Review

Bode plot using asymptotic curves

$$H(s) = \frac{100s}{s^2 + 420s + 8000}$$

$$= \frac{100s}{(s+20)(s+400)}$$

$$= \frac{100s}{20\left(1+\frac{s}{20}\right) \times 400\left(1+\frac{s}{400}\right)}$$

$$= \frac{\frac{100}{20 \times 400} \times s}{\left(1+\frac{s}{20}\right)\left(1+\frac{s}{400}\right)} = \frac{\frac{1}{80} \times s}{\left(1+\frac{s}{20}\right)\left(1+\frac{s}{400}\right)}$$

$$H(s) = \frac{1}{80} \times s \times \frac{1}{\left(1+\frac{s}{20}\right)} \times \frac{1}{\left(1+\frac{s}{400}\right)}$$

$$[H(s)] = \left[\frac{1}{80}\right] + [s] + \left[\frac{1}{1+\frac{s}{20}}\right] + \left[\frac{1}{1+\frac{s}{400}}\right]$$

?

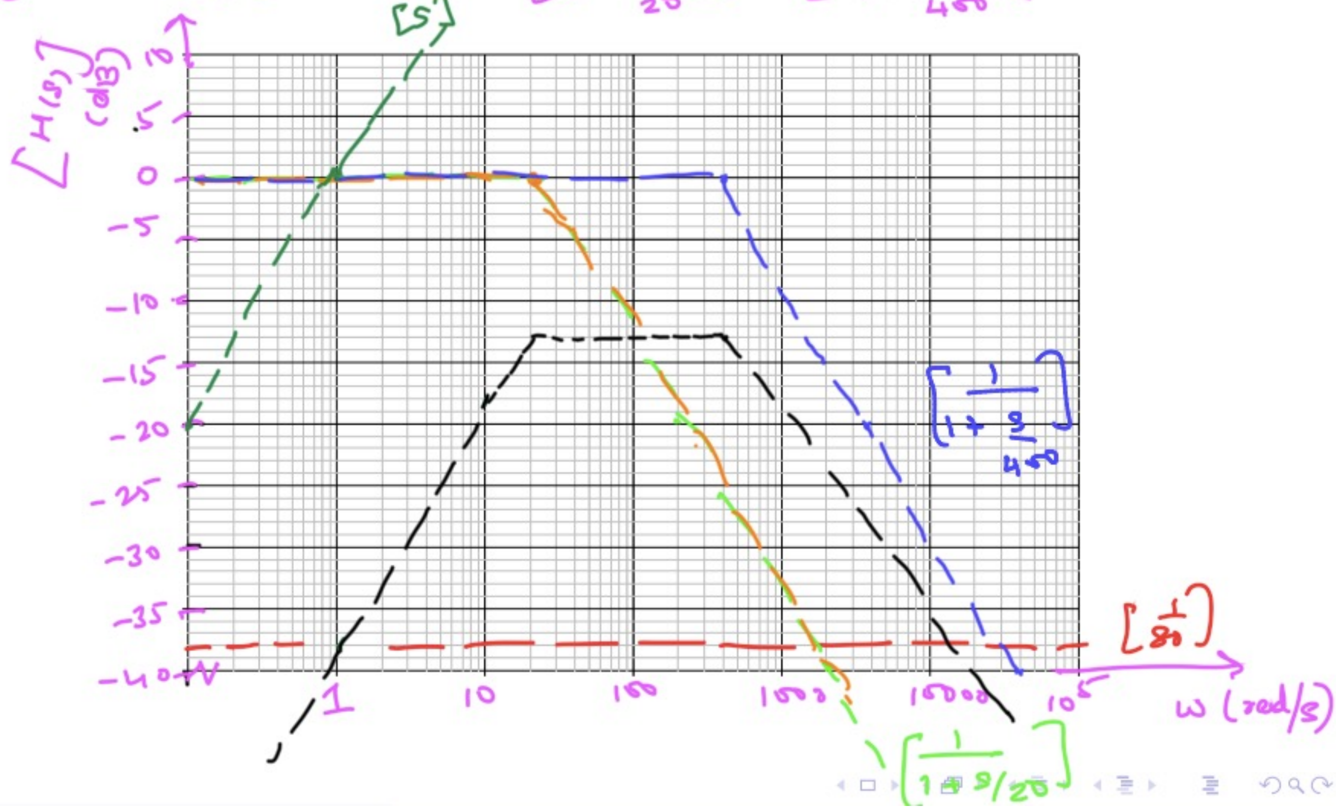
$[s] = [|j\omega|] = 20\log_{10}|\omega|$ ②

ω	$\lvert s\rvert$	$[s]$
0.01	0.01	$20\log_{10}(0.01) = -40$ $20\log_{10}(10^{-2})$
0.1	0.1	$20\log_{10}(0.1) = -20$
1	1	$20\log_{10}(10^{0}) = 0$
10	10	$20\log_{10}(10^{1}) = +20$
100	100	$20\log_{10}(10^{2}) = 40$
1000		

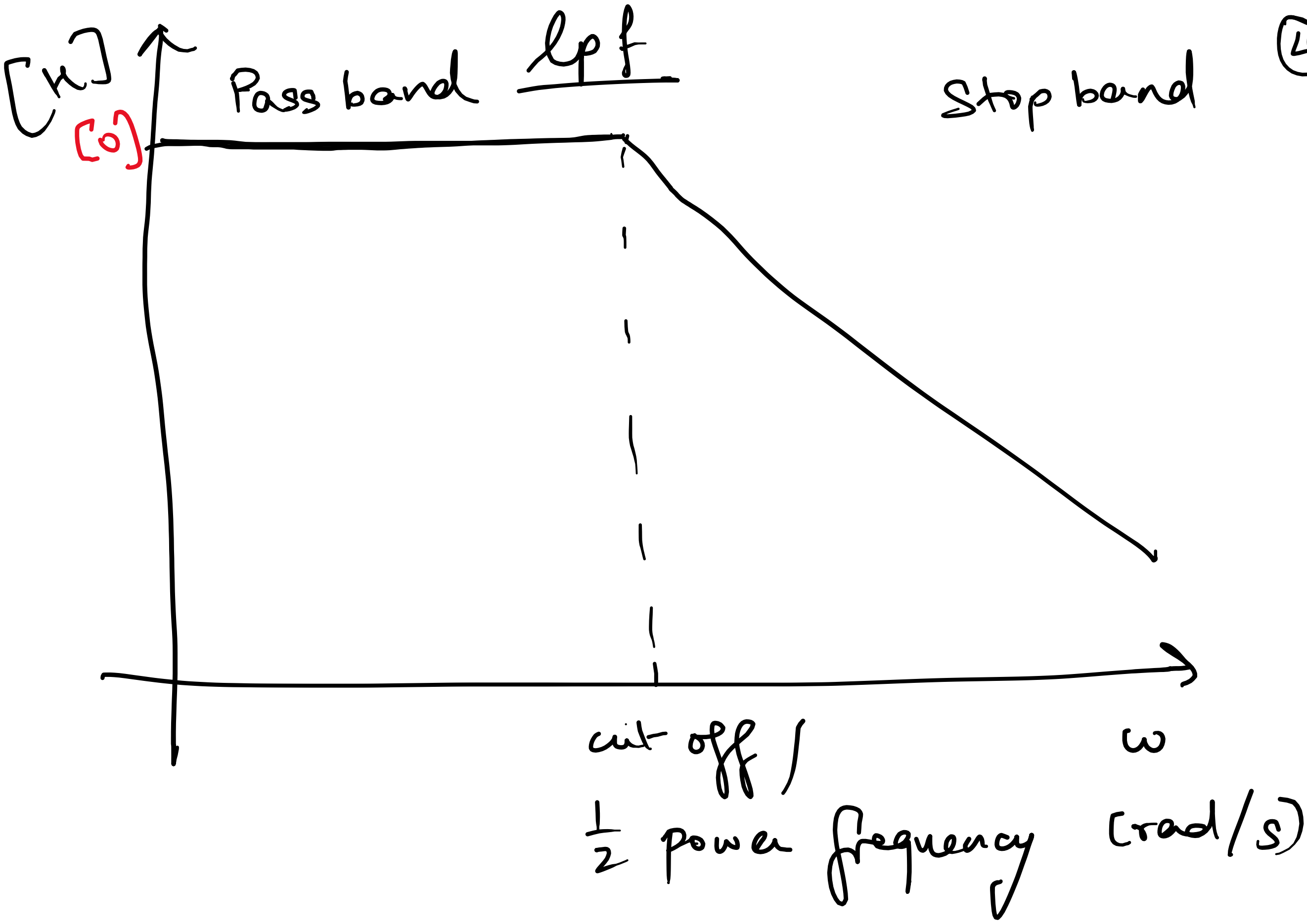
$\uparrow$

Plot of $[s]$

$$[H(s)] = \left[\frac{1}{80}\right] + [s] + \left[\frac{1}{1+\frac{s}{20}}\right] + \left[\frac{1}{1+\frac{s}{450}}\right]$$



Passive 2nd order band pass filter



$$H(s) = \frac{K}{s^n + a_{n-1}s^{n-1} + \dots + a_0}$$

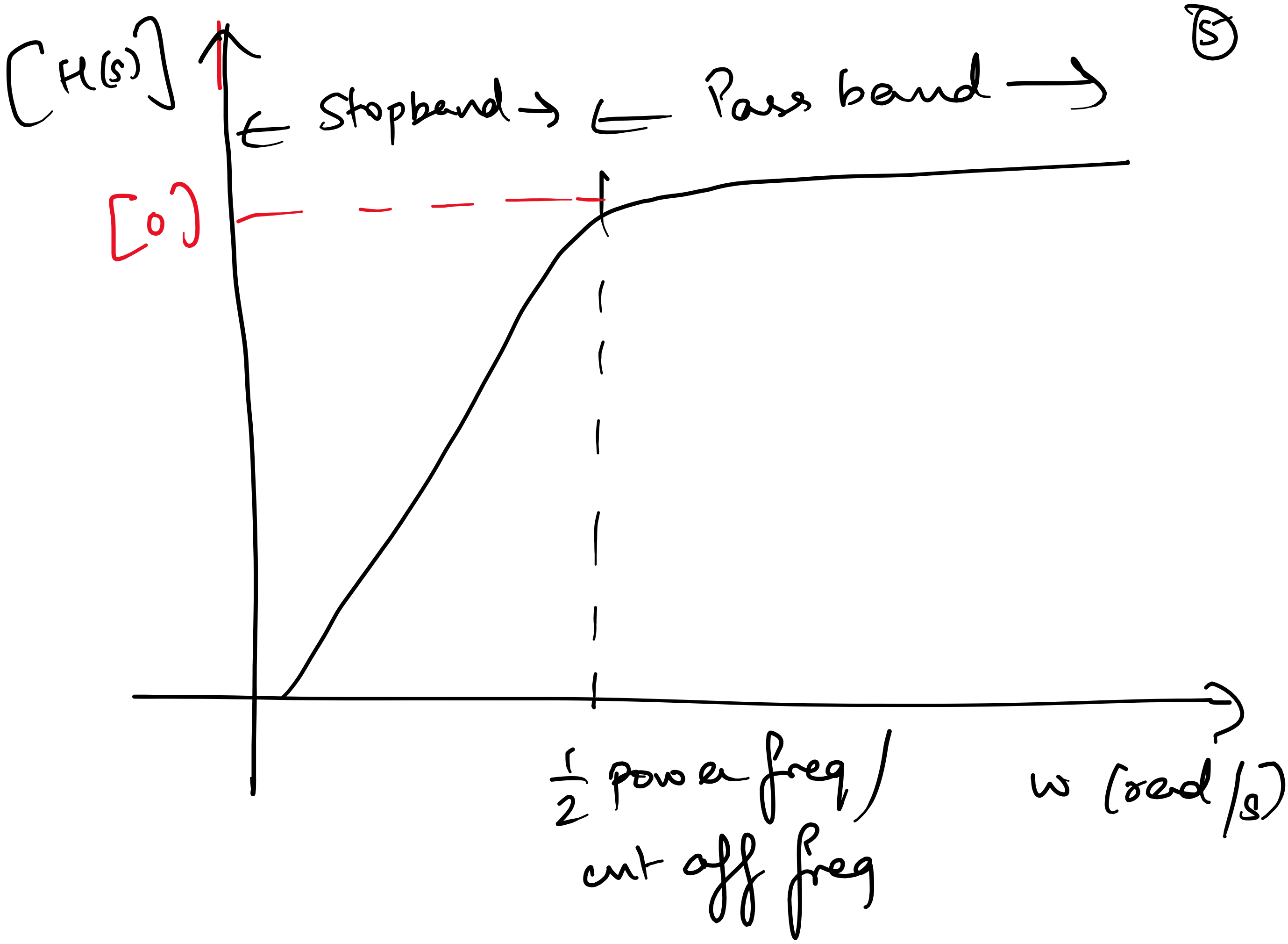
active / passive n^{th} order lpf

↓

number of poles / number of memory elements

$$\frac{1}{1+s/p_1} \rightarrow \quad -20\ dB/decade$$

$$\frac{1}{(1+s/p_1)^2} \rightarrow \quad -40\ dB/decade$$

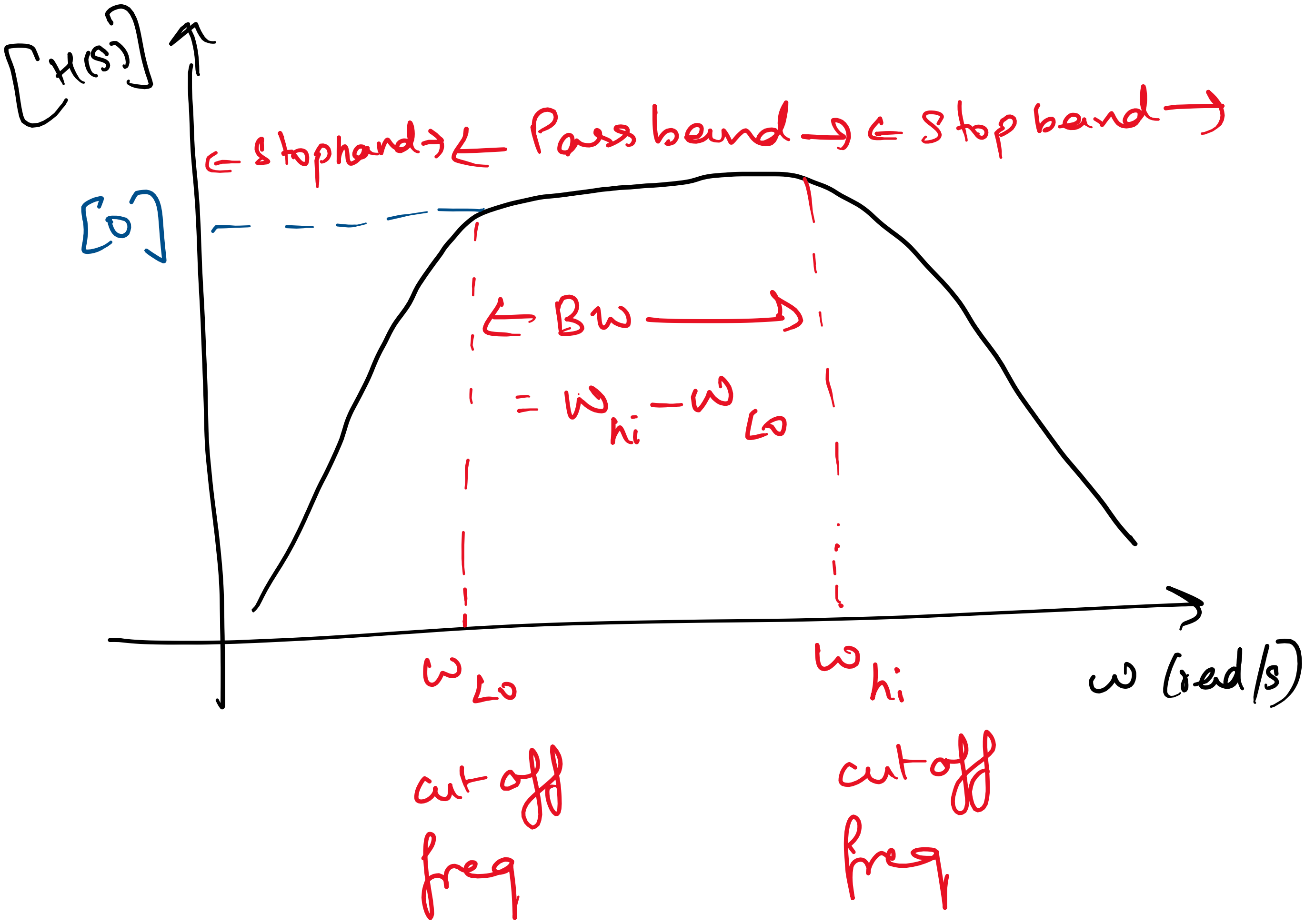


$$H(s) = \frac{K s^n}{s^n + a_{n-1} s^{n-1} + \dots + a_0}$$

$$\rightarrow \quad \frac{s}{s+a}$$

active | passive n^{th} order hpf

Band Pass filter



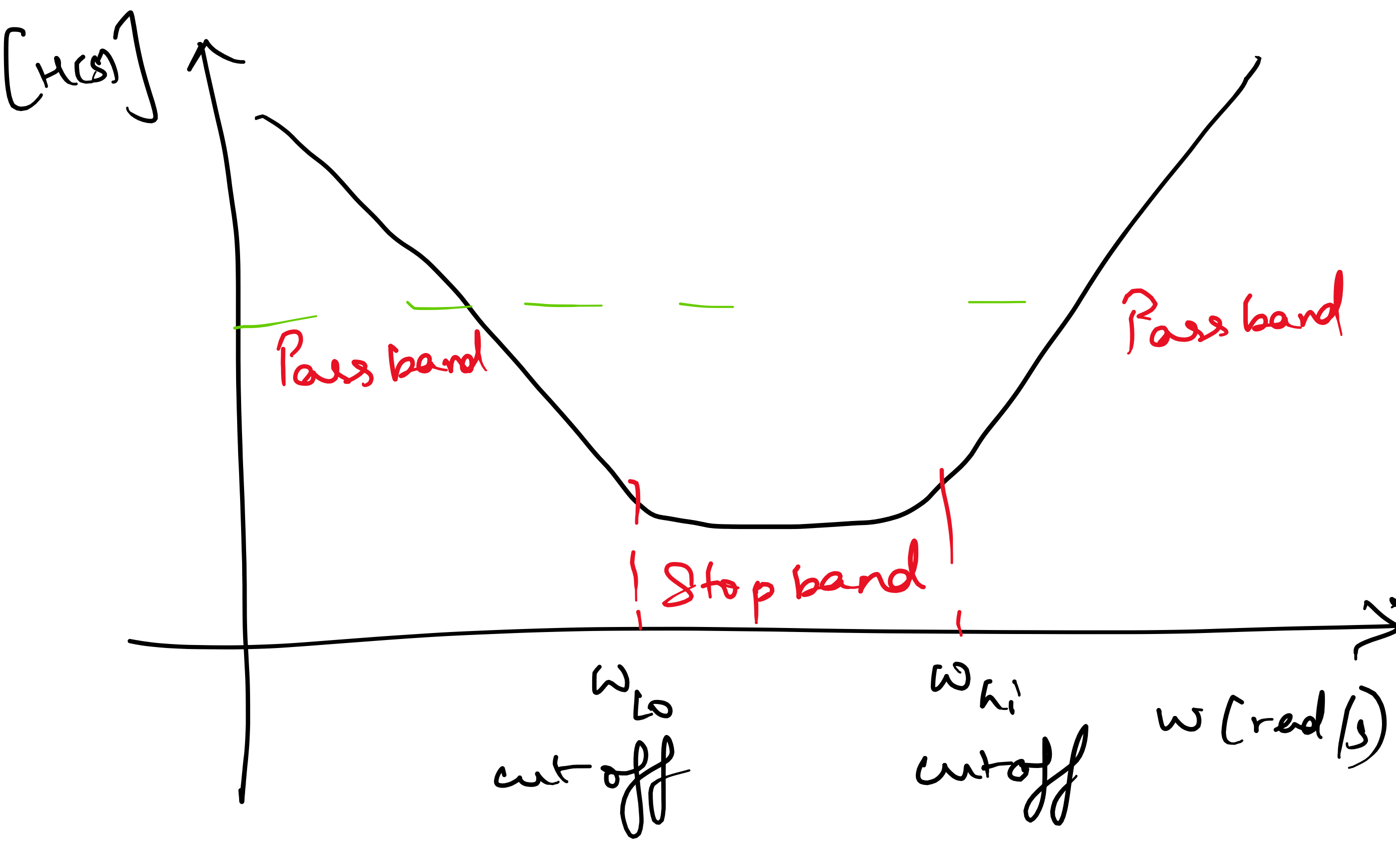
$$H(s) = \frac{k s^{n/2}}{s^n + a_{n-1} s^{n-1} + \cdots a_0}$$

min $n = 2$ (n always even)

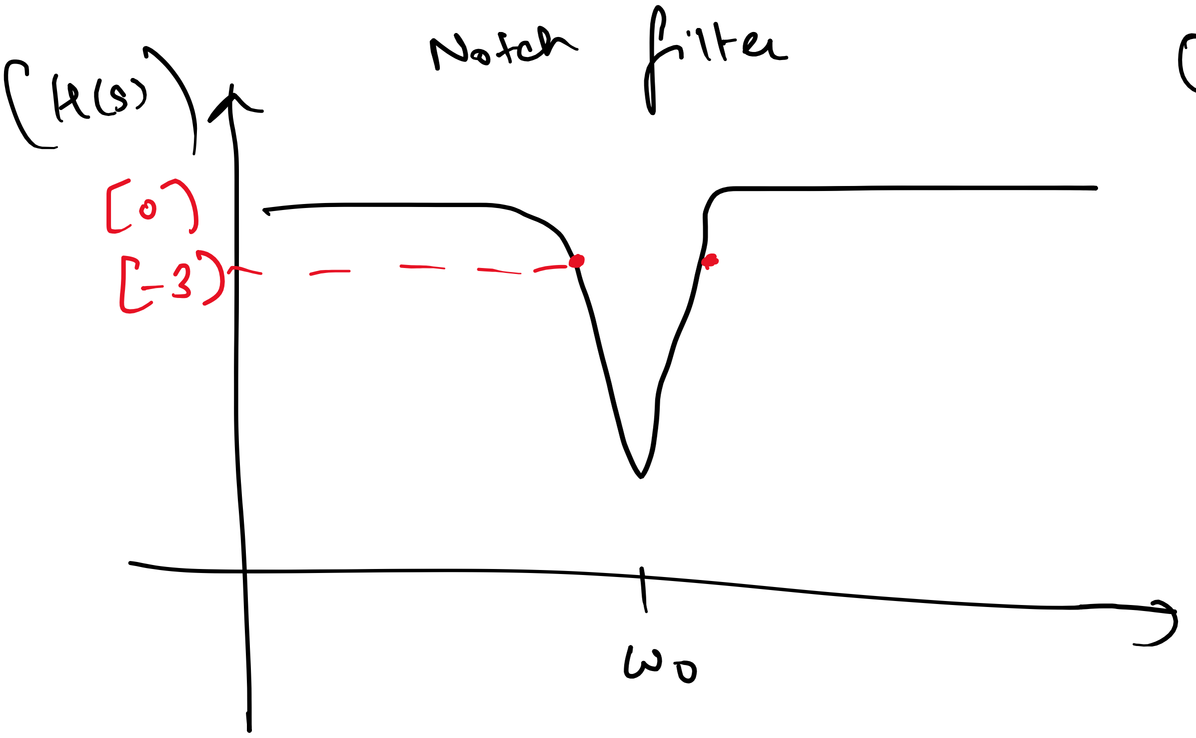
active/ passive n^{th} order bpf

All pass filter

Band stop filter

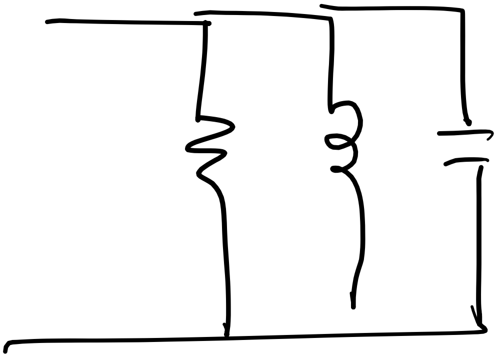


Notch filter



$$H(s) = \frac{K(s^2 + \omega_0^2)^{n/2}}{s^n + a_{n-1}s^{n-1} + \cdots + a_0}$$

Parallel | Series



$$Z(\omega) = R + j\left(\omega L - \frac{1}{\omega C}\right)$$

$$Y(\omega) = \frac{1}{R} + \frac{1}{j\omega L} + j\omega C$$

$$Y(\omega) = \frac{1}{R} + j\left(\omega C - \frac{1}{\omega L}\right)$$

$$\boxed{\text{Resonant frequency @ } \operatorname{Im}\{Z\} \text{ or } \operatorname{Im}\{Y\} = 0}$$

$$\omega_0 C - \frac{1}{\omega_0 L} = 0$$

$$\omega_0 L = \frac{1}{\omega_0 C}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

(10)

$$Q = 2\pi \frac{\text{max energy stored in a ckt}}{\text{energy dissipated in } T}$$

$Q = \omega_0 RC$ | $Q = \frac{\omega_0 L}{R}$

$$\boxed{Q = \frac{BW}{\omega_0} = \frac{\omega_{hi} - \omega_{LO}}{\omega_0}}$$ (no unit)

High Q circuit is $Q \geq 5$

- A parallel RLC circuit is built using L = 50mH, C = 33mF. If $Q_0 = 10$, determine the value of R, and bandwidth.

$$L = 50 \times 10^{-3} \text{ H}$$

$$C = 33 \times 10^{-3} \text{ F}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{50 \times 33 \times 10^{-6}}} = 24.62 \text{ rad/s}$$

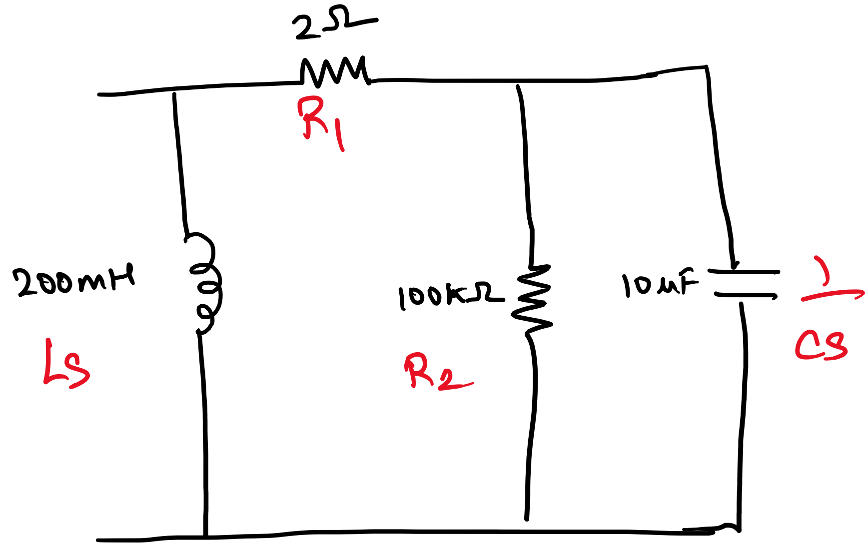
$$Q = \omega_0 RC$$

$$\text{or } R = \frac{Q}{\omega_0 \times C} = 12.31\,\Omega$$

$$\text{Bandwidth} = Q \times \omega_0 = 246.18 \text{ rad/s}$$

- What is the input admittance of the network? Determine the resonant frequency and the bandwidth of the network.

$Z(s) \Rightarrow$



$$Z(s) = \left\{ \left[\frac{1}{Cs} \parallel R_2 \right] + R_1 \right\} \parallel Ls$$

$$= \left\{ \frac{\frac{R_2}{Cs}}{R_2 + \frac{1}{Cs}} + R_1 \right\} \parallel Ls$$

$$= \left\{ \frac{R_2}{1 + R_2 Cs} + R_1 \right\} \parallel Ls$$

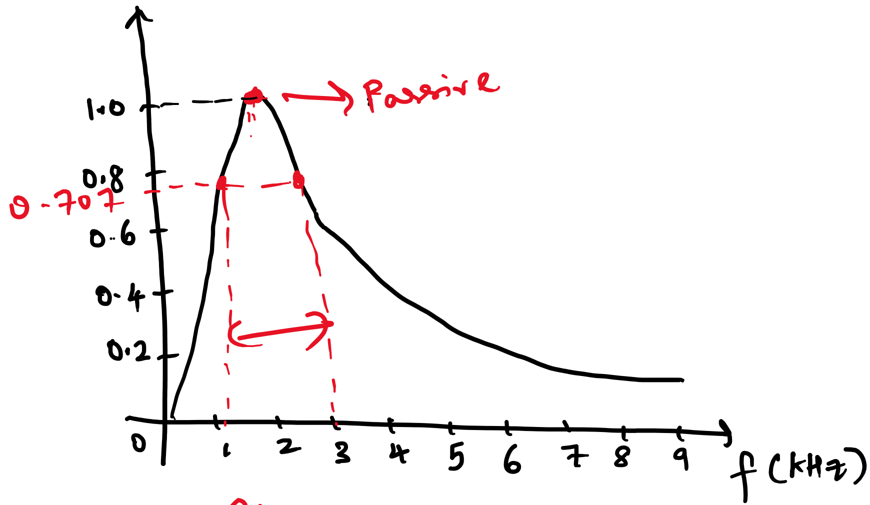
$$= \frac{R_1 + R_2 + R_1 R_2 Cs}{1 + R_2 Cs} \parallel Ls$$

$$Y(s) = \frac{1}{Ls} + \frac{1 + R_2 C s}{R_1 + R_2 + R_1 R_2 C s}$$

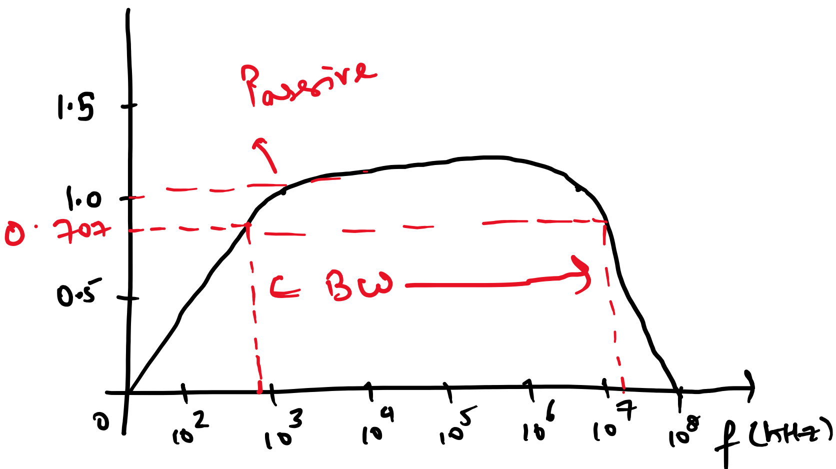
$$= \frac{R_1 + R_2 + R_1 R_2 C s + L s + R_2 L C s^2}{(R_1 + R_2 + R_1 R_2 C s) L s}$$

Solve it numerically

- Find the bandwidth of the each of the response curves.



2 kHz



900 kHz

2×10^4 kHz

$(2 \times 10^7 - 900)$ kHz