LOOP GAIN SIMULATION

=> LOOP GAIN SIMULATION USED TO FIND PHASE-MARGIN AND GAIN-MARGIN

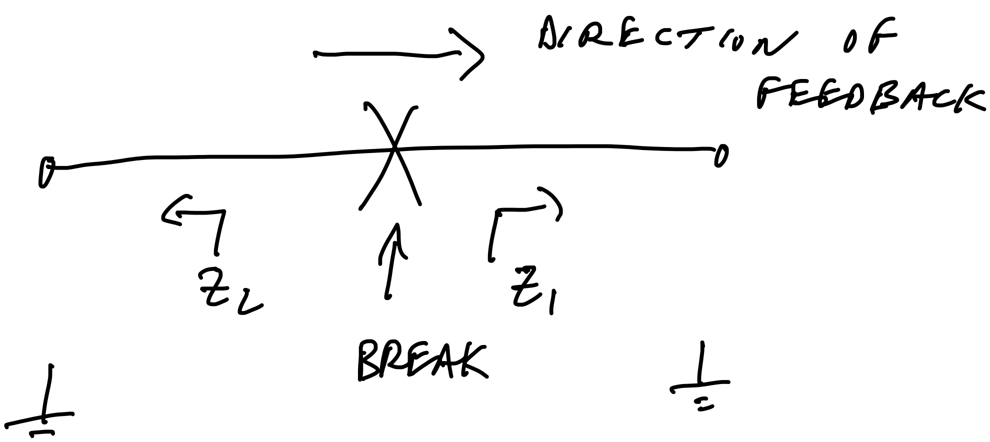
=> SOME SPICE SIMULATORS HAVE BUILT IN LOOP GAIN SIMULATION BLOCKS

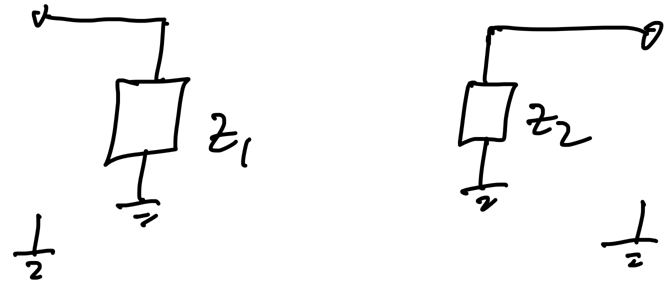
=> LTSPICE DOES <u>NOT</u>

=> IF NOT BUILT-IN => CAN STILL SIMULATE LOOP GAIN <u>BUT</u>

=> NEED TO ENSURE BIAS STILL CORRECT

=> NEED TO ENSURE LOADING EFFECTS ARE CORRECT.



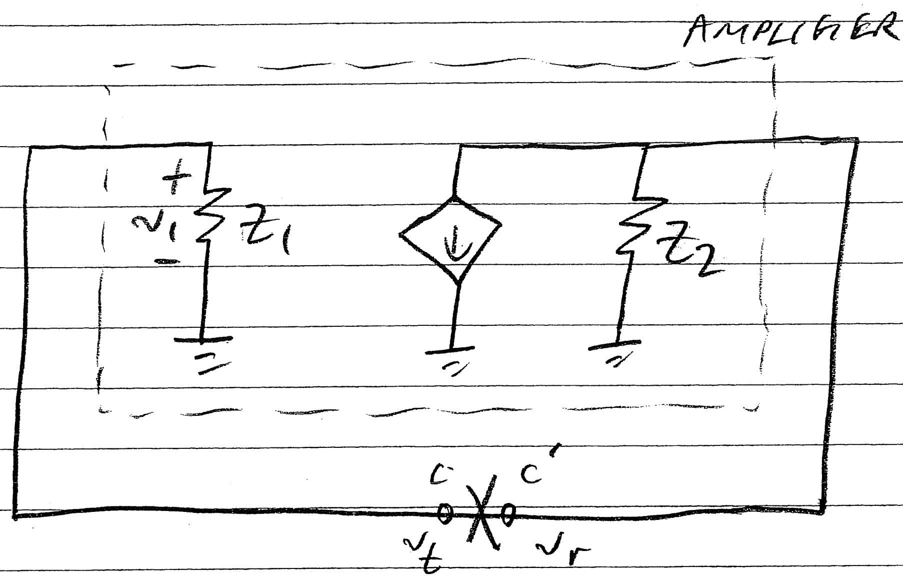


Z_1 & Z_2 GENERALLY COMPLEX

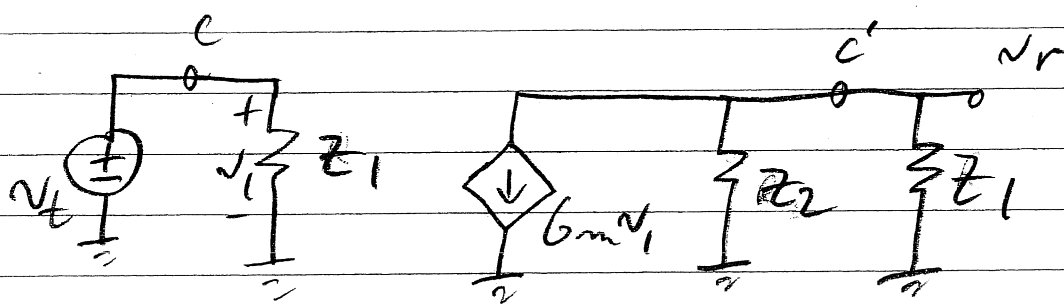
LSI

LOOP GAIN (SIMULATION METHODS)

RECALL



Z_1, Z_2 COMPLEX



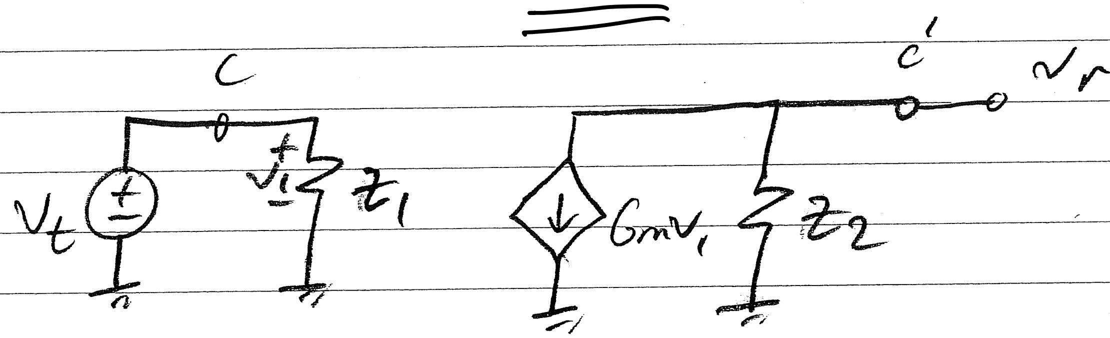
NEED TO TERMINATE CUT CORRECTLY

$$L \equiv -\frac{v_r}{v_t} = G_m (Z_1 \| Z_2)$$

$$L = G_m \left(\frac{Z_1 Z_2}{Z_1 + Z_2} \right) \quad (1)$$

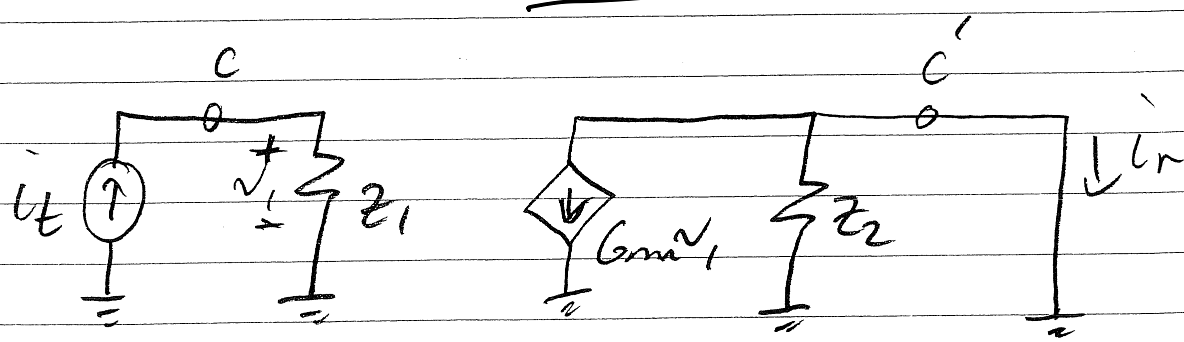
LOOP GAIN ALTERNATIVE METHOD # 1

DEFINE T_{oc} AS VOLTAGE LOOP GAIN WITH "CUT" OPEN CIRCUIT



$$T_{oc} \equiv -\frac{v_r}{v_t} = G_m z_2 \qquad (2)$$

DEFINE T_{sc} AS CURRENT LOOP GAIN WITH "CUT" SHORT CIRCUIT



$$T_{sc} \equiv -\frac{i_r}{i_t} = G_m z_1 \qquad (3)$$

CAN COMBINE 1 2 & 3

TO FIND

$$\frac{1}{L} = \frac{1}{T_{OC}} + \frac{1}{T_{SC}}$$

OR

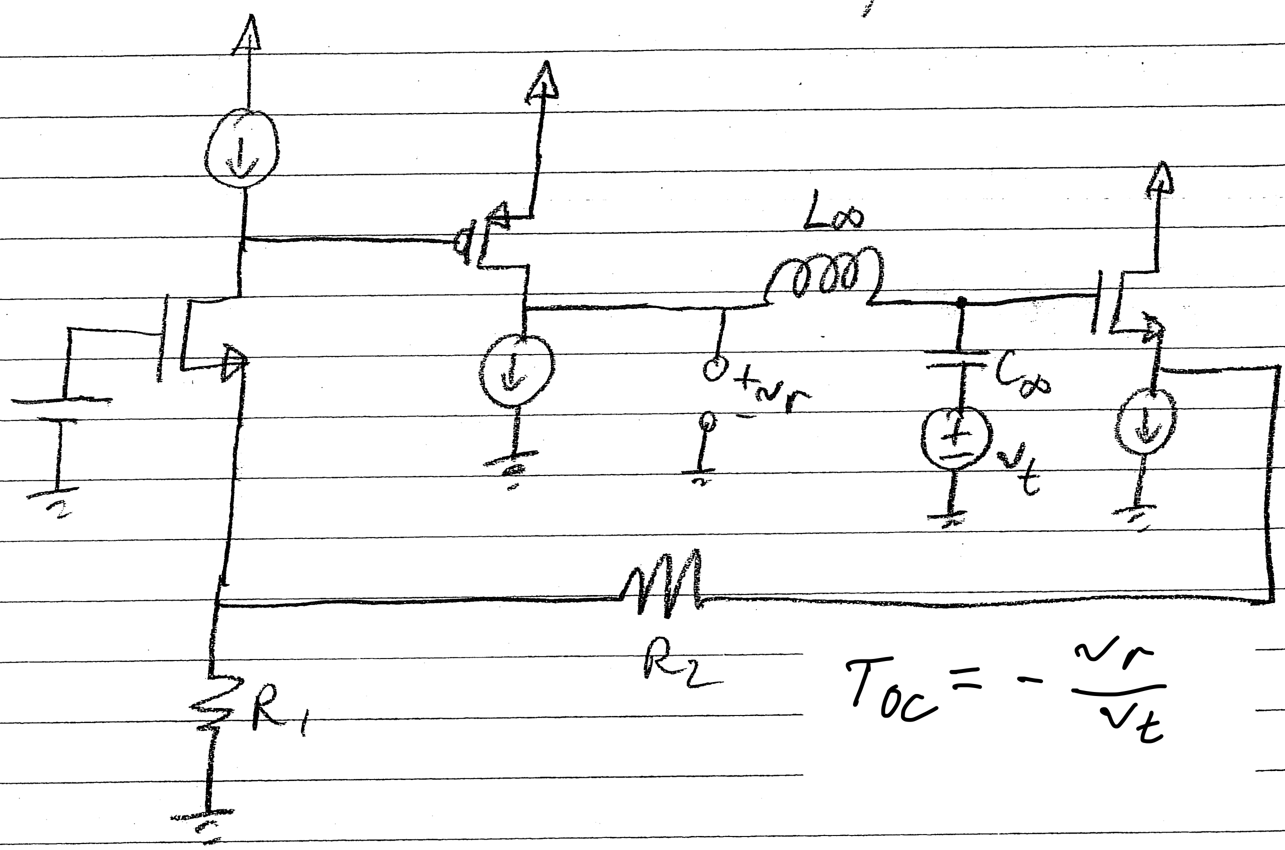
$$L = \left(\frac{1}{T_{OC}} + \frac{1}{T_{SC}}\right)^{-1}$$

- CAN USE THIS APPROACH WHEN SIMULATING A CIRCUIT.
- CAN USE LARGE INDUCTORS & CAPACITORS TO BREAK LOOP WITHOUT AFFECTING BIAS CONDITIONS.

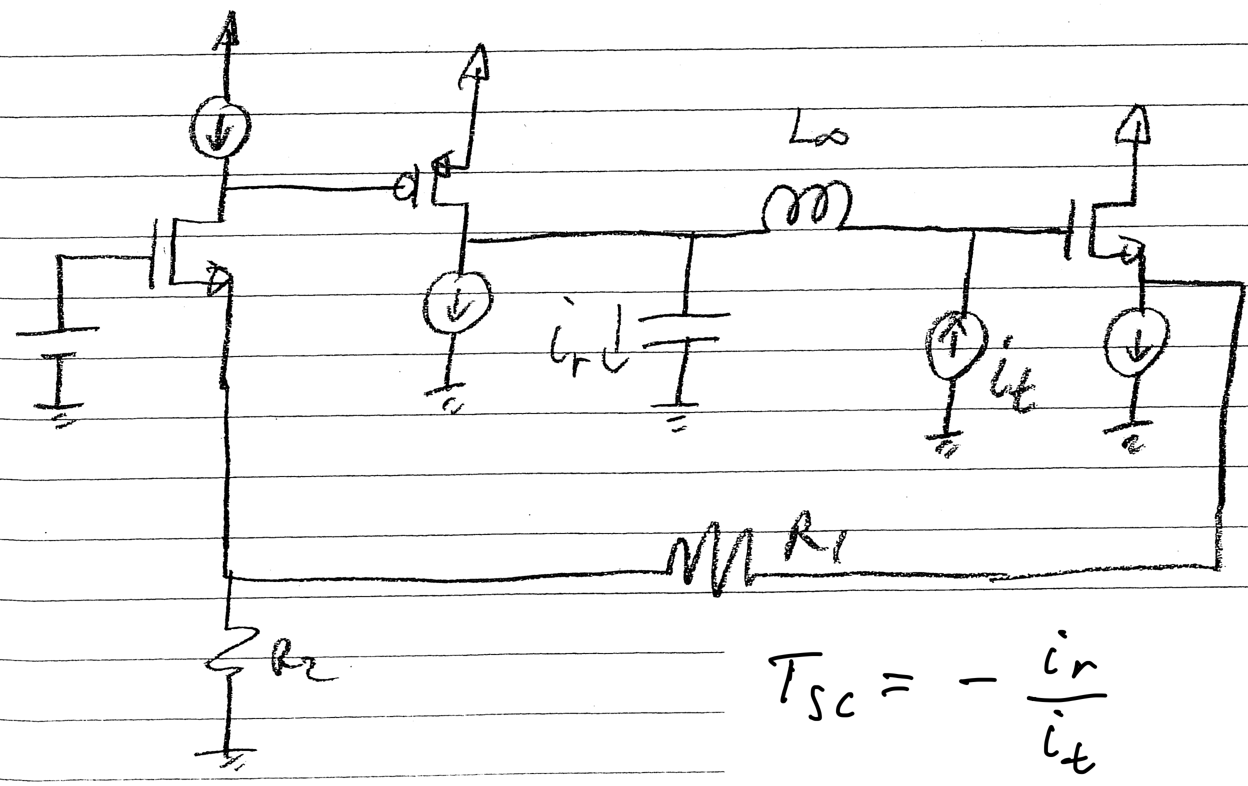
5A

EXAMPLE

L_∞, C_∞ LARGE



$$T_{oc} = -\frac{v_r}{v_t}$$

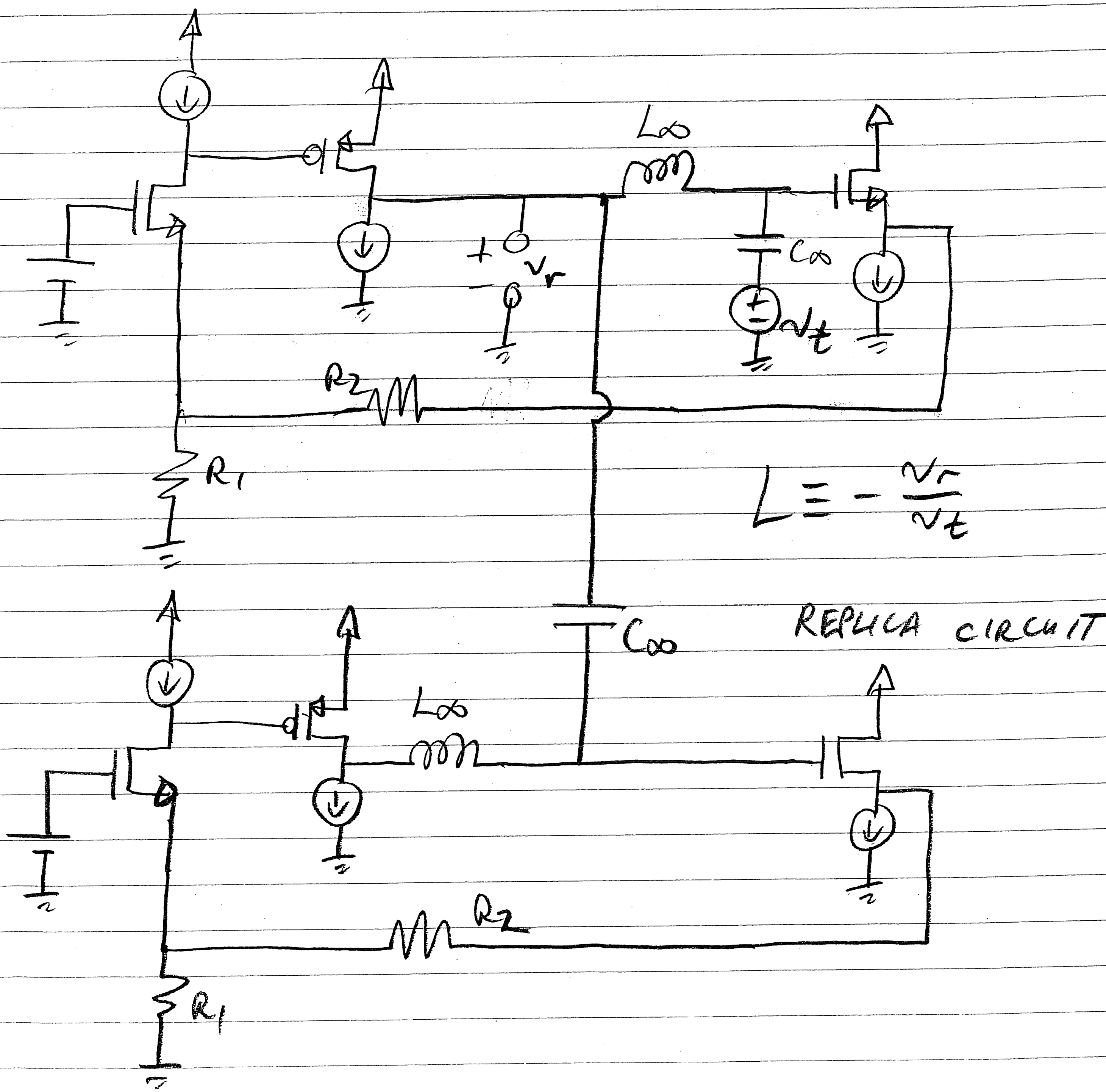


$$T_{sc} = -\frac{i_r}{i_t}$$

LOOP GAIN

ALTERNATE METHOD #2

USE REPLICA CIRCUIT TO INCLUDE LOADING EFFECT.



$$L \equiv -\frac{v_r}{v_t}$$

⇒ METHOD #1

⇒ 2 SIMULATIONS AND COMBINE

⇒ CAN BE DONE IN ONE SIMULATION & DUPLICATE CIRCUIT.

⇒ METHOD #2

⇒ TWICE AS LARGE CIRCUIT IN ONE SIMULATION

⇒ ABOUT SAME SIMULATION TIME FOR EACH METHOD.