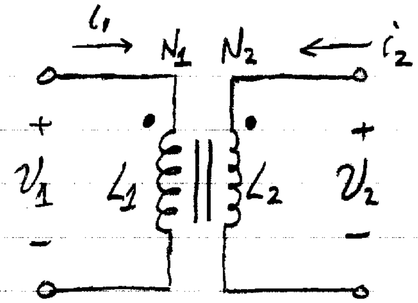
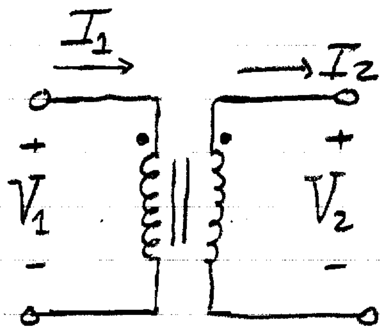
Transformer Differential AC Coupling

a very busy title...

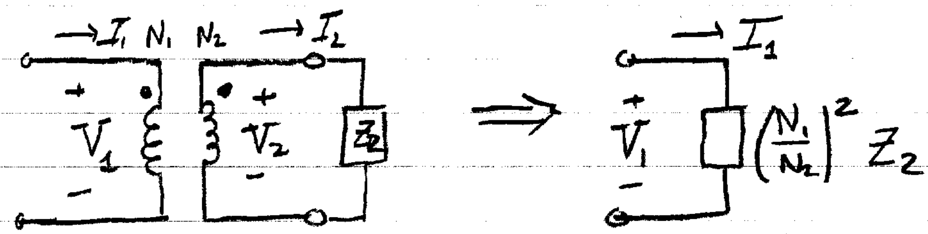


Instantaneous (Time Domain)

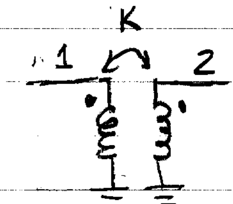


Phasors (Freq Domain)

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$$



Input Impedance Reflection

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L1 1 0 1mH
L2 2 0 1mH
K L1 L2 0.99
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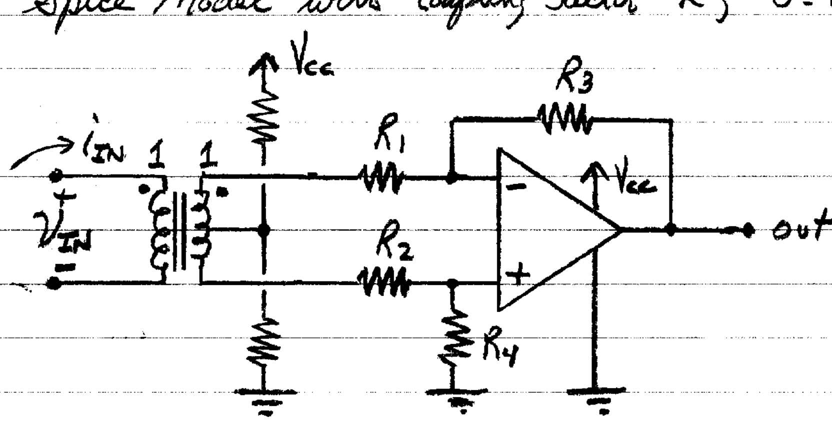
$$K = \frac{M}{\sqrt{L_1 L_2}}$$

M = mutual inductance

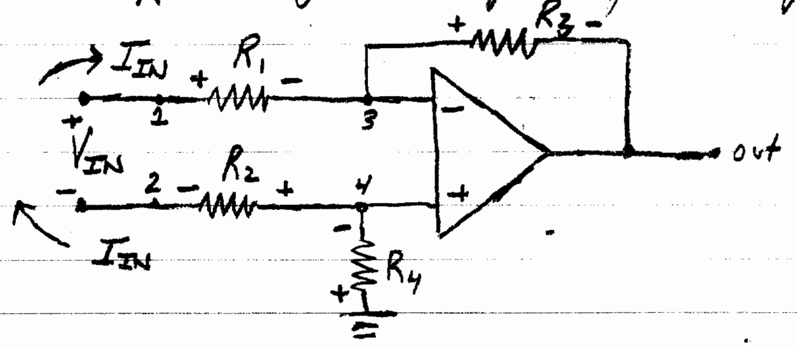
L_1, L_2 = self inductances

Spice Model with Coupling Factor K; $0 \le K \le 1$



Differential Input Amplifier

Equivalent ac Circuit after transformer phase shift



Taking KVL through V_{IN}:

$$V_{OUT} + I_{IN} R_3 + I_{IN} R_1 - V_{IN} + I_{IN} R_2 + I_{IN} R_4 = 0$$

[1] $$V_{OUT} = V_{IN} - I_{IN}(R_1 + R_2 + R_3 + R_4)$$

Taking KVL through the 2nd path from out to gnd (through the op-amp input terminals)

[2] $$V_{OUT} = -I_{IN}(R_3 + R_4)$$

Subtracting [2] from [1]

$$0 = V_{IN} - I_{IN}(R_1 + R_2)$$

[1'] $$I_{IN} = \frac{V_{IN}}{R_1 + R_2} \implies \boxed{|Z_{IN}| = R_1 + R_2}$$

Substituting [1'] into [2]

$$V_{OUT} = \frac{-V_{IN}}{R_1 + R_2}(R_3 + R_4)$$

$$\frac{V_{OUT}}{V_{IN}} = \frac{-(R_3 + R_4)}{R_1 + R_2} \implies \boxed{G_{AIN} = \frac{-(R_3 + R_4)}{R_1 + R_2}}$$