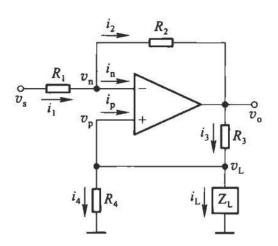# Homework for Chapter 2

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2.3.8 将电压源 v_s 转换为电流源 i_L，驱动线圈 Z_L 的电压-电流转换器，如图题 2.3.8 所示。求 i_L/v_s 表达式。（注电路中为使 i_L 独立于 Z_L，设 $\dfrac{R_2}{R_1 R_3} = \dfrac{1}{R_4}$。）

Solution Since we have $v_n = v_p = v_L = i_L Z_L$ and $i_n = i_p = 0$

$$i_1 = i_2$$
$$i_3 = i_4 + i_L$$

Furthermore,

$$\frac{v_s - v_n}{R_1} = \frac{v_n - v_o}{R_2}$$
$$\frac{v_o - v_L}{R_3} = \frac{v_L}{R_4} + \frac{v_L}{Z_L}$$

Then we have

$$\frac{v_s - i_L Z_L}{R_1} = \frac{i_L Z_L - v_o}{R_2}$$
$$\frac{v_o - i_L Z_L}{R_3} = \frac{i_L Z_L}{R_4} + \frac{i_L Z_L}{Z_L}$$

So that

$$v_s = \left(\frac{i_L Z_L - v_o}{R_2} \right) R_1 + i_L Z_L$$

$$v_o = i_L Z_L + \left(\frac{i_L Z_L}{R_4} + \frac{i_L Z_L}{Z_L} \right) R_3$$

$$v_s = \left(\frac{i_L Z_L - \left(i_L Z_L + \left(\frac{i_L Z_L}{R_4} + \frac{i_L Z_L}{Z_L} \right) R_3 \right)}{R_2} \right) R_1 + i_L Z_L$$

$$= \left(\frac{- \left(\frac{i_L Z_L}{R_4} + \frac{i_L Z_L}{Z_L} \right) R_3}{R_2} \right) R_1 + i_L Z_L$$

$$= \left(\frac{- \left(\frac{i_L Z_L}{R_4} + i_L \right) R_3 R_1}{R_2} \right) + i_L Z_L$$

$$= \left(- \left(\frac{i_L Z_L}{R_4} + i_L \right) R_4 \right) + i_L Z_L$$

$$= -i_L Z_L - i_L R_4 + i_L Z_L$$

$$= -i_L R_4$$

Finally,

$$\frac{v_s}{i_L} = -R_4$$