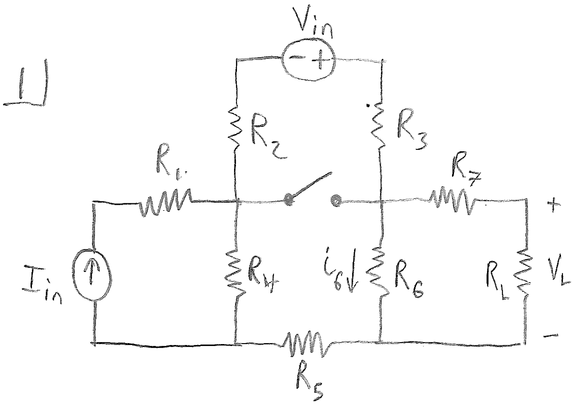
1)



a) $V_6 = i_6 R_6$

$$V_L = V_6 \cdot \frac{R_L}{R_7 + R_L} \Rightarrow V_L(R_7 + R_L) = V_6 R_L$$

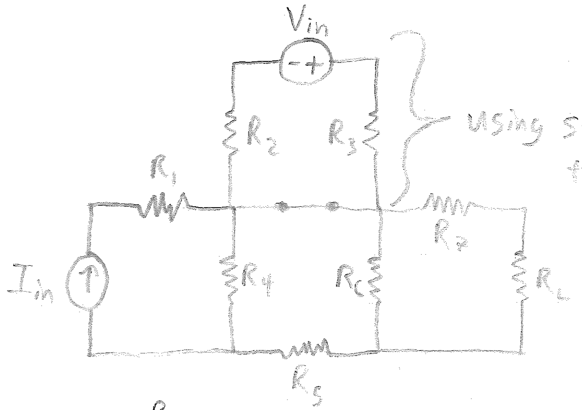
$$\Rightarrow R_L(V_6 - V_L) = V_L R_7 \Rightarrow \boxed{R_L = \frac{V_L R_7}{(V_6 - V_L)}}$$

b) $\boxed{i_{V_{in}}} = i_6 + \frac{V_L}{R_L}$

$$\boxed{V_{in}} = i_{V_{in}} R_3 + i_{V_{in}} (R_6 \| (R_7 + R_L)) + i_{V_{in}} R_5 + (i_{V_{in}} - I_{in}) R_4 + i_{V_{in}} R_2$$

$$= i_{V_{in}} (R_2 + R_3 + R_4 + R_5 + (R_6 \| (R_7 + R_L))) - I_{in} R_4$$

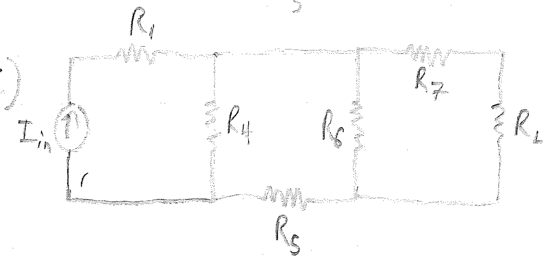
$\boxed{V_{I_{in}}} = I_{in} R_1 + (I_{in} - i_{V_{in}}) R_4$ $\boxed{P_{supplied} = V_{I_{in}} \cdot I_{in} + V_{in} i_{V_{in}}}$



Using superposition, we can see that closing the switch shorts the circuit, therefore current across R_2 and R_3 is only from V_{in}, and current across all other resistors is only from I_{in}

$\therefore$ d) $\boxed{P_{R_L}(V_{in}) = 0\ W}$

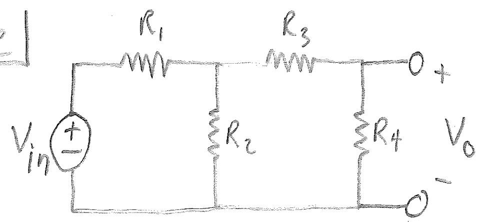
c)



$$i_5 = \frac{I_{in} R_4}{R_4 + (R_5 + R_6 \| (R_7 + R_L))}$$

$$i_L = \frac{i_5 R_6}{R_6 + R_7 + R_L} \qquad \boxed{V_L = i_L R_L}$$

2)

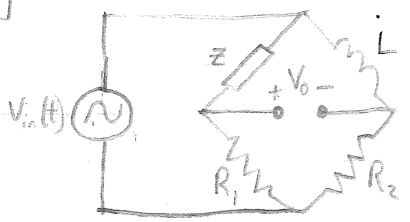


a) $V_2 = \frac{V_{in} (R_2 \| (R_3 + R_4))}{R_1 + R_2 \| (R_3 + R_4)} \Rightarrow \boxed{V_0 = \frac{V_2 R_4}{R_3 + R_4} = V_{Th}}$

$$\boxed{R_{eq} = R_4 \| (R_3 + R_1 \| R_2)}$$

b) $\boxed{V_5 = \frac{V_0 R_5}{R_{eq} + R_5}}$

3)



a) $Z_L = j\omega L$

$V_{in}(t) = I_1(t)(Z+R_1) = I_2(t)(Z_L+R_2) \Rightarrow I_2 = I_1\frac{Z+R_1}{Z_L+R_2}$

$V_0 + I_2R_2 - I_1R_1 = 0 \Rightarrow I_1R_1 = I_2R_2 \Rightarrow I_2 = I_1\frac{R_1}{R_2}$

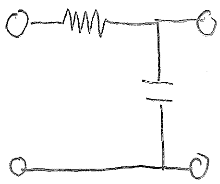
$\cancel{I_1}\frac{R_1}{R_2} = \cancel{I_1}\frac{Z+R_1}{Z_L+R_2} \Rightarrow Z+\cancel{R_1} = \frac{R_1}{R_2}Z_L + \cancel{R_1} \Rightarrow \boxed{Z = \frac{R_1}{R_2}Z_L}$

b) Inductor: $\boxed{L_{eq} = \frac{Z}{j\omega}}$

c) $Z_{eq} = (Z+R_1)\|(Z_L+R_2)$ $\quad I_m = \frac{V_m}{|Z_{eq}|}$ $\quad \boxed{|S| = \frac{V_m \cdot I_m}{2}}$

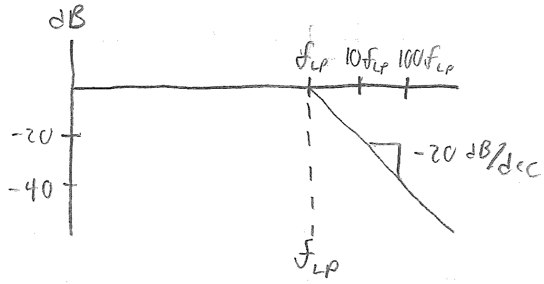
4)

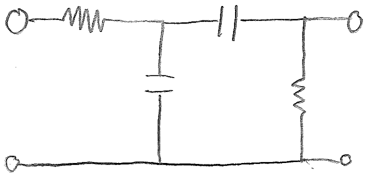
a)



1st order Low-Pass filter

$f_{B,LP} = (2\pi RC)^{-1}$



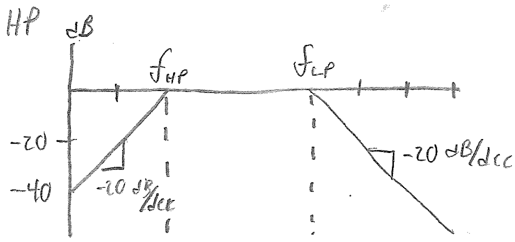


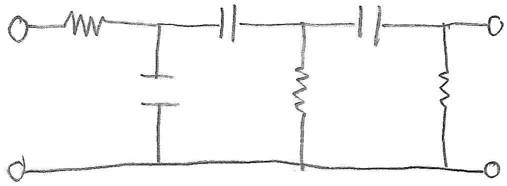
1st order LP + 1st order HP

or

1st order Band-Pass

$f_{B,HP} = (2\pi RC)^{-1}$

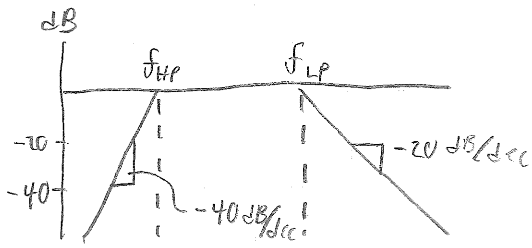




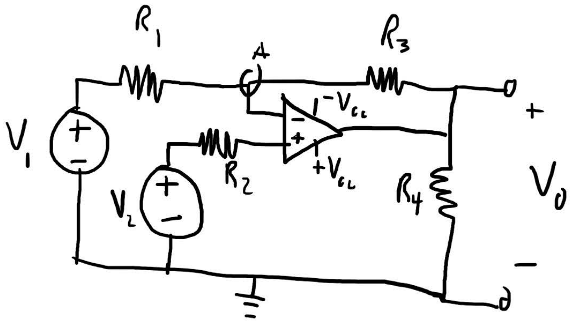
1st order LP

+

2nd order HP



5|



a) $V_A = V_2$

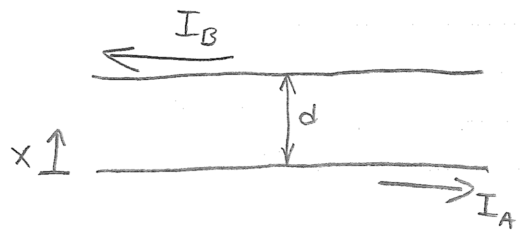
$$\frac{V_1 - V_2}{R_1} + \frac{V_o - V_2}{R_3} = 0$$

$$\boxed{V_o = V_2\left(1+\frac{R_3}{R_1}\right) - V_1\left(\frac{R_3}{R_1}\right)}$$

b) $V_1 \in [-v_1, v_1]$

$V_2 \in [-v_2, v_2]$ $\quad \boxed{|V_{cc}| \geq V_o(v_1, v_2)}$

6|



a)

$$\vec{B} = \int d\vec{B} = \frac{\mu_0 I}{4\pi}\int \frac{d\vec{s} \times \hat{r}}{r^2} \xRightarrow[\text{wire}]{\text{Infinite}} |B| = \frac{\mu_0 I}{4\pi}\frac{2}{r} = \frac{\mu_0 I}{2\pi r}$$

$$\vec{B}(x) = \vec{B}_A(x) + \vec{B}_B(x) = \frac{\mu_0 I_A}{2\pi x} + \frac{-\mu_0 I_B}{2\pi (x-d)} = \boxed{\frac{\mu_0 I}{2\pi}\left(\frac{1}{x} - \frac{1}{x-d}\right)}$$

b) $\boxed{d = 0}$