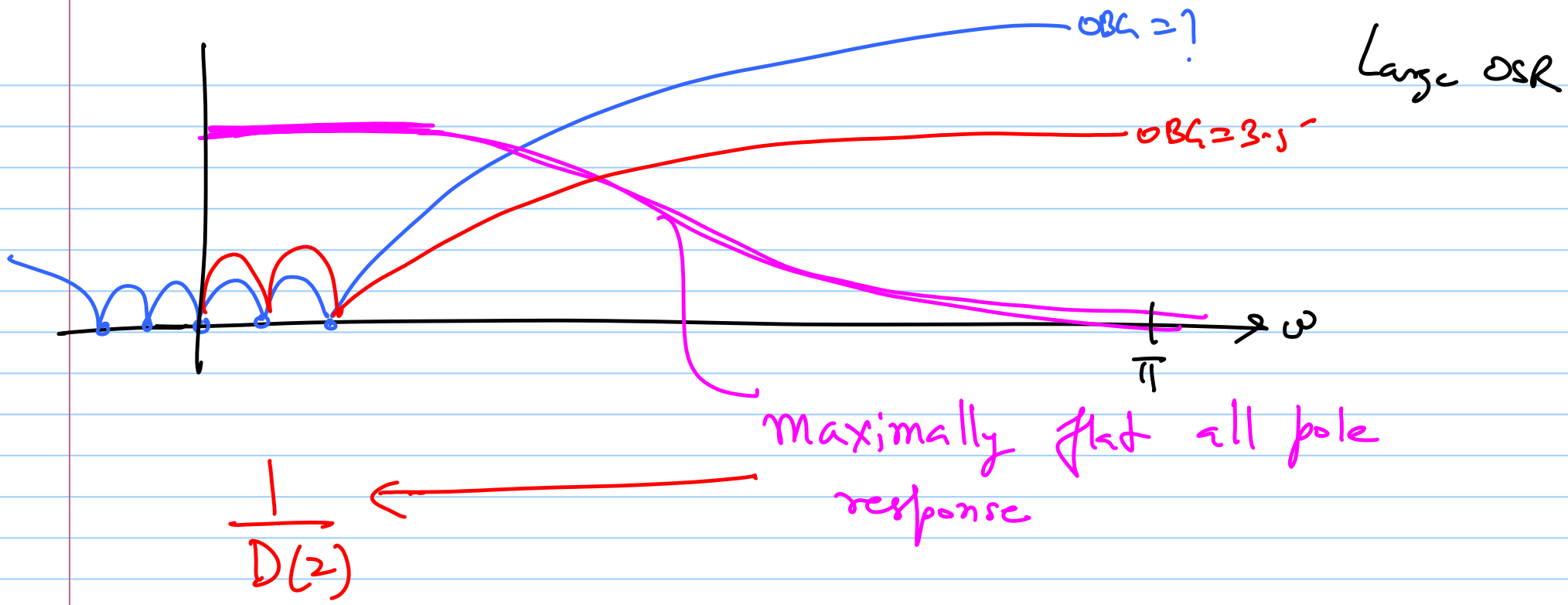


Spread the NTF zeros in the signal band to minimize IBN

↓

in-band noise

N	zero locations (normalize to ω_B)	SQNR increase
1	0	0 dB
2	$\pm \frac{1}{\sqrt{3}}$	3.5 dB
3	$0, \pm\sqrt{3/5}$	8 dB
4	$\pm\sqrt{\frac{3}{7} \pm \sqrt{\left(\frac{3}{7}\right)^2 - \frac{3}{35}}}$	13 dB
5	$0, \pm\sqrt{\frac{5}{9} \pm \sqrt{\left(\frac{5}{9}\right)^2 - 5/21}}$	18 dB


OBG = ?
Large OSR
OBG = 3.5
ω
π
maximally flat all pole response
1
D(z)

① Choose the order N based upon the desired SQNR, OSR, and quantizer resolution (N_0)

② choose the NTF type

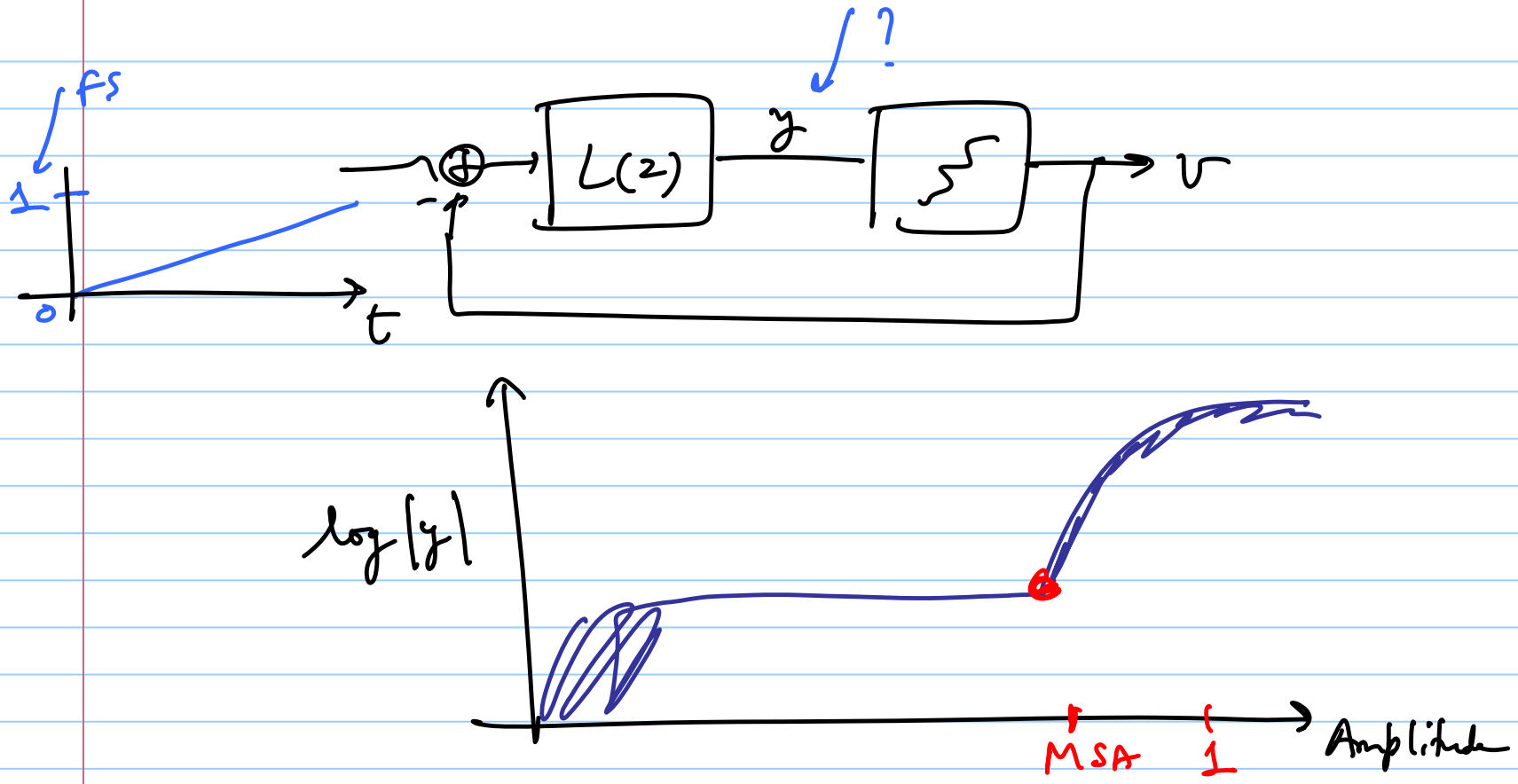
③ Place the 3dB cutoff frequency slightly above the signal band $\omega_{3dB} > \frac{\pi}{OSR}$

④ obtain zeros of the NTF, apply the realizability condition → pole locations

⑤ Simulate to predict stability of the modulator

⑥ If don't meet the SQNR specs, ω_{adj} ↑

⑦ Iterate till design closure.


fs
1
0
t
?
L(z)
y
v
log|y|
MSA
1
Amplitude