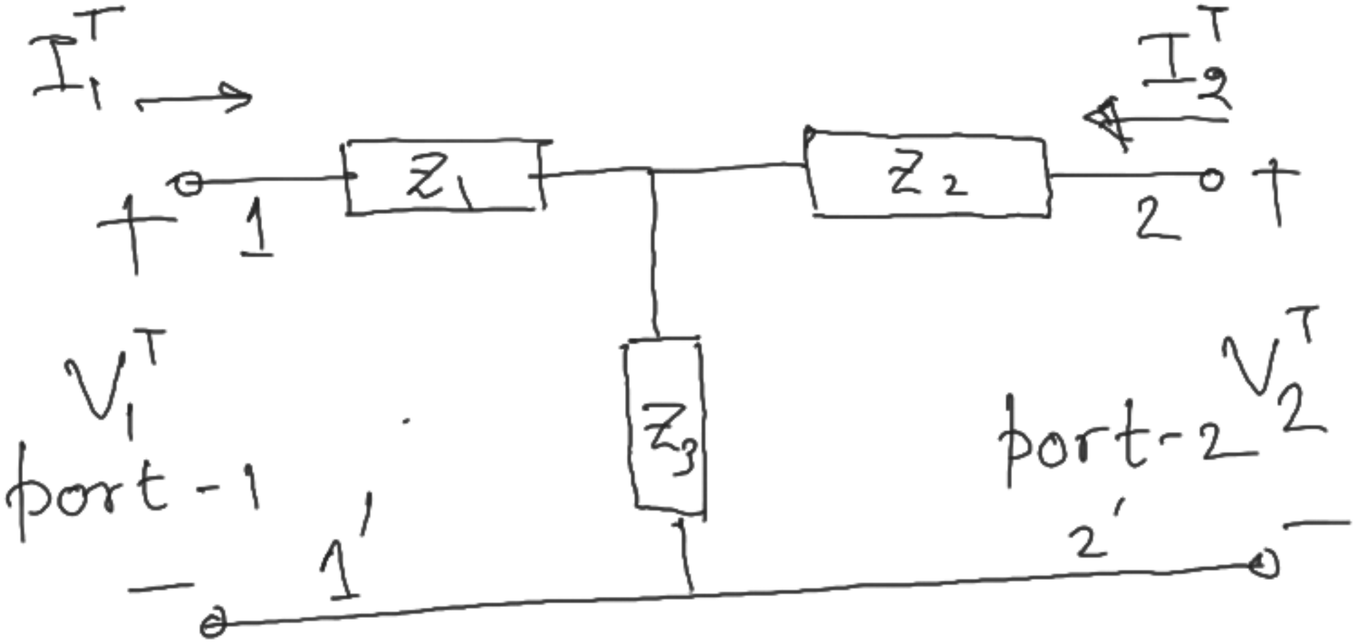
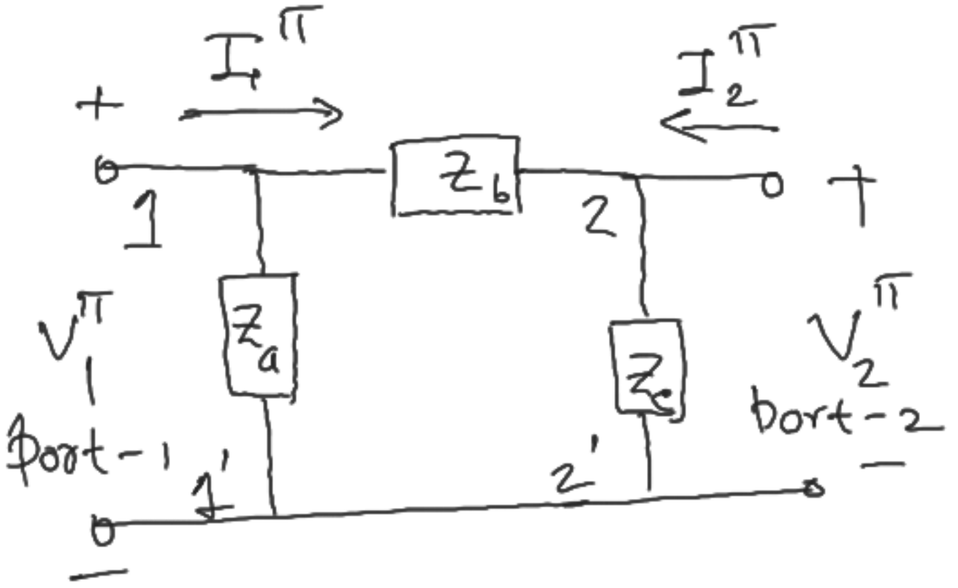
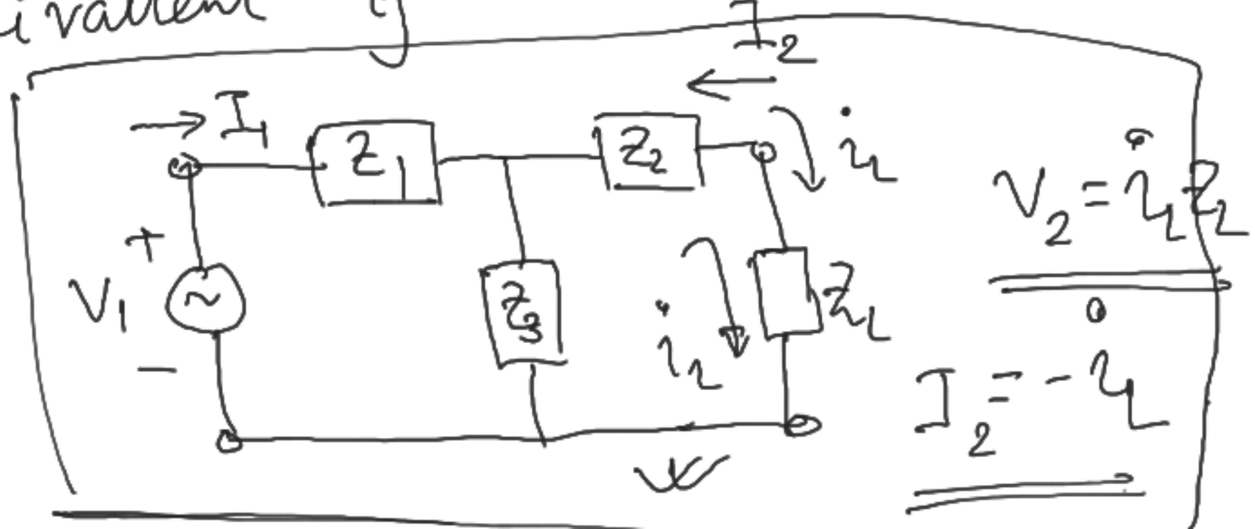
1. T – π network transformation (Star – delta transformation)

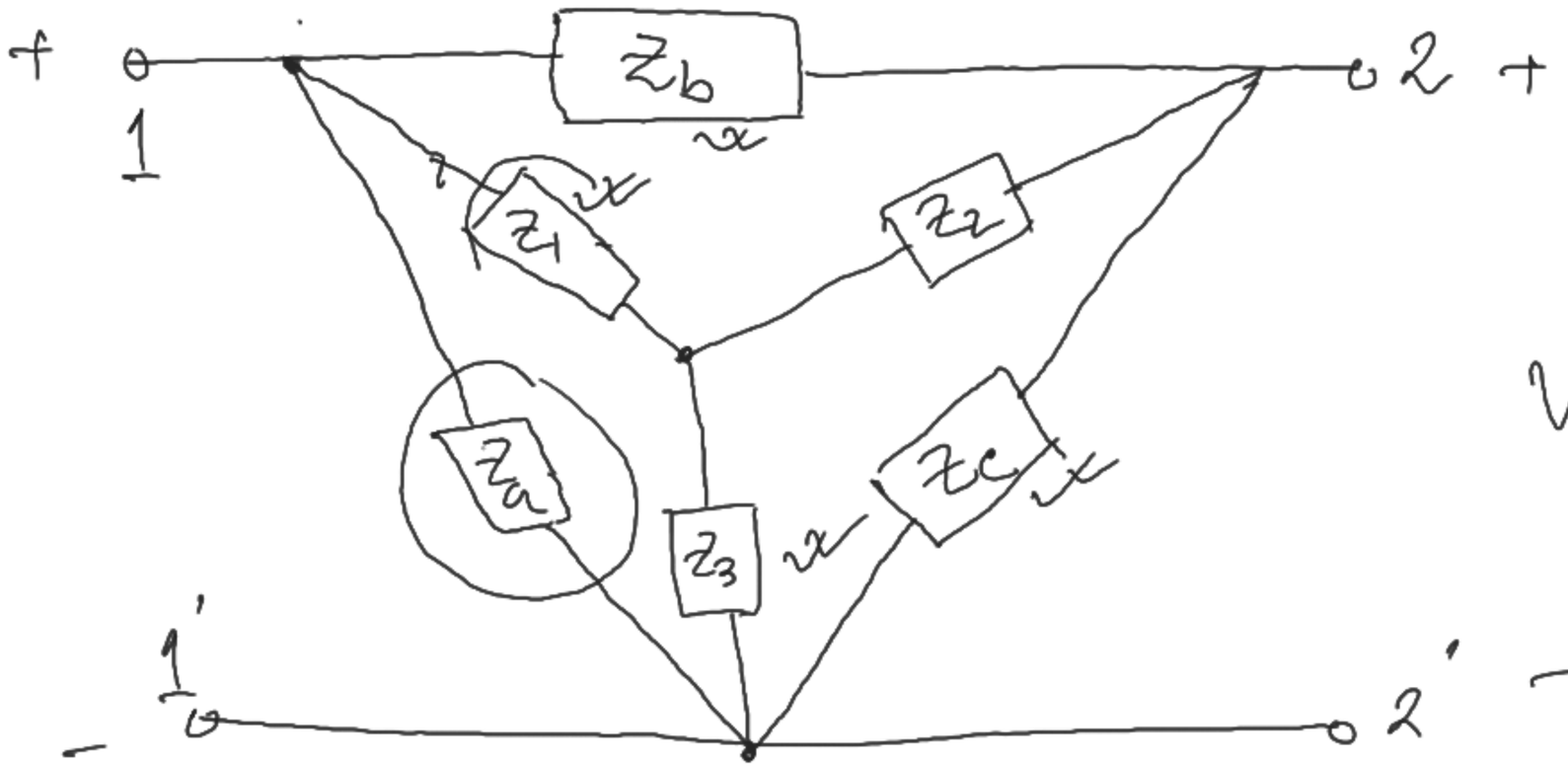




These two networks are equivallent if

$$V_1^T = V_1^{\pi} \;;\quad V_2^T = V_2^{\pi}$$
$$I_1^T = I_1^{\pi} \;;\quad I_2^T = I_2^{\pi}$$





* Ohm's law

↓ I & V

KVL, KCL

Energy conservation

Charge conservation

→ I

$V_1 = IZ$.

$$Z_1 = \frac{Z_a Z_b}{Z_a + Z_b + Z_c} \qquad Z_3 = \frac{Z_a Z_c}{Z_a + Z_b + Z_c}$$

$$Z_2 = \frac{Z_b Z_c}{Z_a + Z_b + Z_c}$$

π to T conversion.

T to π Conversion

T network impedances are Z_1, Z_2 and Z_3.

$$\left.\begin{aligned} Z_A &= \frac{Z_1Z_2 + Z_2Z_3 + Z_1Z_3}{Z_2} \\ Z_B &= \frac{Z_1Z_2 + Z_2Z_3 + Z_1Z_3}{Z_3} \\ Z_C &= \frac{Z_1Z_2 + Z_2Z_3 + Z_1Z_3}{Z_1} \end{aligned}\right\}.$$

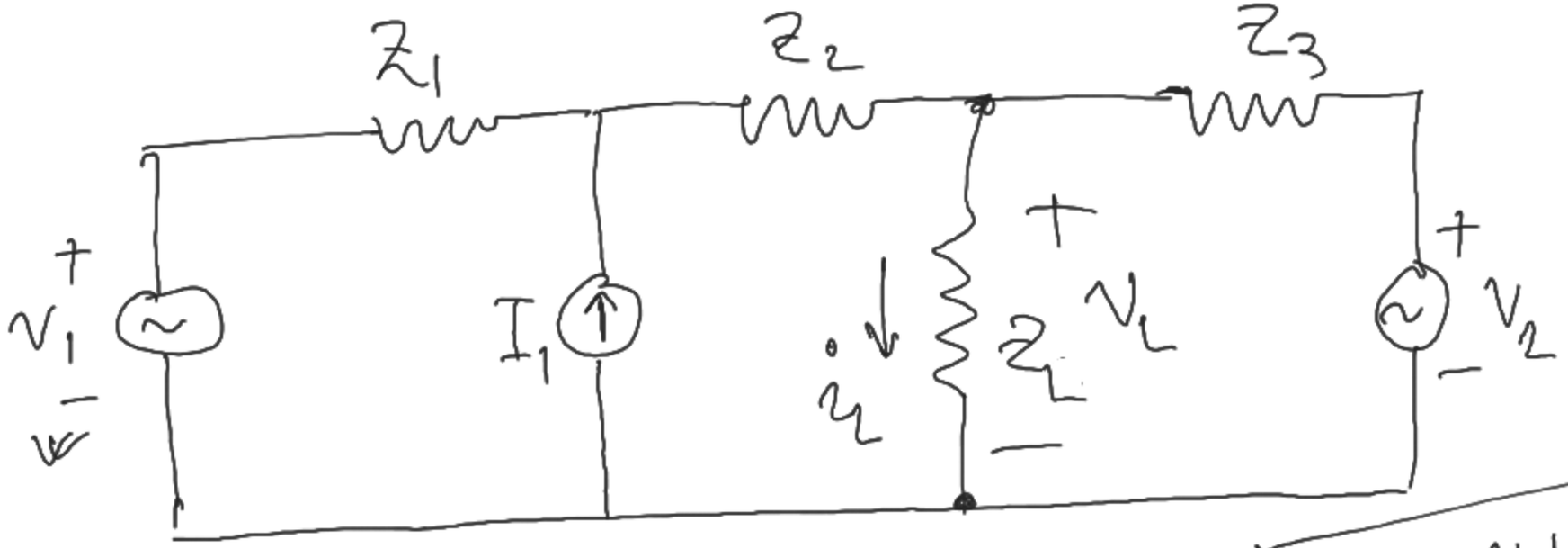
2. Superposition Theorem

Statement: If a network of linear elements contains several independent energy sources, the total response is the sum of all the responses if each independent source acted separately and all other sources were replaced by their internal impedances.

Linear element: I - V relation is linear.

$I \propto V$.

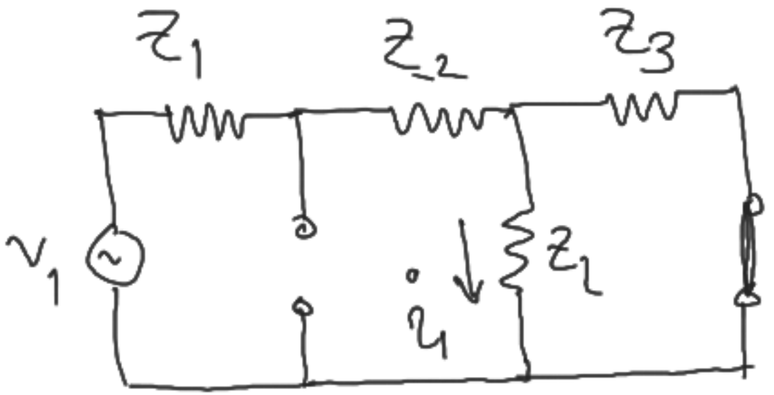
$I \propto V^{3/2}$

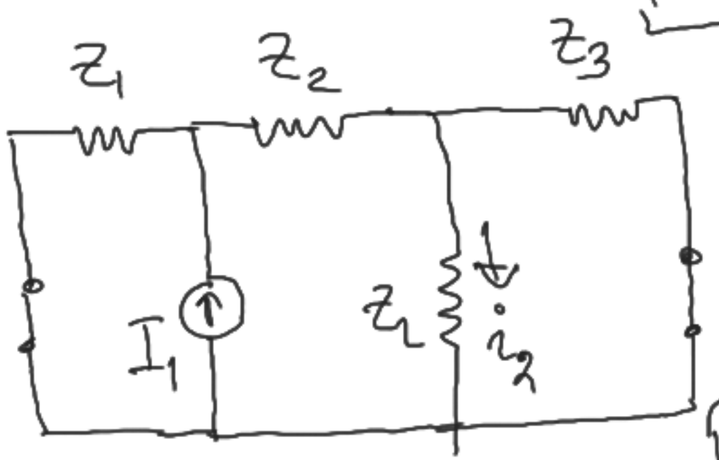


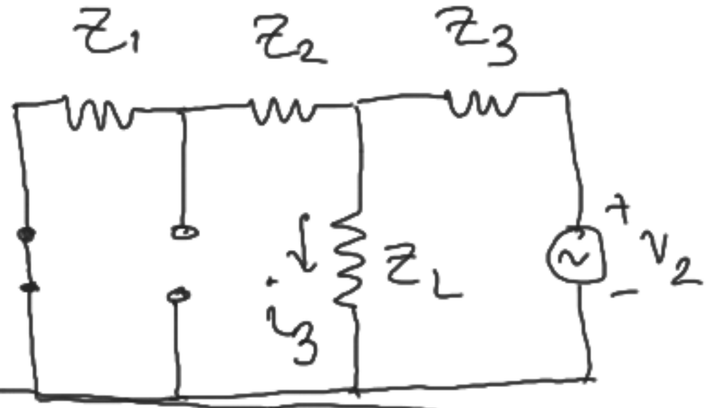
$V_L = V_1 + V_2 + V_3$

$V_L = i_1 Z_L + i_2 Z_L + i_3 Z_L$

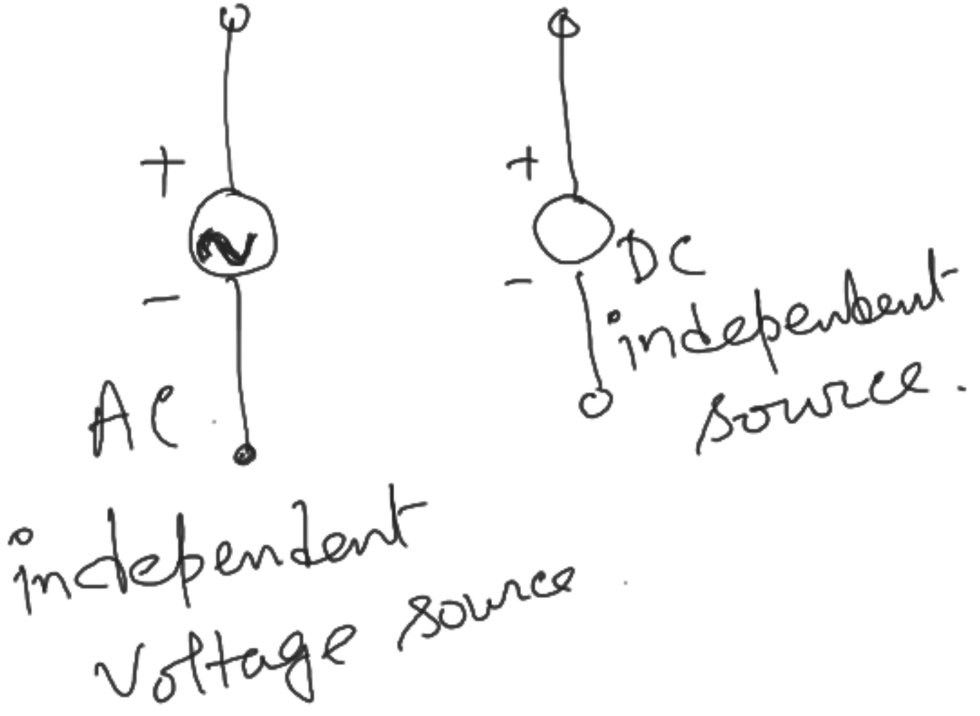
V_1, I_1 and V_2 are independent:

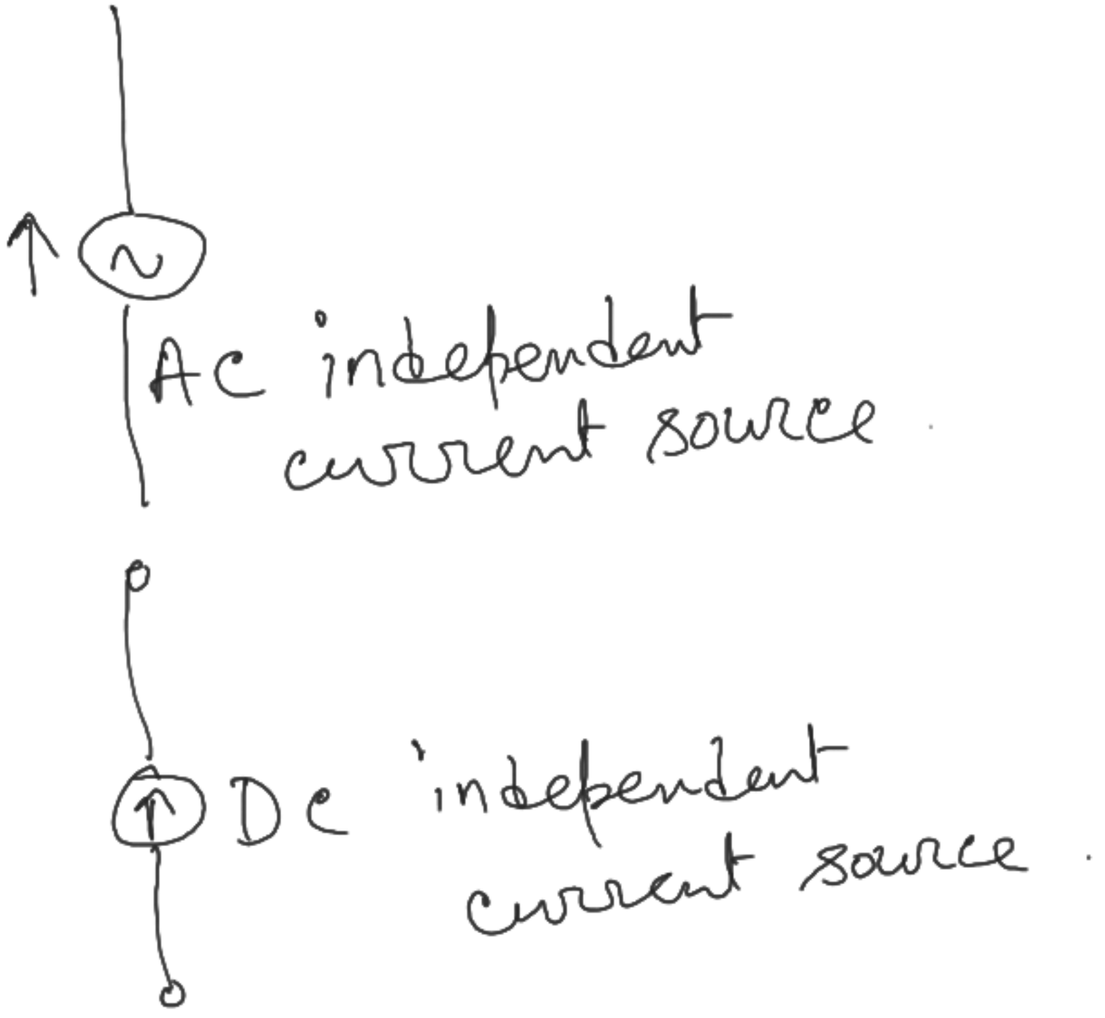


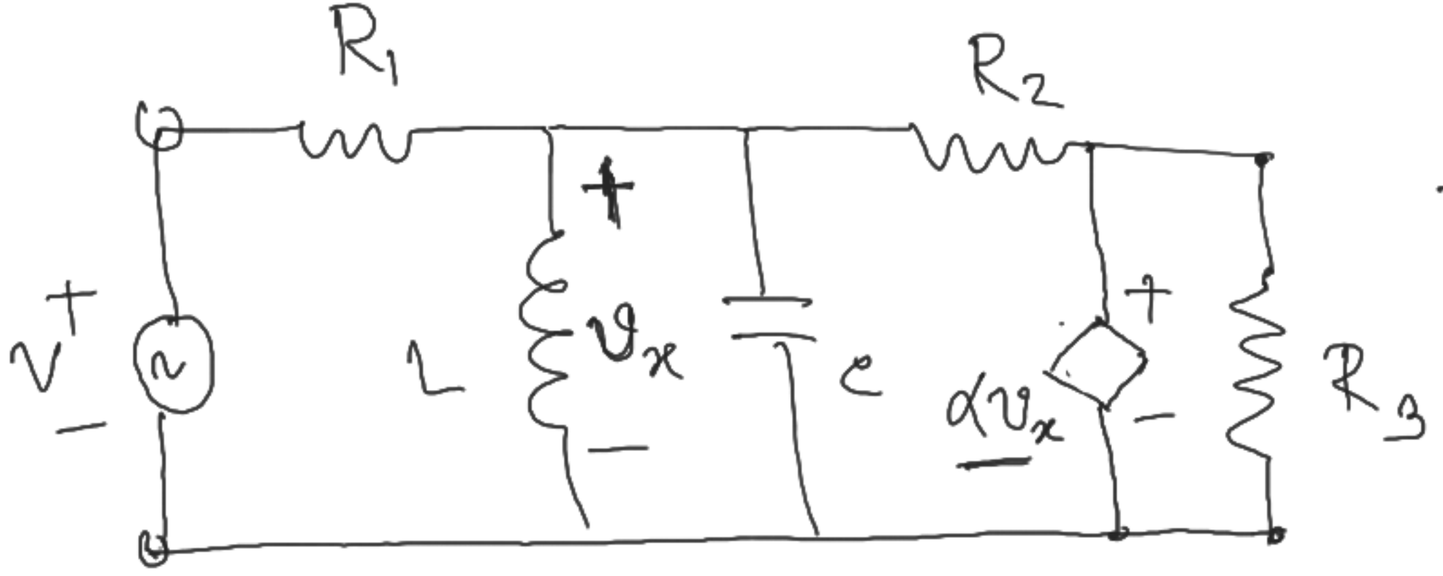


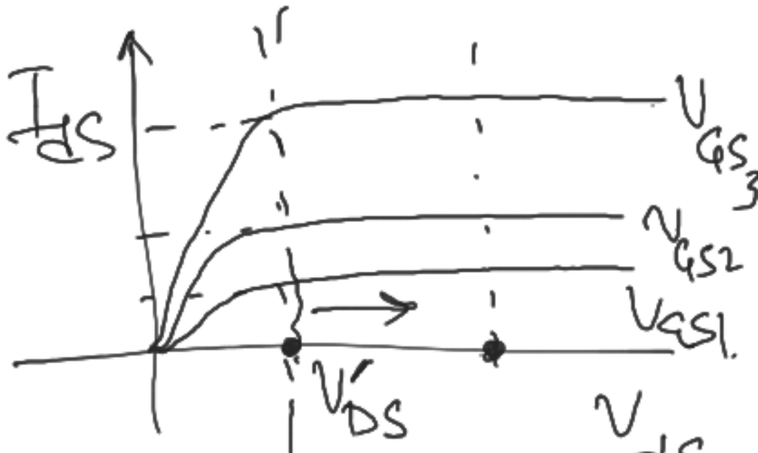


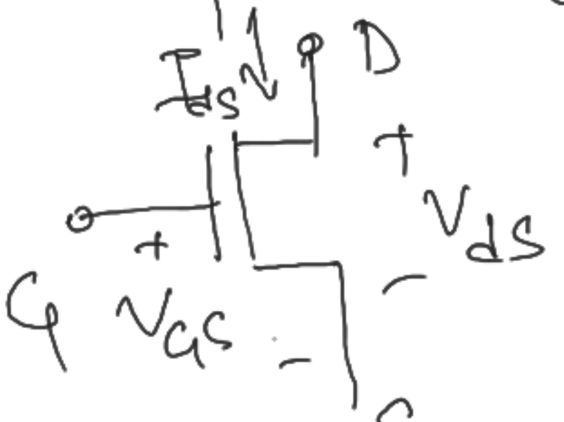
$i_L = i_1 + i_2 + i_3$


+
−
AC
independent
voltage source
+
−
DC
independent
source.


AC independent
current source
DC independent
current source.





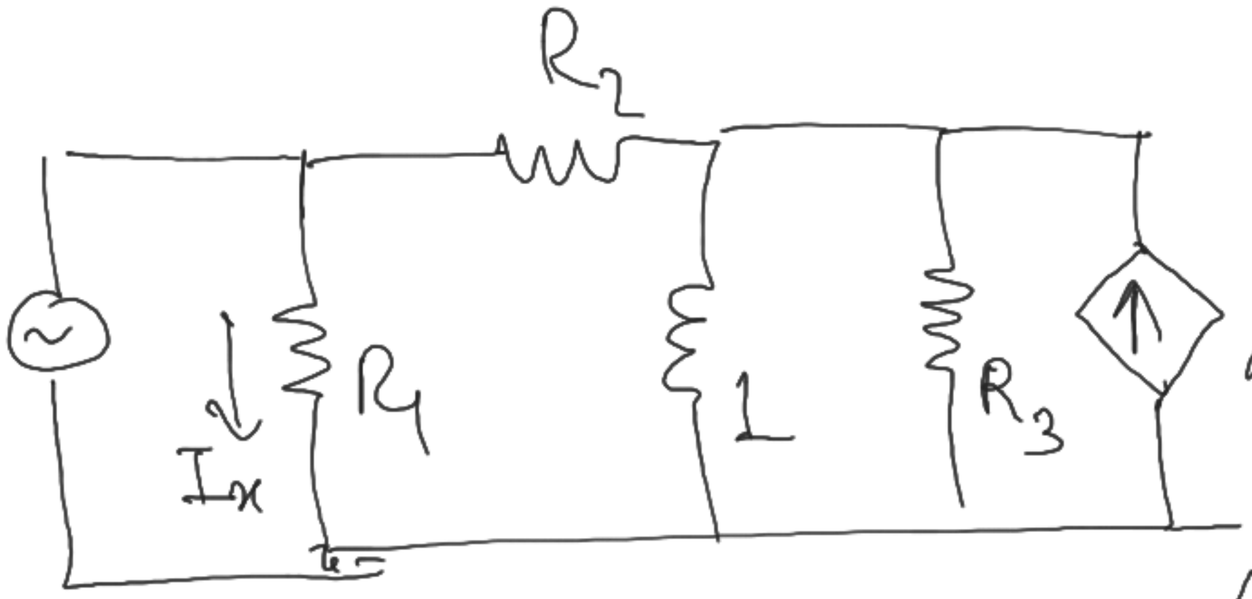


* Current dependent current source. α is a constant.

✓ Voltage dependent current source.

✓ Voltage dependent voltage source.

$I_{ds} \Rightarrow f(V_{GS})$ beyond V_{ds}



Current controlled (dependent) current source.