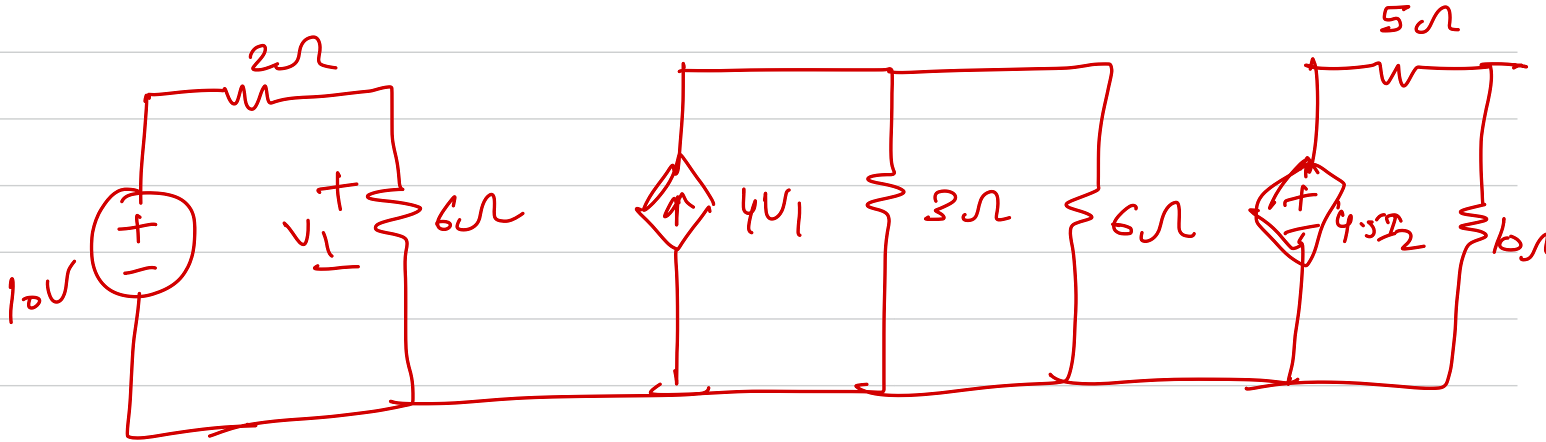
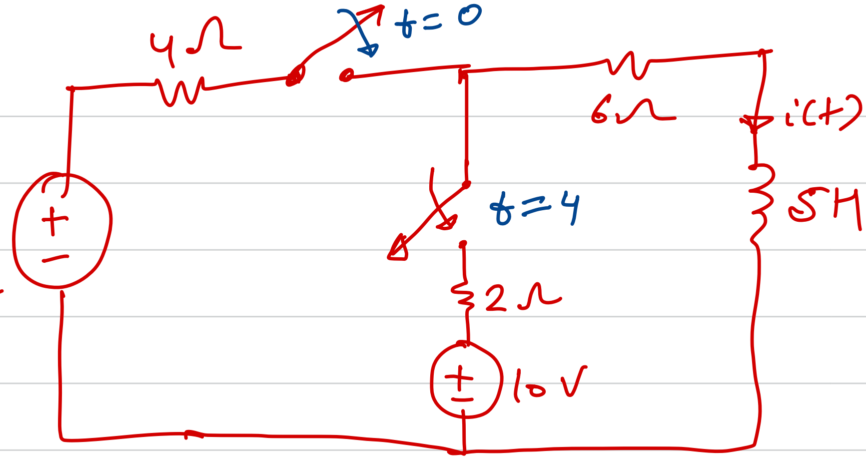

2Ω
10V
+
−
+
V_1
−
6Ω
$4V_1$
3Ω
6Ω
5Ω
+
−
$4.5I_2$
10Ω

Q



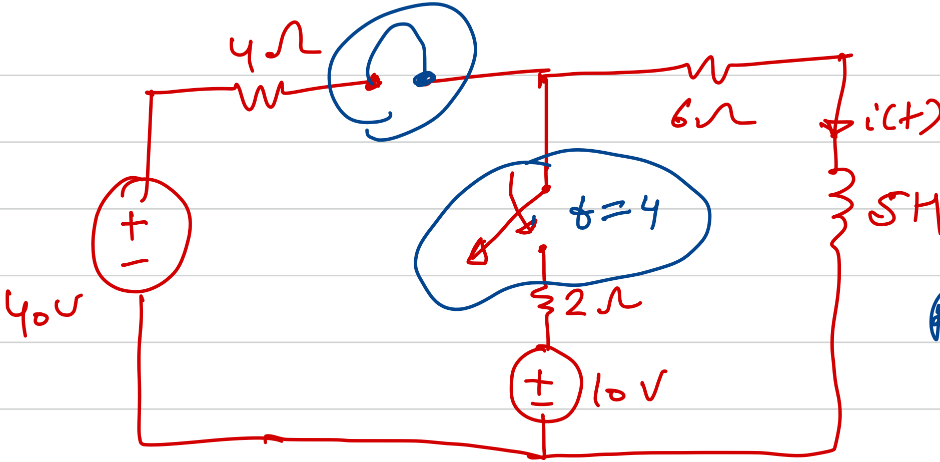
$i(t)$ $t>0$

$t<0$ $0<t<4$ $t\geq 4$

$-\infty < t < 0$

$i(0-) = 0 = i(0+)$

$0 < t < 4$

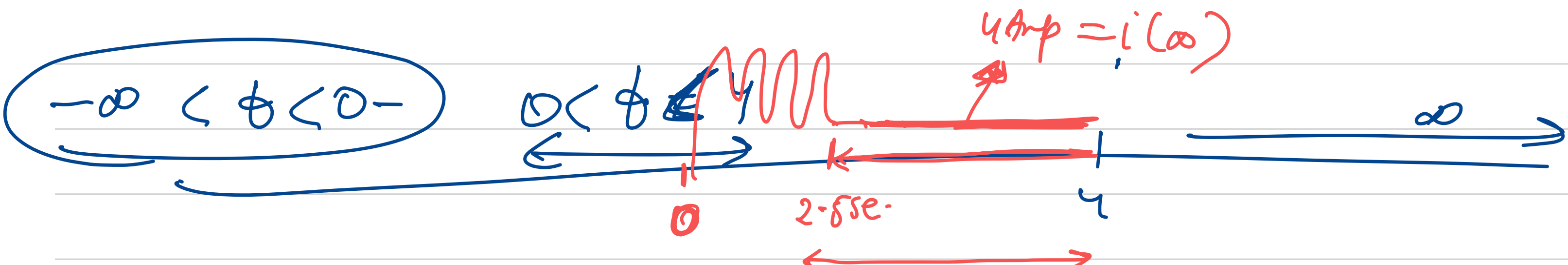


$i(\infty)$ $i(2.5) =$

$i(\infty) = 4$ Amp

$R_{th} = 10$ $\tau = 0.5$

$5\tau = 2.5$ sec



$i_L(t) = i(\infty) + (i(0) - i(\infty))\, e^{-t/\tau}$

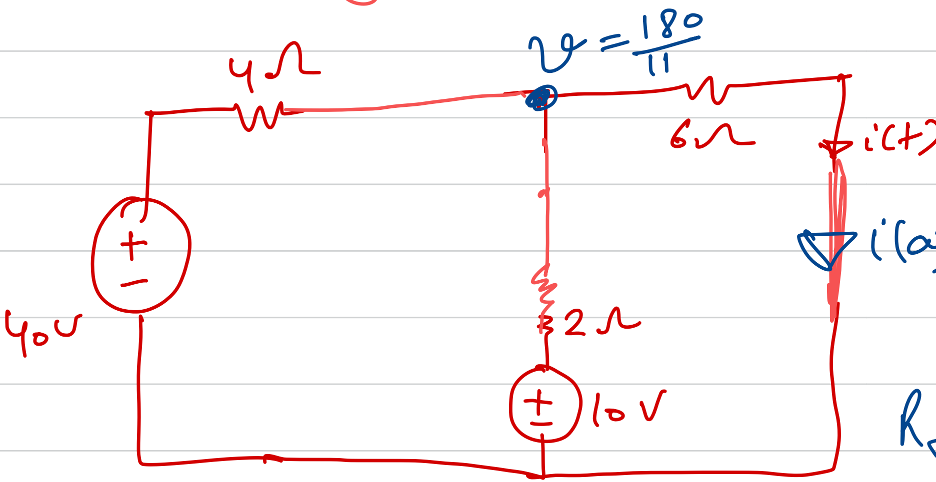
$i(t) \Rightarrow 4 - \cancel{0} - 4e^{-t/\tau} \Rightarrow 4(1 - e^{-2t})$ Amp. $0 < t < 4$

$$4(1-e^{-2t}) \quad 0<t<4 \Rightarrow 4(1-e^{-2t})\left[u(t)-u(t-4)\right]$$

$t>4$

$$i(4^-) = 4(1-e^{-2\times4}) = 4\,\text{Amp} = i(4^+)$$

$i(\infty)$



$$i(\infty) = \frac{180}{11\times6} = 2.727$$

$$R_{th} = (4\|2)+6 = \frac{22}{3}\,\Omega$$

$$\tau = \frac{L}{R_{th}} = \frac{15}{22}\,\text{sec}$$

$$i(t) = i(\infty) + \left(i(4^{+}) - i(\infty)\right)e^{-(t-4)/\tau}$$

$$= 2.727 + (4 - 2.727)e^{-(t-4)/\tau}$$

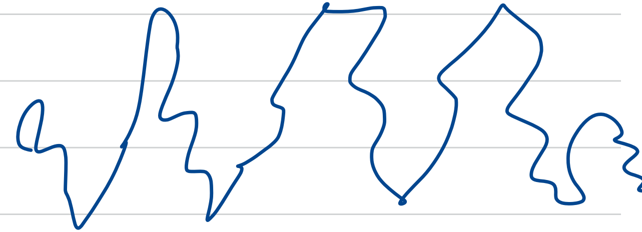
$$\Rightarrow$$

$$i(t) = \begin{cases} 0 & t < 0 \\ 4(1-e^{-2t}) & 0 \le t < 4 \\ 2.727 + 1.273e^{-1.4667(t-4)} & t \geq 4 \end{cases}$$

$i(t)$ $(t=2)$

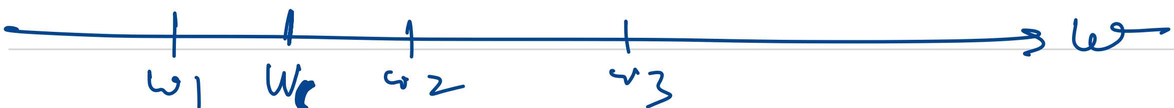
$(t=5)$

{Filters}

$\cos\omega_1 t + \cos\omega_2 t + \cos\omega_3 t =$ 

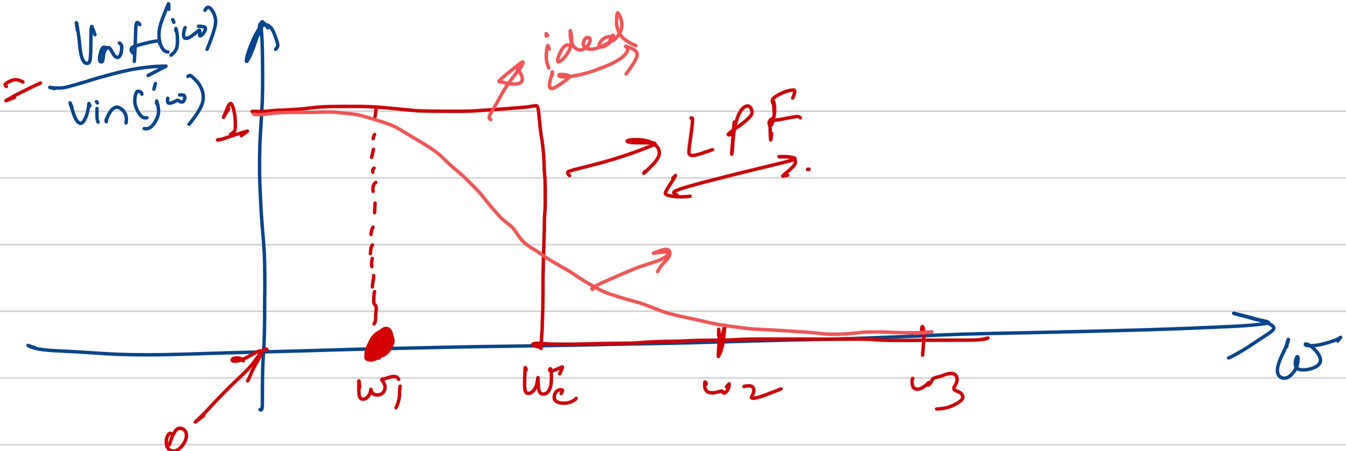
Device $\rightarrow$ ($\cos\omega_1 t$)

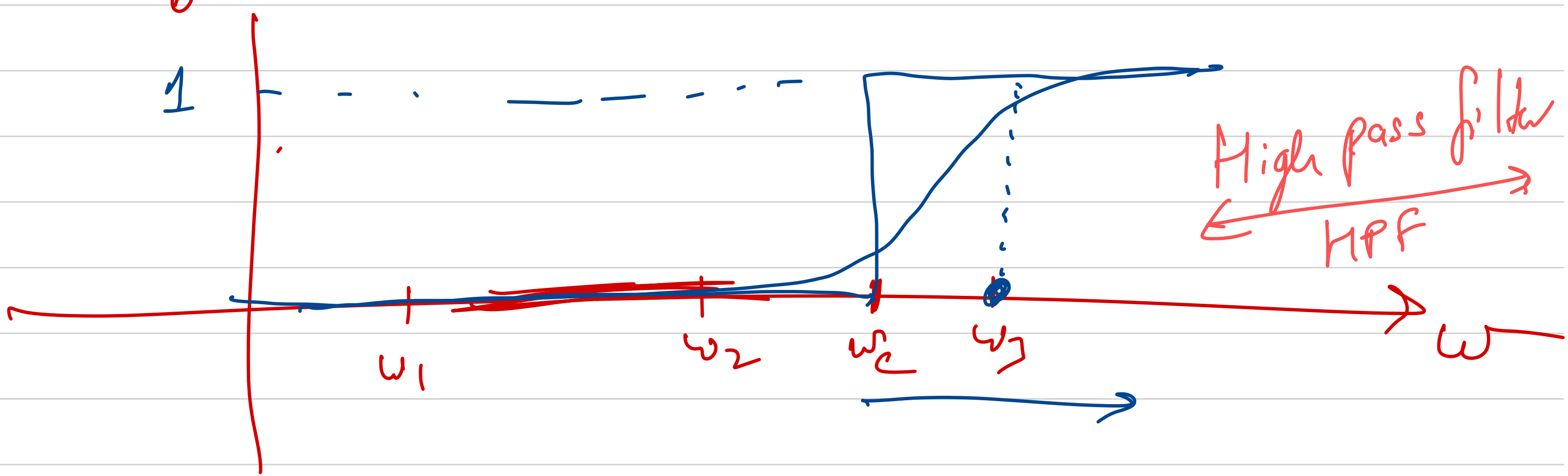
LPF (Low pass filters)

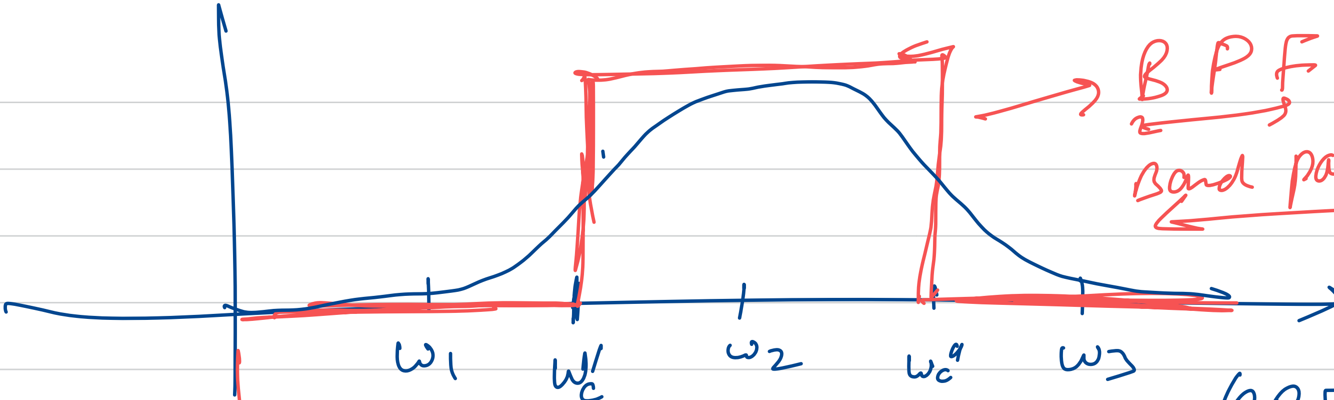


$\omega_1 < \omega_2 < \omega_3$

$$A_v = \frac{V_{out}(j\omega)}{V_{in}(j\omega)}$$

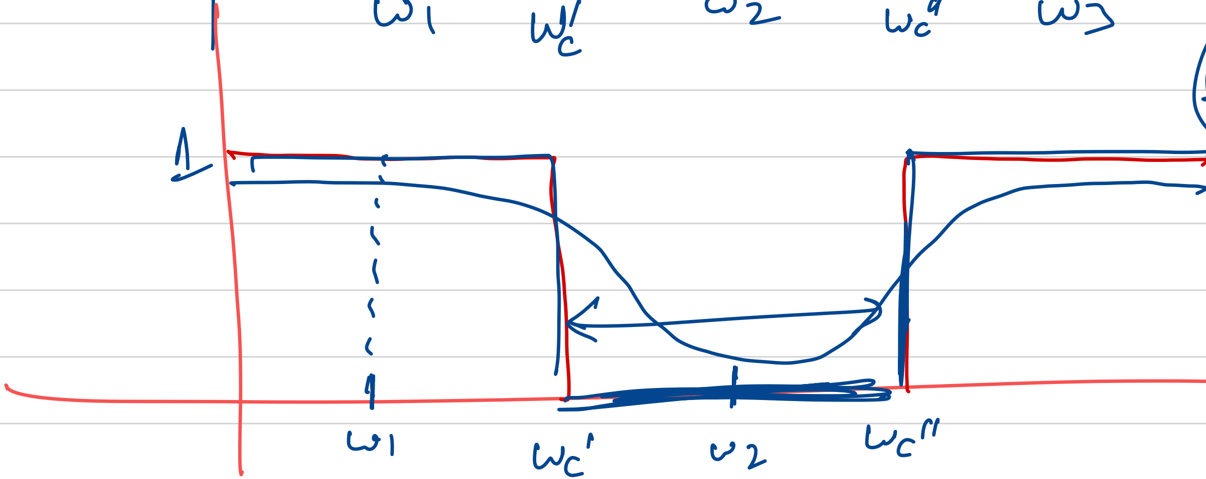






BPF

Band pass filter

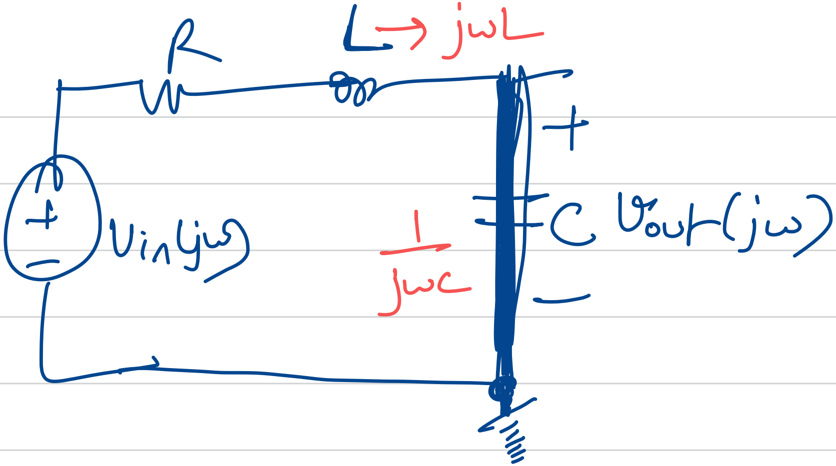


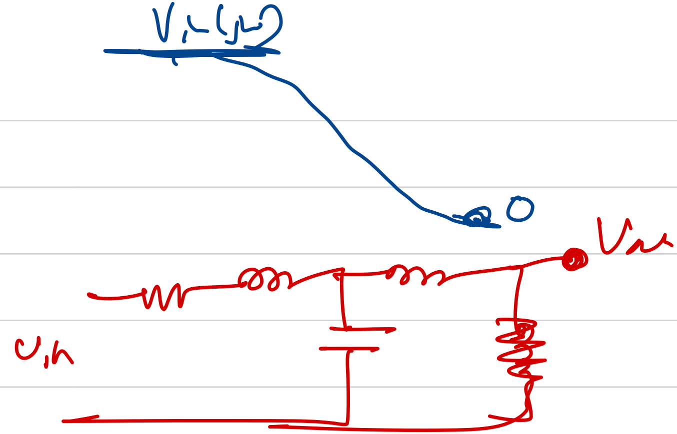
(BRF)

Bandreject filter

Passive circuit

"Opamp" → Active circuit



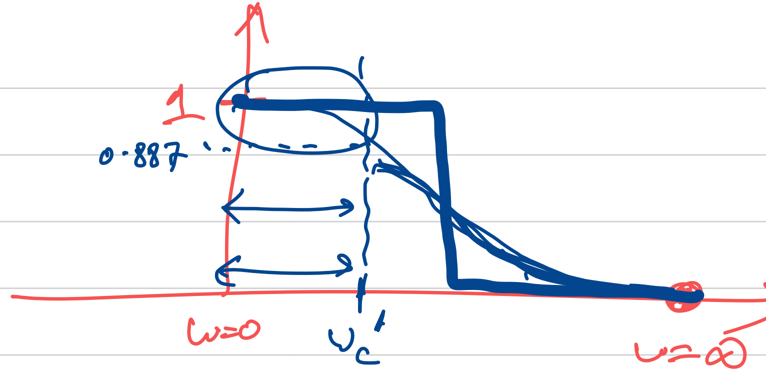


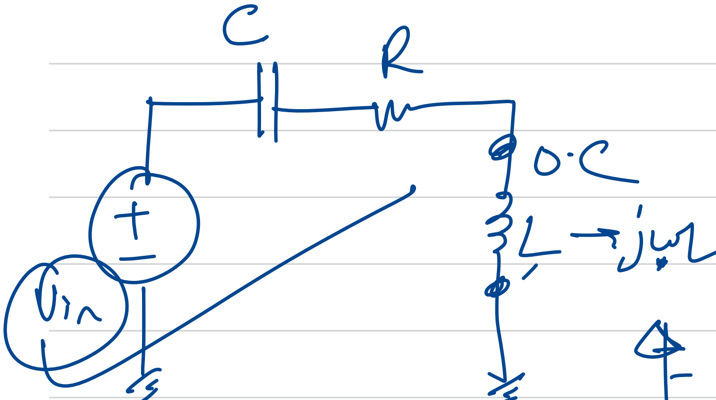
$$v_{out}(j\omega) = \frac{\frac{1}{j\omega C}}{\left(\frac{1}{j\omega C} + R + j\omega L\right)} v_{in}(j\omega)$$

$$\frac{v_{out}(j\omega)}{v_{in}(j\omega)} = \frac{1/LC}{\left\{\left(\frac{1}{LC} - \omega^2\right) + j\omega R/L\right\}} = \text{"}A_v\text{"}$$

$\omega \to 0 \Rightarrow 1$

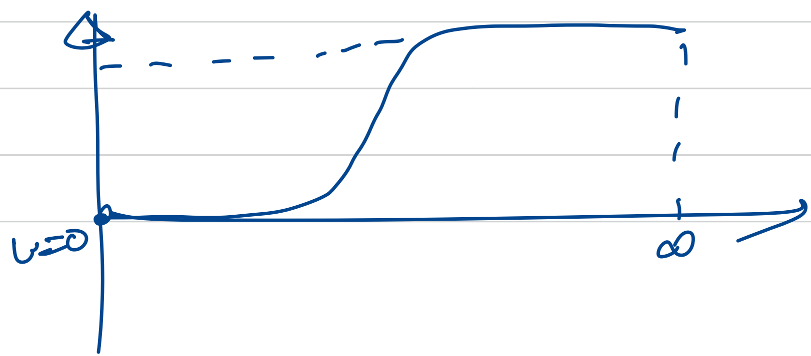
$\omega \to \infty \Rightarrow 0$





$\omega = 0 \to L = S.C = 0 \quad V_o = 0$

$\omega \to \infty \quad L = O.C \Rightarrow V_{in}$



$$\frac{V_{out}(j\omega)}{V_{in}(j\omega)} = \frac{j\omega L}{\left(R + j\omega L + \frac{1}{j\omega C}\right)}$$

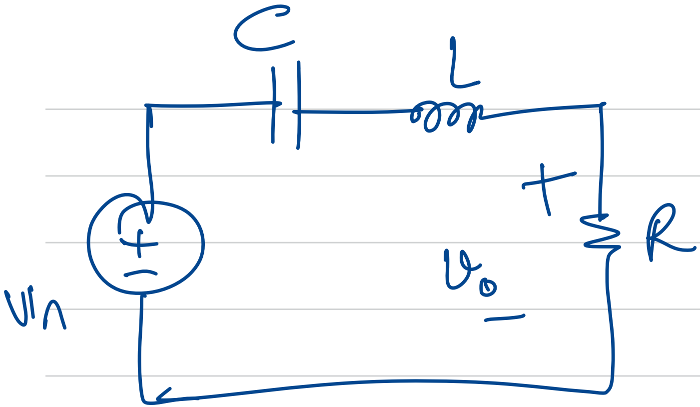
High pass filter

$$= \left\{ \frac{-\omega^2}{\left(\frac{1}{LC} - \omega^2\right) + j\frac{R\omega}{L}} \right\}$$

$\omega = 0$

0

$\omega \Rightarrow \infty \rightarrow 1$

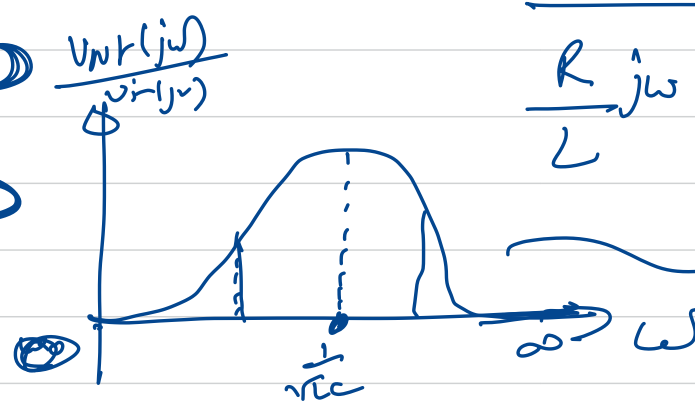


$$\frac{v_o(j\omega)}{v_{in}(j\omega)} = \frac{R}{\left(R + j\omega L + \frac{1}{j\omega C}\right)}$$

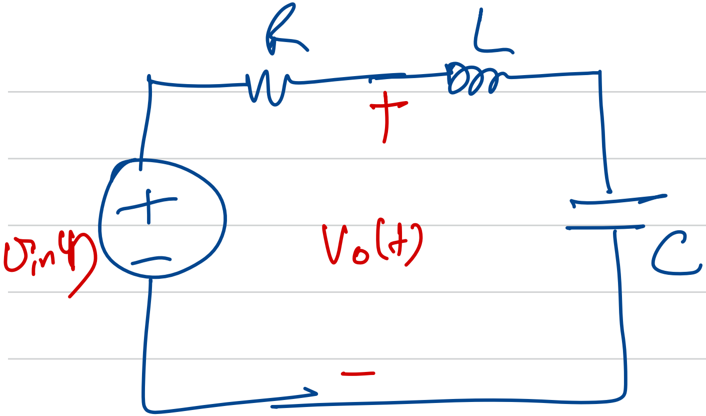
$$= \frac{\frac{R}{L} j\omega}{\frac{R}{L} j\omega + \left(\frac{1}{LC} - \omega^2\right)}$$

$\omega \to 0 \rightarrow 0$

$\omega = \infty \rightarrow 0$



B.P.F



$\cancel{V_o(t)}$

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

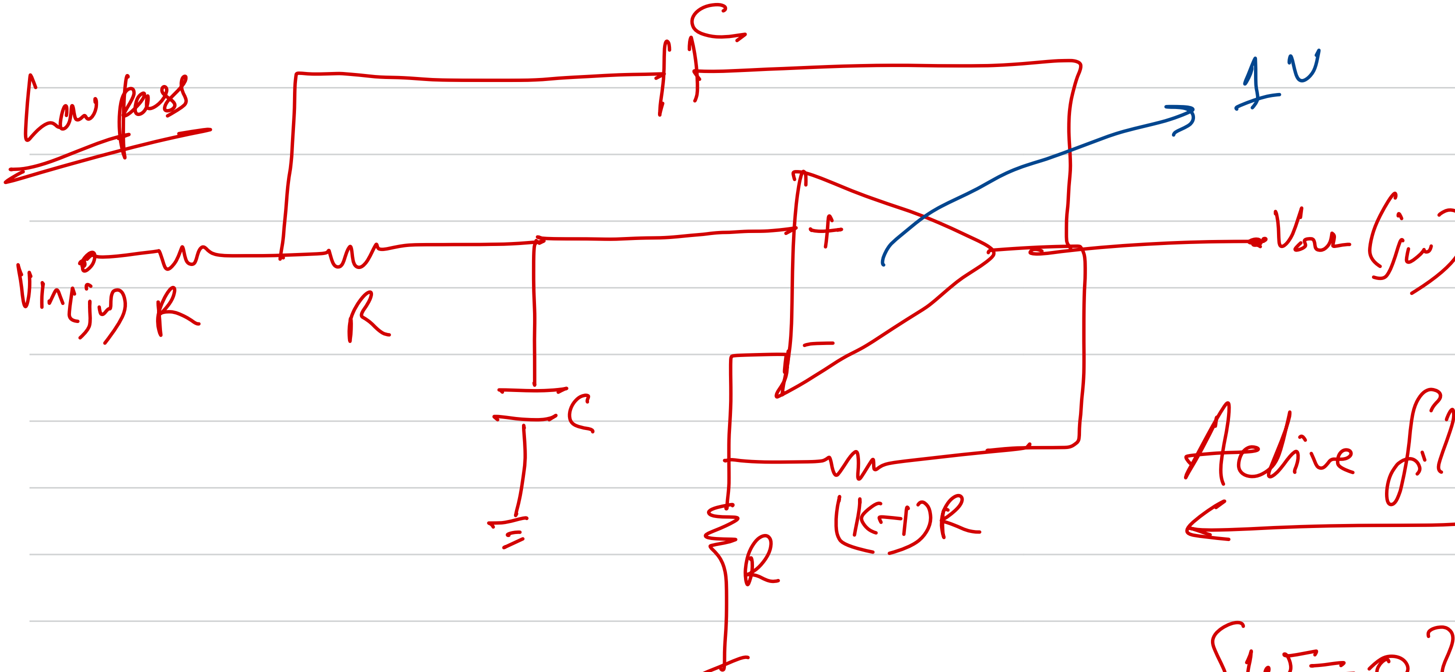
$\omega \Rightarrow 0$ 1

$\omega \to \infty$ 1

$$\frac{V_o(j\omega)}{v_i(j\omega)} = \frac{\frac{1}{LC} - \omega^2}{\left(\frac{1}{LC} - \omega^2\right) + j\frac{R}{L}\omega}$$

Passive filters

Low pass



Active filters

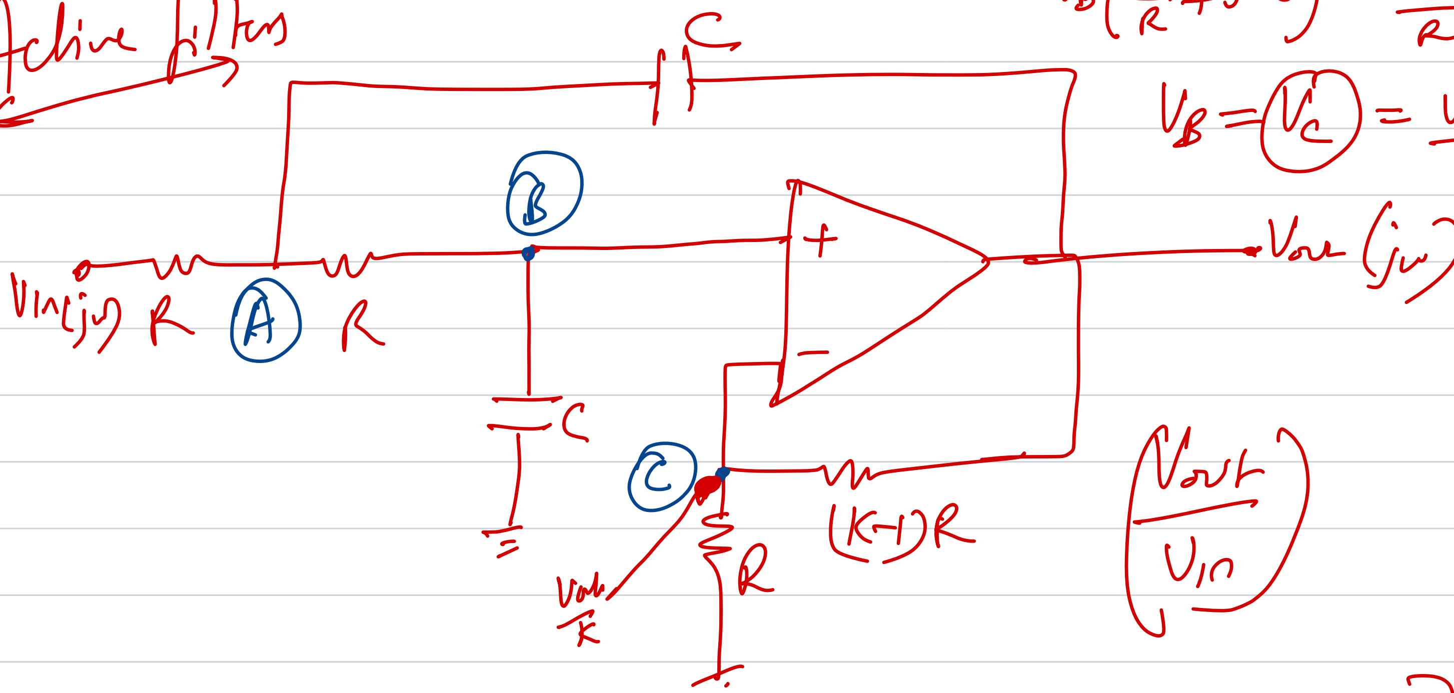
$$\boxed{\frac{V_{out}}{V_{in}} = \frac{K/R^2C^2}{\left(\frac{1}{R^2C^2} - \omega^2\right) + \frac{j\omega}{RC}(3-K)}}$$

$$\left\{\begin{array}{l}\omega = 0 \\ \omega \to \infty\end{array}\right\}$$

Active filters

$$V_B\left(\frac{1}{R}+j\omega C\right)-\frac{V_A}{R}=0$$

$$V_B=V_C=\frac{V_{out}}{K}$$



$$\left(\frac{V_{out}}{V_{in}}\right)$$

$$\left\{V_A\left\{\frac{1}{R}+\frac{1}{R}+j\omega C\right\}-V_{out}\,j\omega C-\frac{V_{out}}{KR}-\frac{V_{in}}{R}=0\right\}$$