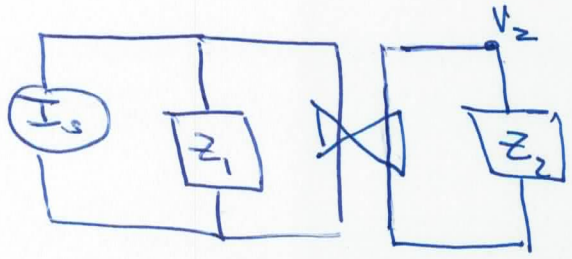
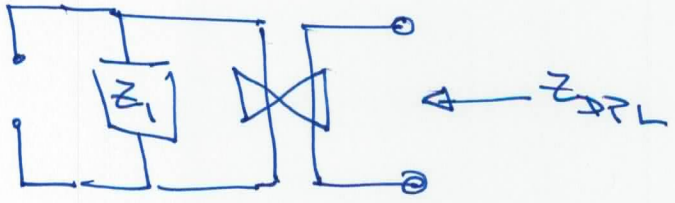
13-20



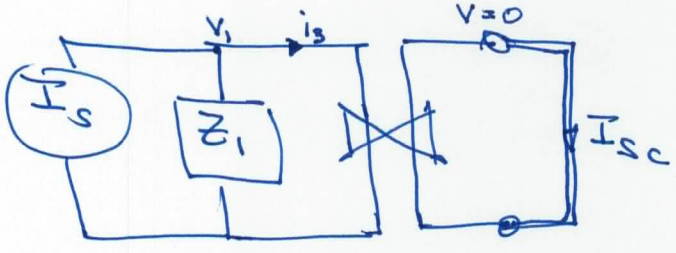
Lets use a Norton Equiv Circuit:

Z_{TPL}:



$$Z_{TPL} = G^2 \frac{1}{Z_1}$$ ✓

I_{sc}:

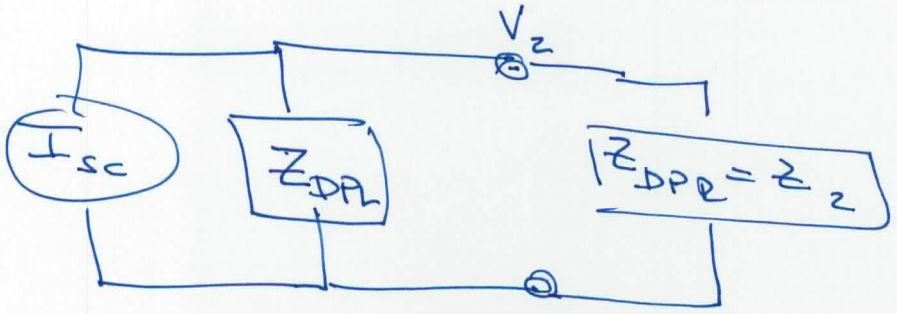


From gyrator eqn: $i_3 = 0$ (since $V=0$)
so all current goes through Z_1, hence:

$$V_1 = Z_1 \cdot I_s$$

since $V_1 = G \cdot I_{sc}$ we get $\boxed{I_{sc} = \frac{Z_1 \cdot I_s}{G}}$ ✓

So we have: (Norton eq ckt)

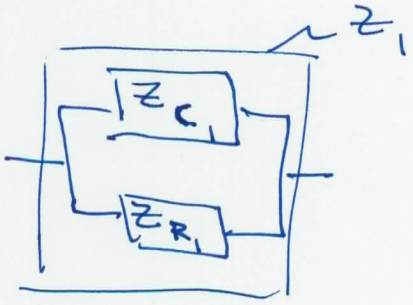


$$V_2 = Z_{DPL} // Z_{DPR} \cdot I_{sc}$$

$$= \frac{Z_{DPL} \cdot Z_{DPR}}{Z_{DPL} + Z_{DPR}} \cdot \left(\frac{Z_1 \cdot I_s}{G} \right)$$

but: $Z_1 = \frac{Z_{R_1} \cdot Z_{C_1}}{Z_{R_1} + Z_{C_1}}$

$$= \frac{R_1 \cdot \frac{1}{C_1 s}}{R_1 + \frac{1}{C_1 s}} =$$



$$\boxed{Z_1 = \frac{R_1}{R_1 C_1 s + 1}} \quad \text{and} \quad \boxed{Z_2 = \frac{R_2}{R_2 C_2 s + 1}}$$

so

$$\boxed{Z_{DPL} = G^2 \cdot \frac{R_1 C_1 s + 1}{R_1}}$$

$$\boxed{Z_{DPR} = Z_2 = \frac{R_2}{R_2 C_2 s + 1}}$$

$$\Rightarrow V_2 = \frac{G^2 \cdot \left(\frac{R_1 C_1 s + 1}{R_1} \right) \cdot \frac{R_2}{(R_2 C_2 s + 1)}}{\left(\frac{R_2}{R_2 C_2 s + 1} \right) G^2 \left(\frac{R_1 C_1 s + 1}{R_1} \right)} \cdot \frac{R_1}{(R_1 C_1 s + 1) G} I_s$$

(3)

$$V_2 = \frac{G \dfrac{R_2}{R_2C_2s+1} \cdot R_1}{R_2R_1 + G^2(R_1C_1s+1)(R_2C_2s+1)} I_s$$

$$= \frac{GR_2R_1}{R_2R_1 + G^2R_1R_2C_1C_2s^2 + G^2(R_1C_1+R_2C_2)s+G^2} I_s$$

$$\Rightarrow \frac{V_2}{I_s} = \frac{\dfrac{1}{C_1C_2G}}{s^2 + \left(\dfrac{1}{R_2C_2} + \dfrac{1}{R_1C_1}\right)s + \dfrac{1}{C_1C_2G^2} + \dfrac{1}{R_1R_2C_1C_2}}$$