EE530L: Home work 1

1. Find the equivalent resistances between each of the terminal pairs (1,2), (2,3), and (3,1) in figure 1.

Use Y-Δ transformation:

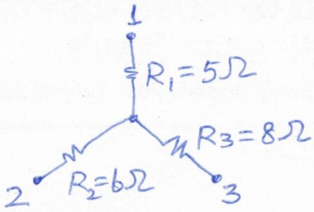

Figure 1

$$R_{12} = R_1 + R_2 + \frac{R_1 R_2}{R_3} = \boxed{14.75\Omega},$$

$$R_{23} = R_2 + R_3 + \frac{R_2 R_3}{R_1} = \boxed{22\Omega},$$

$$R_{31} = R_3 + R_1 + \frac{R_3 R_1}{R_2} = \boxed{19.67\Omega}.$$

2. Solve for the current i flowing through impedance Z_0 in Fig. 2. Assume v, i_1, i_2, $Z_1, \ldots, Z_7$ are all given.

Use KVL around ADB.

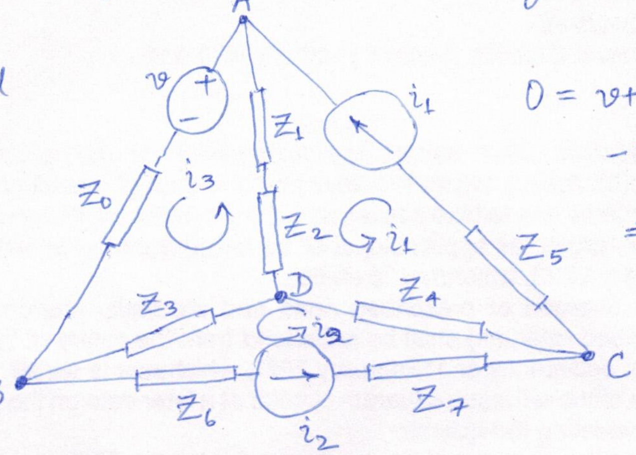

Figure 2

$$0 = v + i_3(Z_0 + Z_3 + Z_1 + Z_2) - i_1(Z_1 + Z_2) - i_2 Z_3$$

$$\Rightarrow i = i_3 = \boxed{\frac{i_1(Z_1+Z_2) + i_2 Z_3 - v}{Z_0 + Z_1 + Z_2 + Z_3}}.$$

3. How many linearly independent currents exist in the network/circuit shown in Figure 3? Assume all the blobs are passive two terminal networks.

Use Euler's formula.

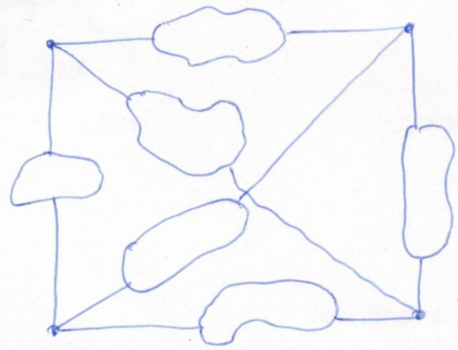

Figure 3

$$V - E + F = 1$$

$$F = 1 + E - V$$

$$= 1 + 6 - 4 = \boxed{3}.$$

④ If the two circuits in Fig. 4 are equivalent as seen from the 2 terminals, find v_{Th} and R_{Th}.

Use Thevenin's thm:

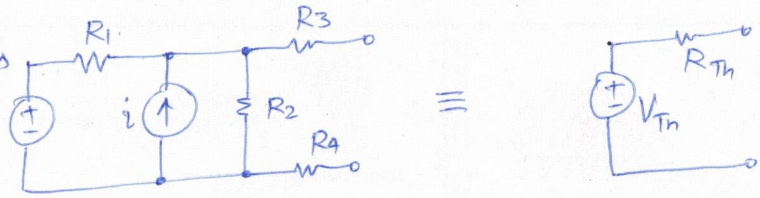

Figure 4

$$V_{th} = \boxed{\frac{\frac{v}{R_1} + i}{\frac{1}{R_1} + \frac{1}{R_2}}},$$

$$R_{th} = \boxed{\frac{R_1 R_2}{R_1 + R_2} + R_3 + R_4}.$$

⑤ If the two circuits in Fig. 5 are equivalent as seen from the two terminals, find i_{No} and R_{No}.

Use Norton's thm:

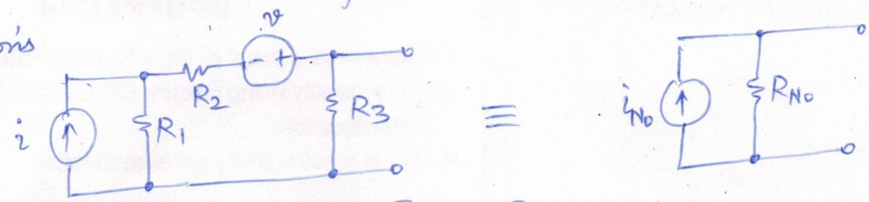

Figure 5

$$i_{No} = \boxed{\frac{v + iR_1}{R_1 + R_2}}.$$

$$R_{No} = \boxed{\frac{R_3(R_1+R_2)}{R_1+R_2+R_3}}.$$

⑥ Solve for the voltage across Z_0 in the circuit of Fig. 6.

Apply ~~KVL~~ KCL at node 1:

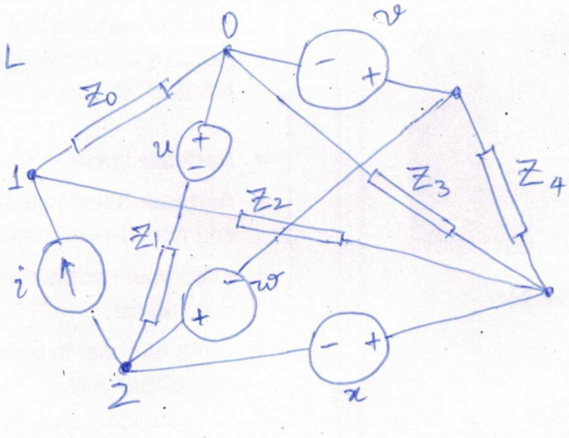

Figure 6

W.l.o.g. $v_0 = 0$.

$$\frac{v_1}{Z_0} + \frac{v_1 - (v + w + x)}{Z_2} = i$$

$$\Rightarrow v_1 = \boxed{\frac{\frac{v+w+x}{Z_2} + i}{\frac{1}{Z_0} + \frac{1}{Z_2}}}.$$

⑦ Find voltage at node 0 in the circuit of Fig. 7. Assume $v_1, v_2, v_3, v_4, i_5, R_1, R_2, L_3, C_4, R_6$ are all known.

Use Millman's thm:

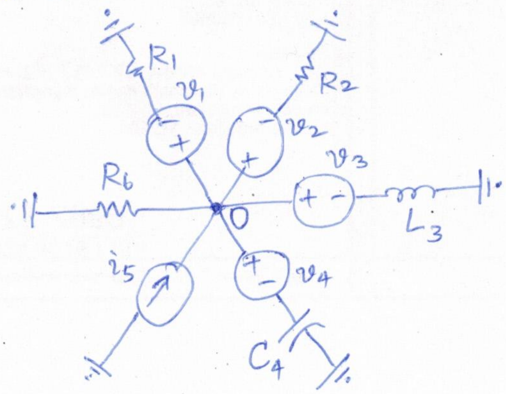

Figure 7

$$v_0 = \boxed{\frac{\frac{v_1}{R_1} + \frac{v_2}{R_2} + \frac{v_3}{sL_3} + v_4 s C_4 + i_5}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{sL_3} + sC_4 + \frac{1}{R_6}}}.$$

(8.) Find (i) R_L given R_S, and (ii) R_S given R_L, for

(a) maximum power transfer from source v_S to load R_L;

(b) maximum efficiency.

Use max. power transfer & efficiency thms:

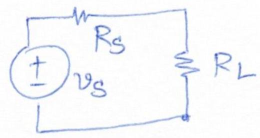

Figure 8

(ai) $R_L = \boxed{R_S}$.

(aii) $R_S = \boxed{0}$.

(bi) $R_L = \boxed{\infty}$.

(bii) $R_S = \boxed{0}$.