

Design for skew:

Midpoint, assume both devices are saturated:

$$V_{DSP} = V_{DSN} = V_{DD}/2 = 2.5V$$

$$V_{GSN} = V_{IN} \quad V_{GSP} = 5 - \underbrace{V_{IN}}_{\text{set}}$$

$$K_n \frac{W}{L} (V_{GSN} - V_{TN})^2 = K_p \frac{W}{L} (V_{GSP} - V_{TP})^2$$

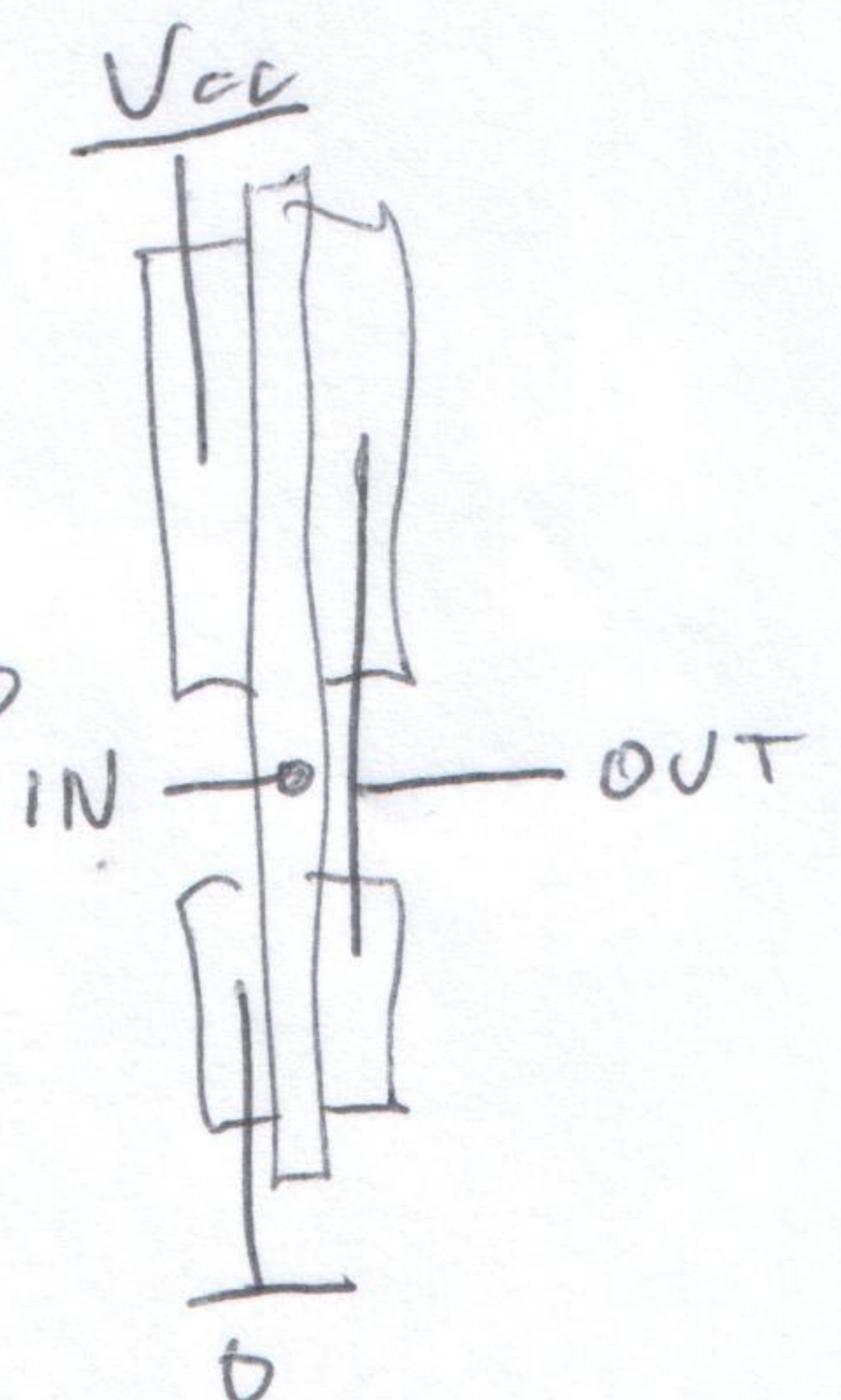
$$\underbrace{\frac{K_n \frac{W}{L}}{K_p \frac{W}{L}}}_{\text{"Current strength ratio"}} = \frac{(5 - V_{IN} - V_{TP})^2}{(\cancel{V_{IN}} - V_{TN})^2}$$

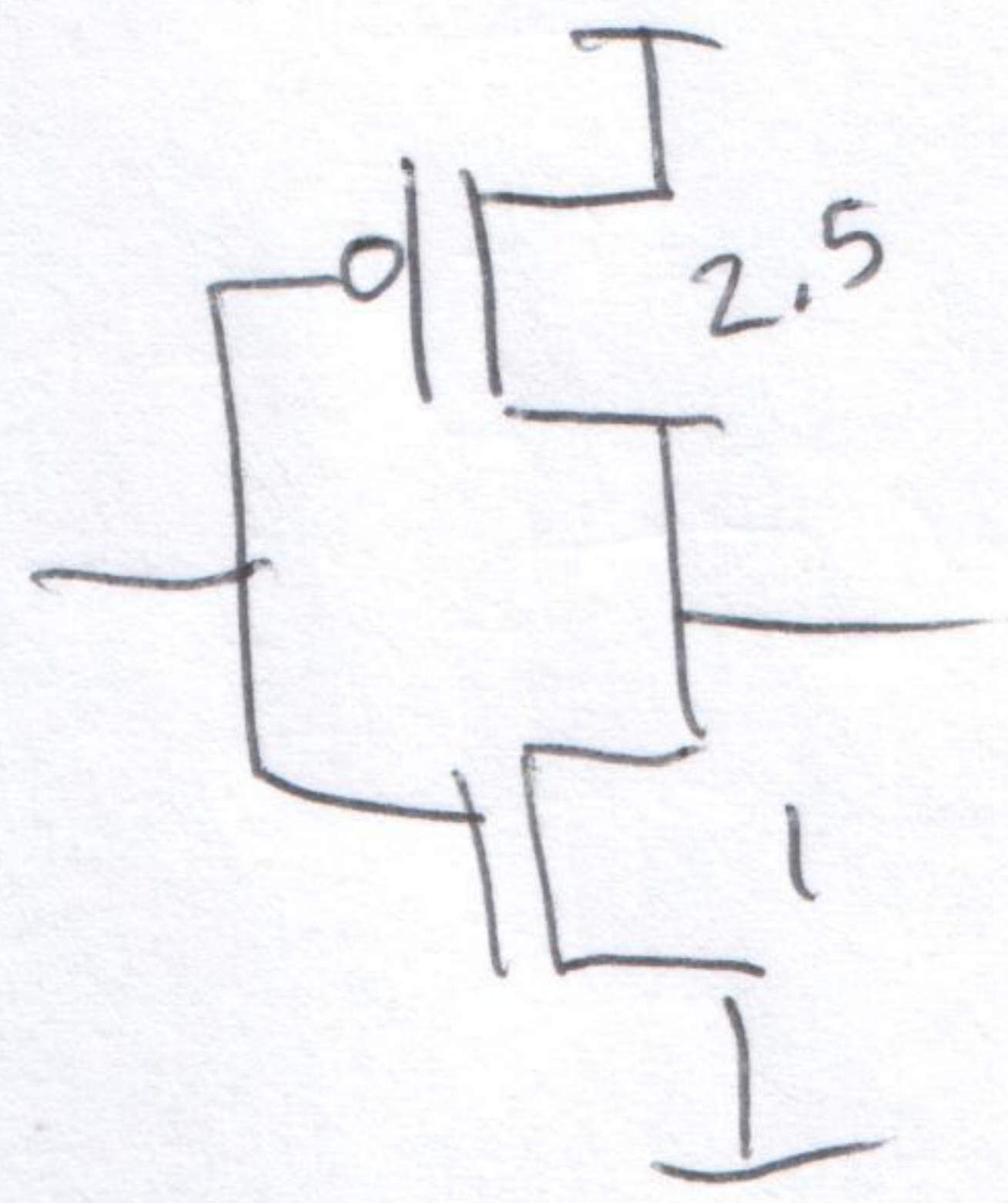
if  $V_{IN} = 2.5$ ;  $V_{TP} = V_{TN}$ :

$$\frac{K_n \frac{W}{L}}{K_p \frac{W}{L}} = 1$$

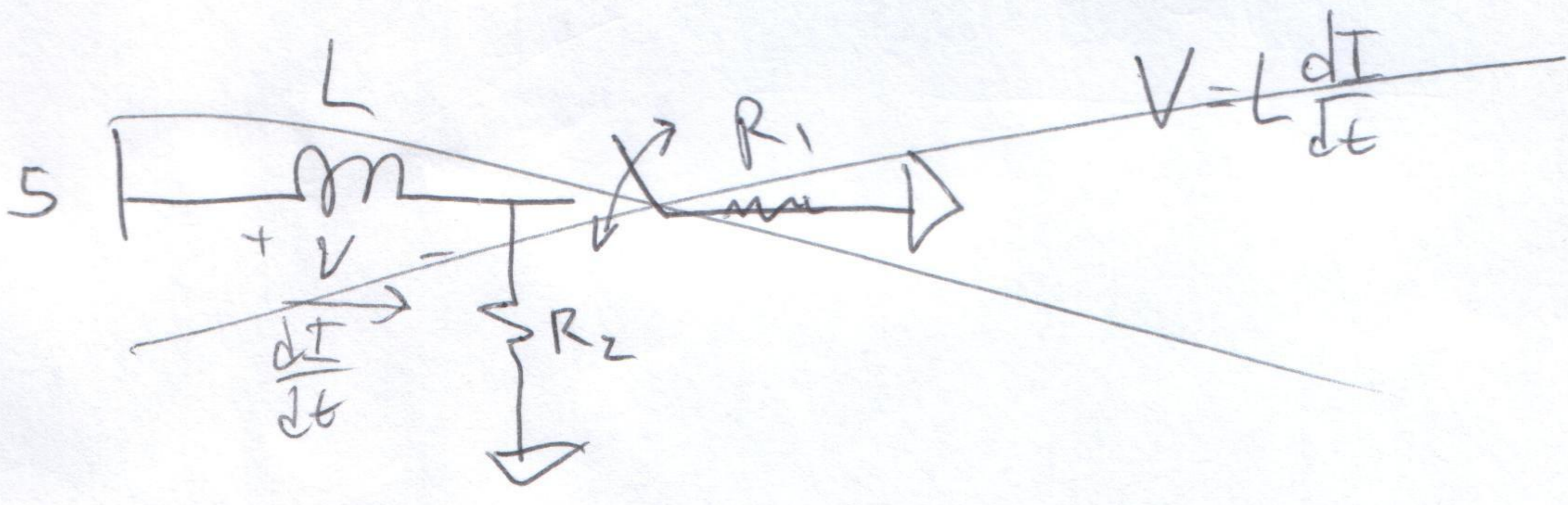
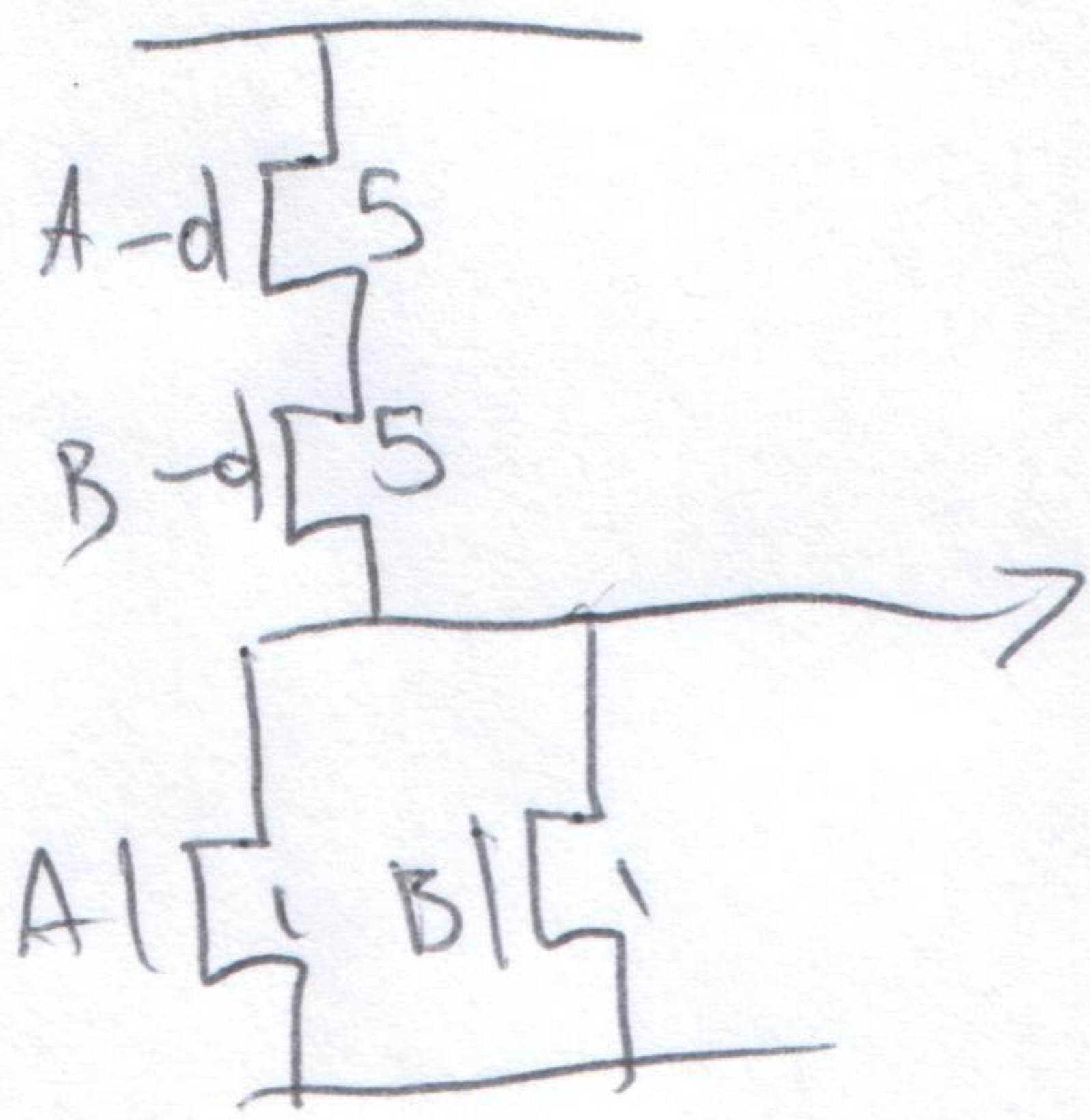
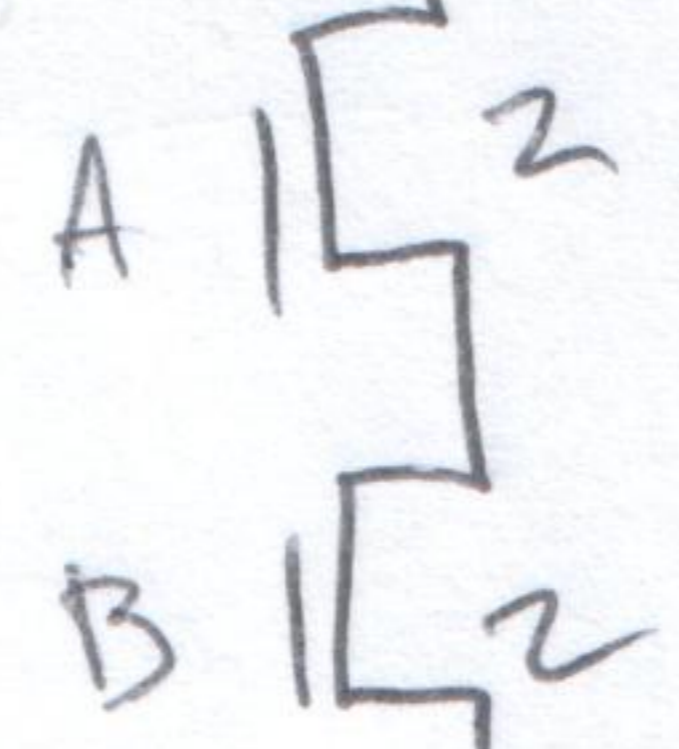
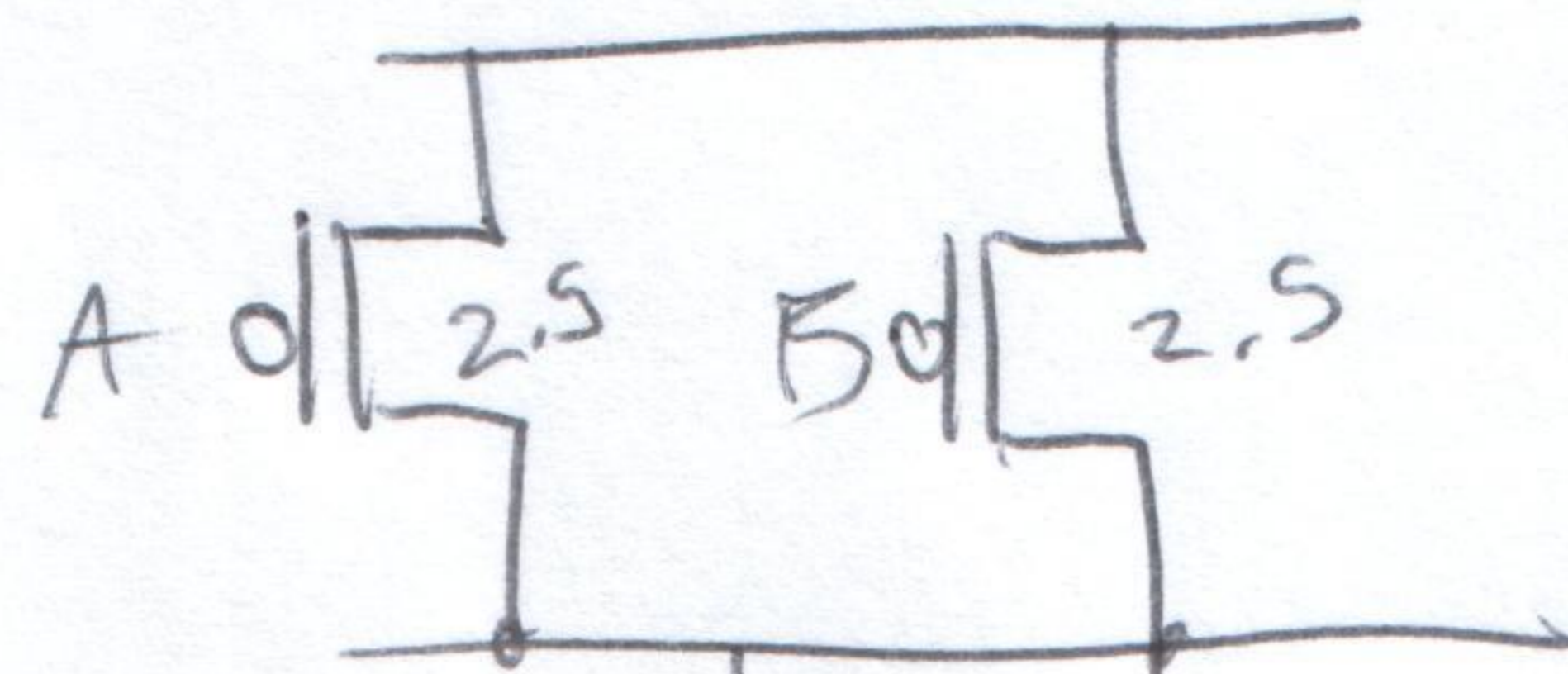
$$K_n \approx 2.5 K_p$$

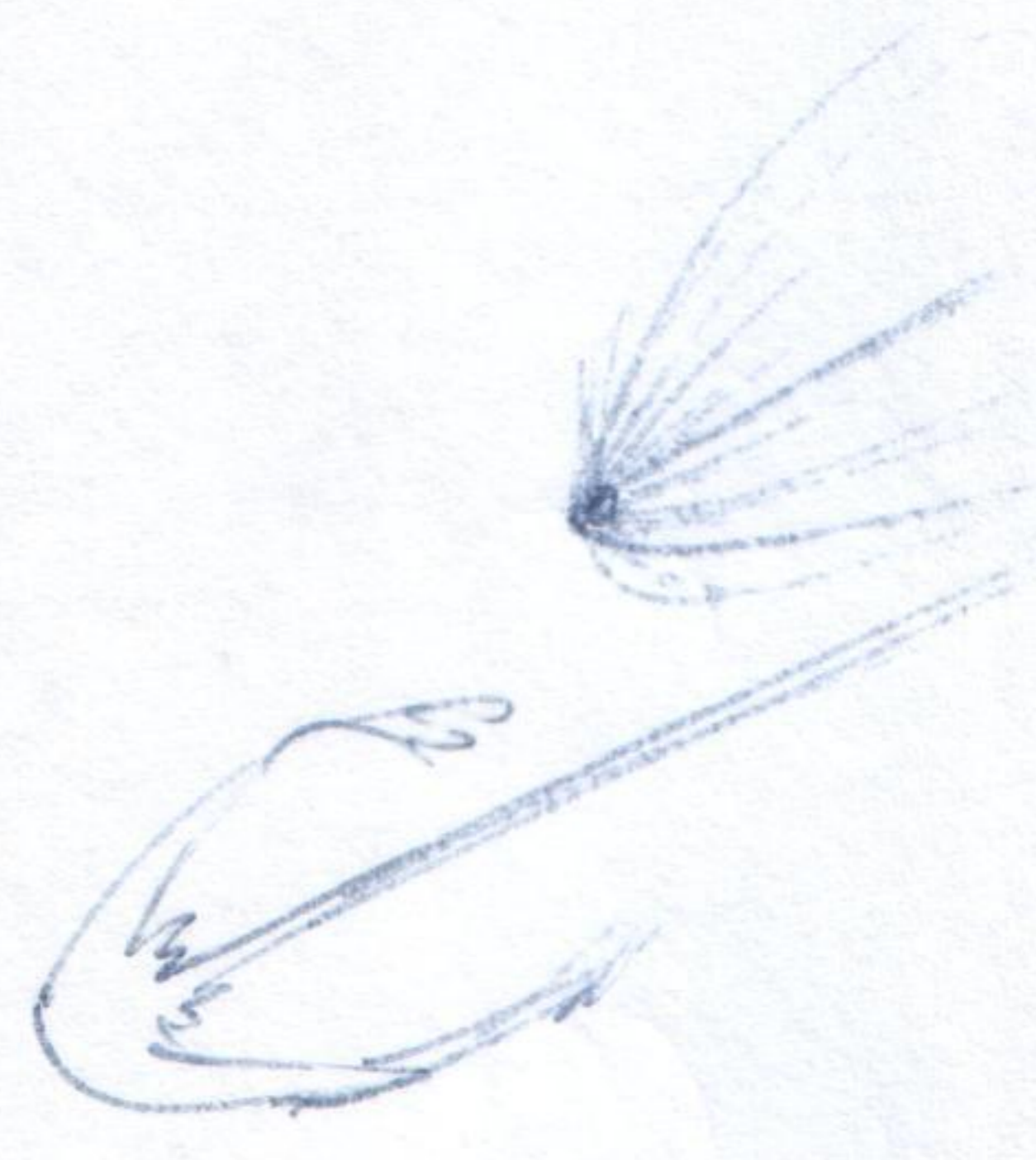
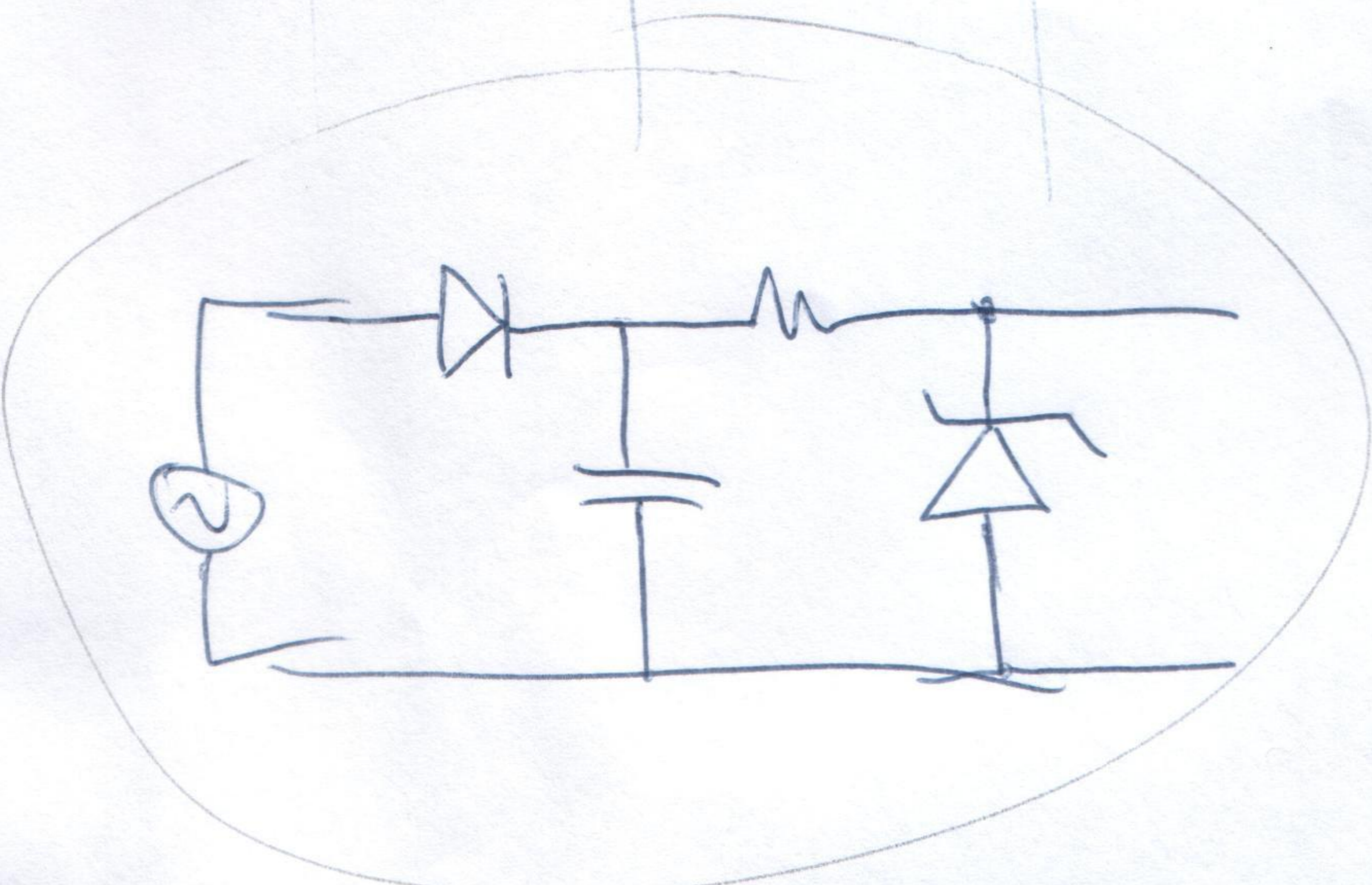
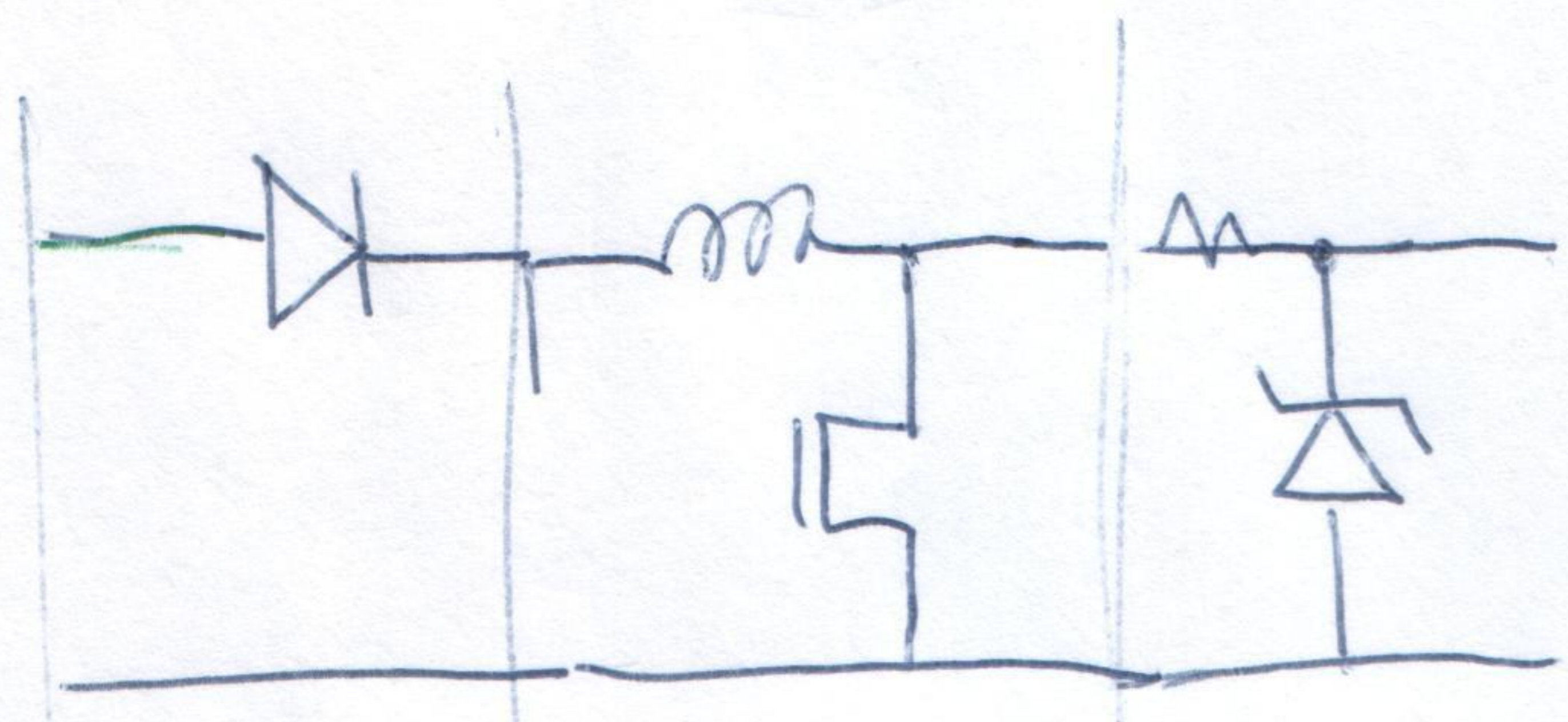
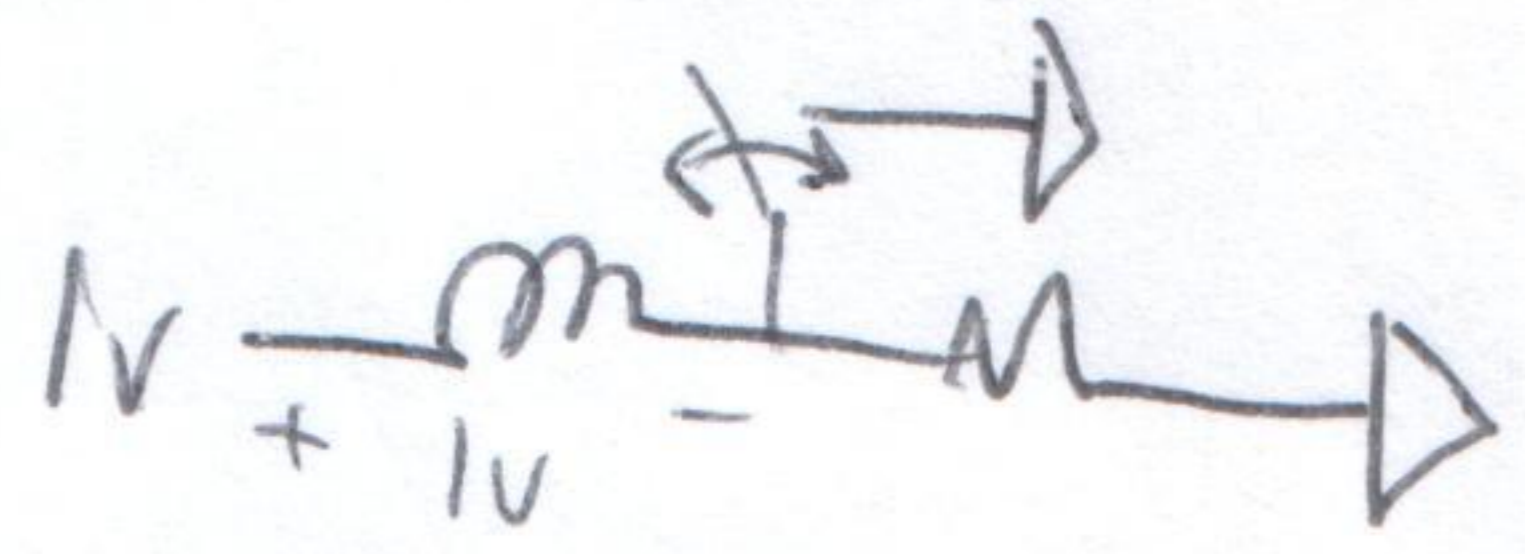
$$\frac{W_p}{L_p} \approx \frac{W_n}{L_n} \cdot 2.5$$



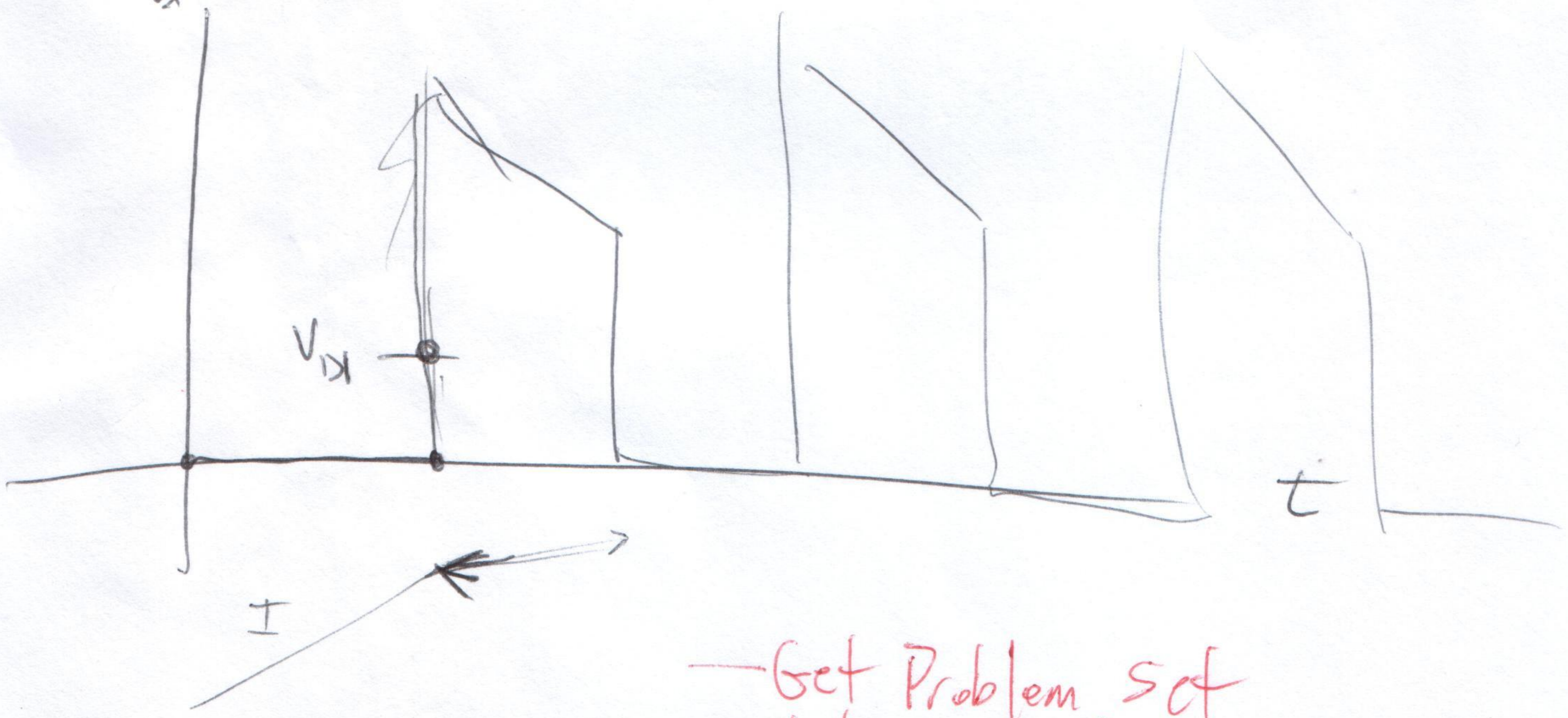
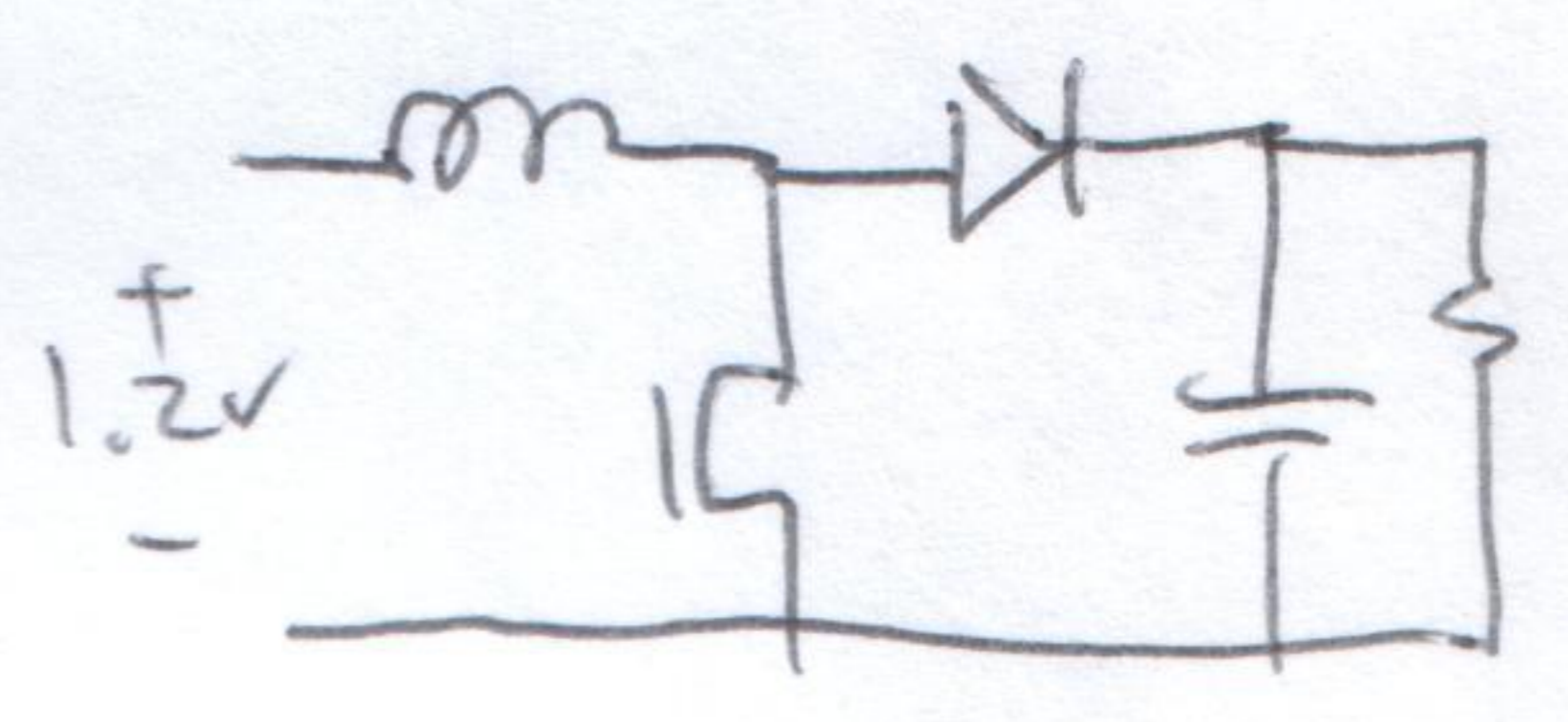
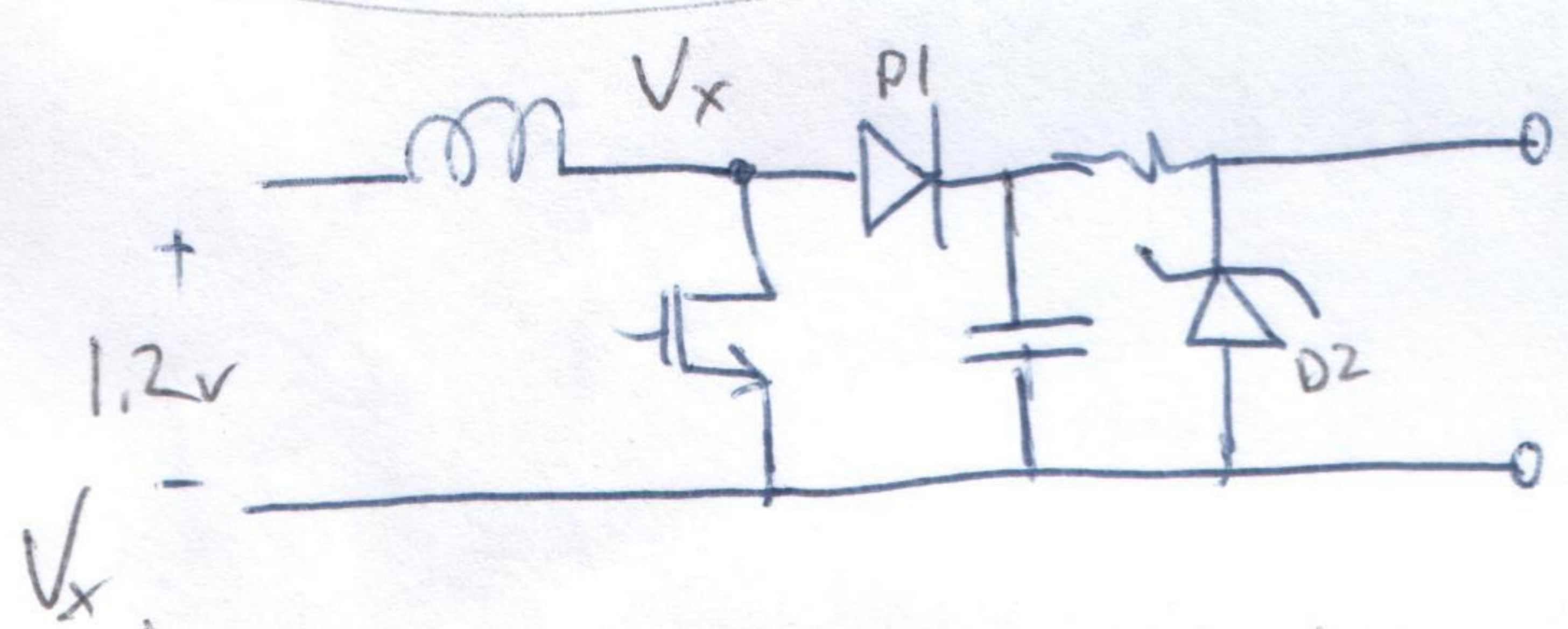


"reference inverter"





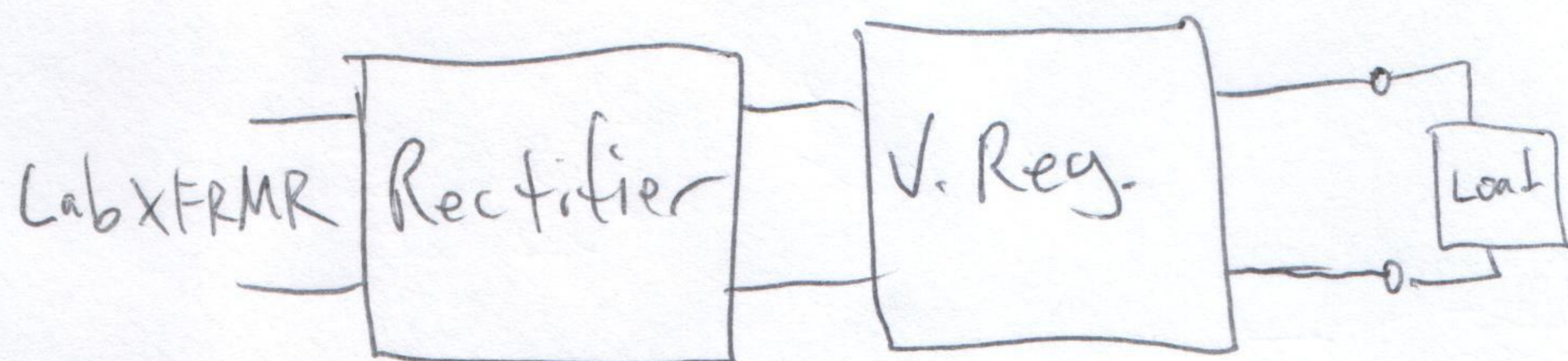
$$V = L \frac{dI}{dt}$$



Get Problem Set  
lab HW2

# Lab Final: Design a 5v PSU

Option 1: Start with AC:



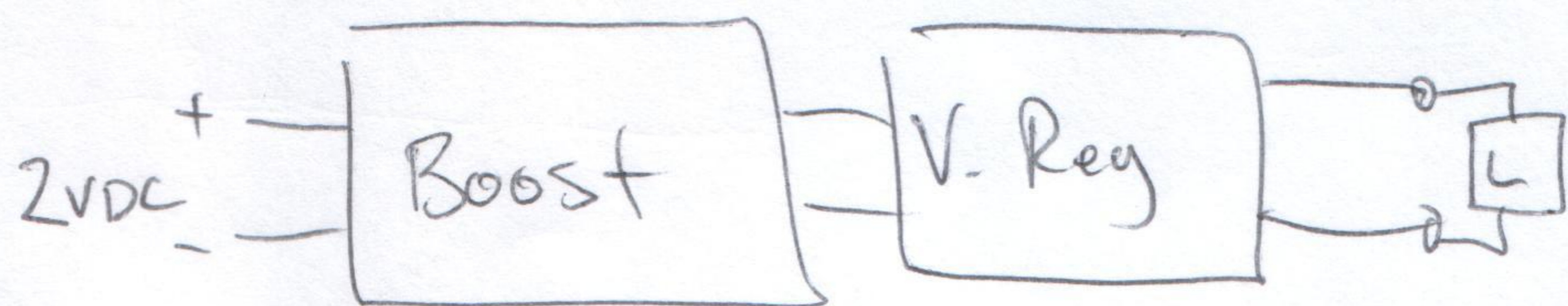
$V_{out} = 5V$

$V_{ripple} = 5\% \text{ Peak}$

$I_{max} = 5mA$

Load Regulation: 5% var. over Max to Min

Option 2: Start with LV DC:

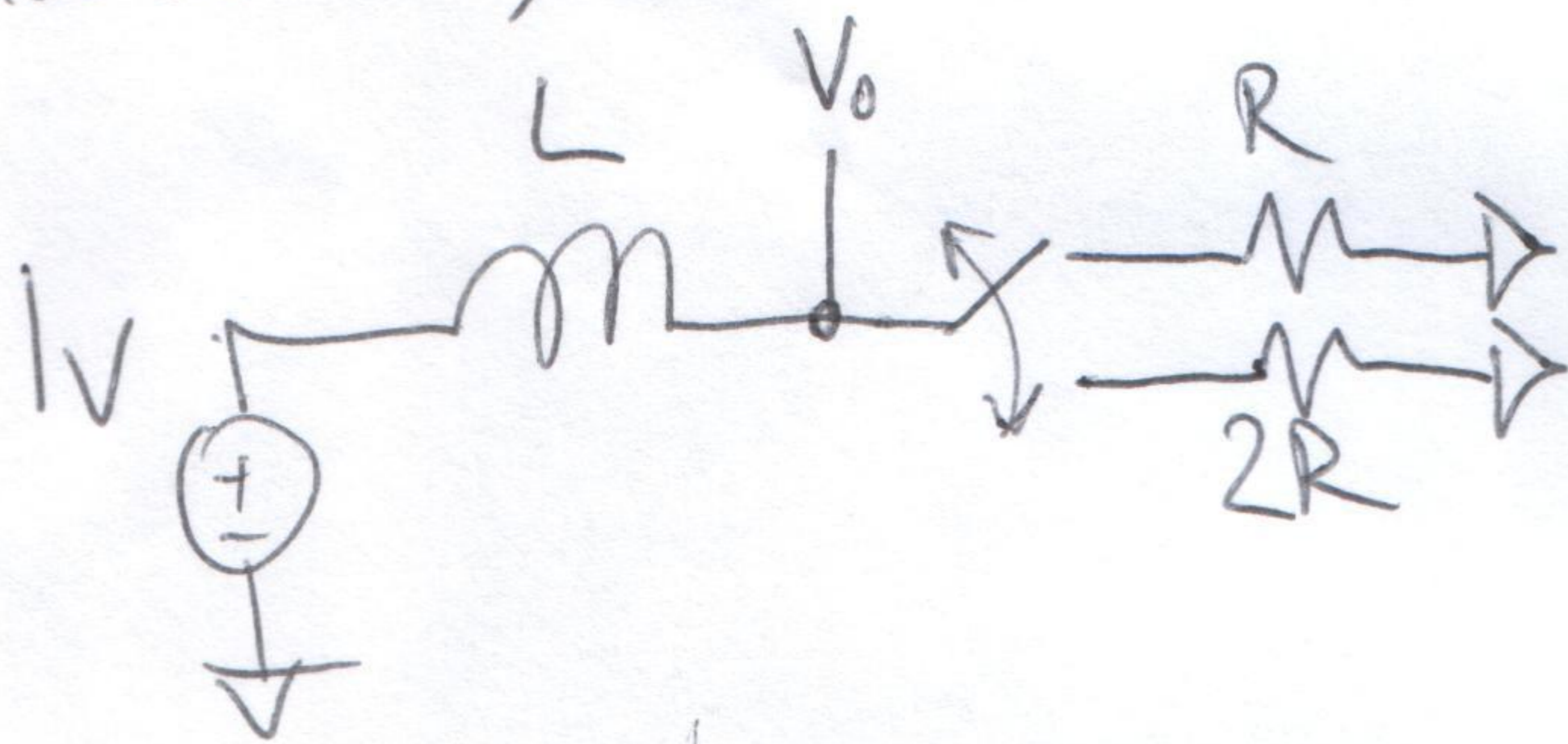


$V_{out} = \text{_____}$

$V_{ripple} = \text{_____}$

$I_{max} = \text{_____}$

## Boost Converter: (Slowed way down)



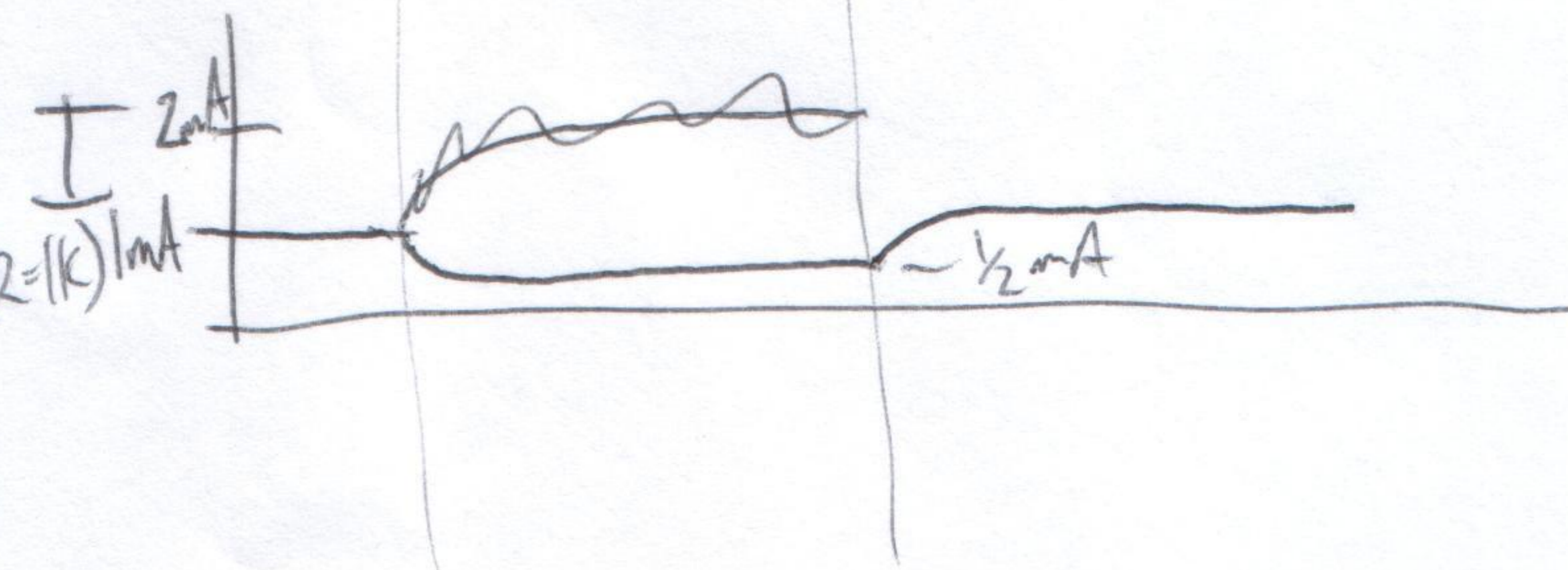
Start steady state in first position:

$I_L = 1V/R$

Switch. Initially  $I_L = 1V/R$   
So  $V_o = 2V!$

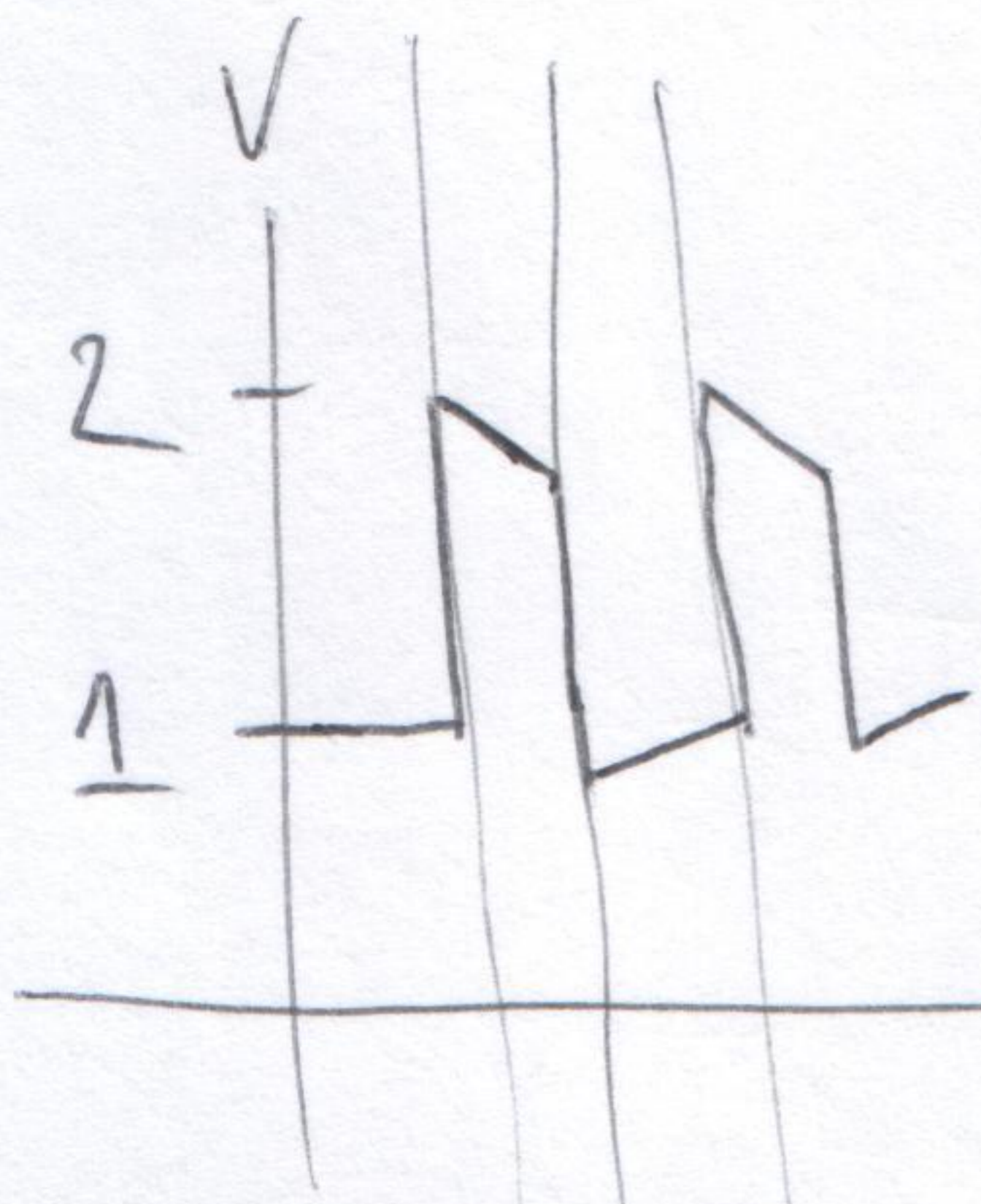
$V = L \frac{dI}{dt}$  so current goes down at  $\frac{V}{L}$  Amps/sec. and "shark fins" down to  $1V$ .

Switch Back.  $I_L = 1V/2R$   
So  $V_o = \frac{1}{2}V$



Note that  $I$  is continuous but  $V$  is discontinuous.

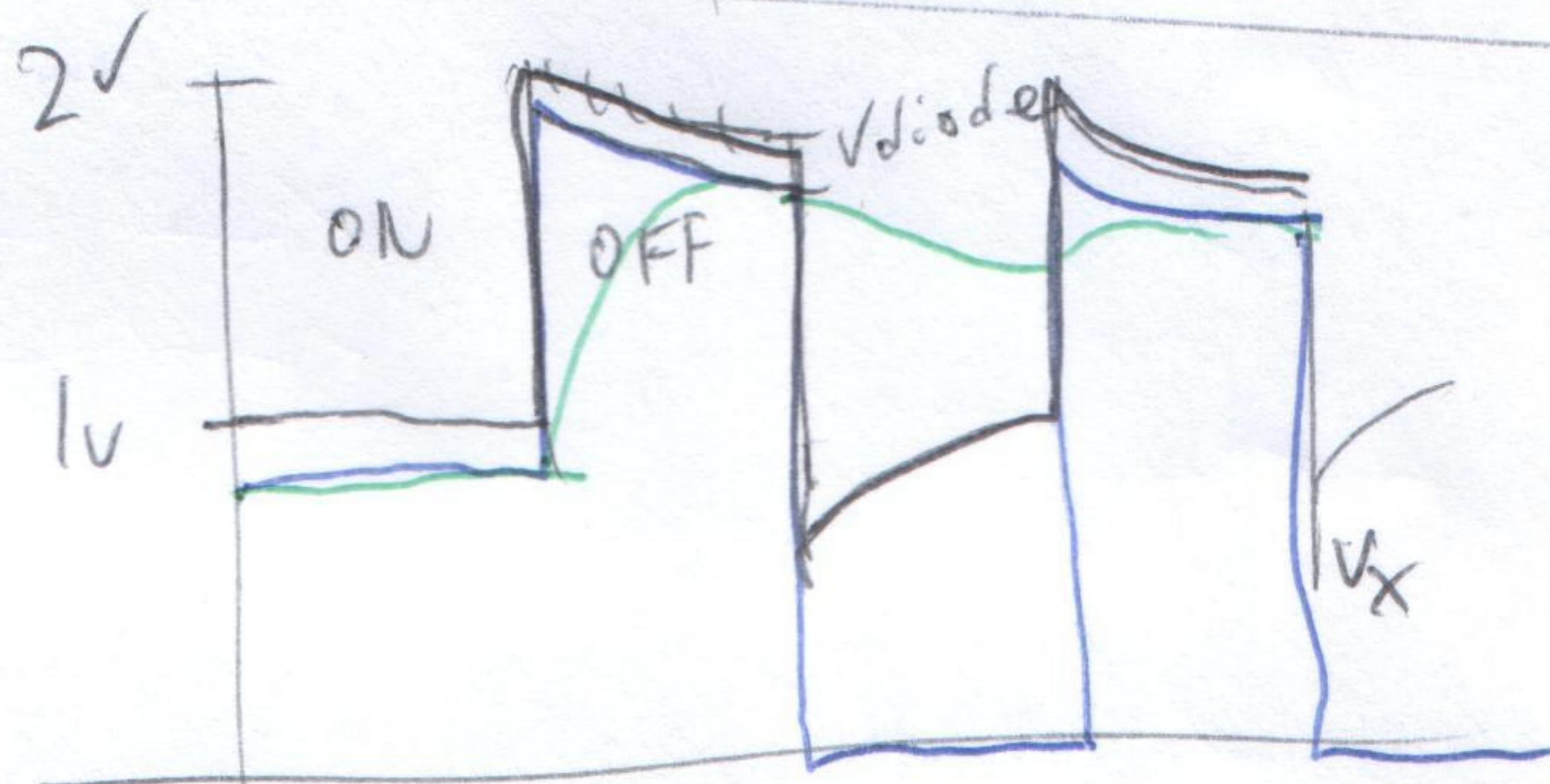
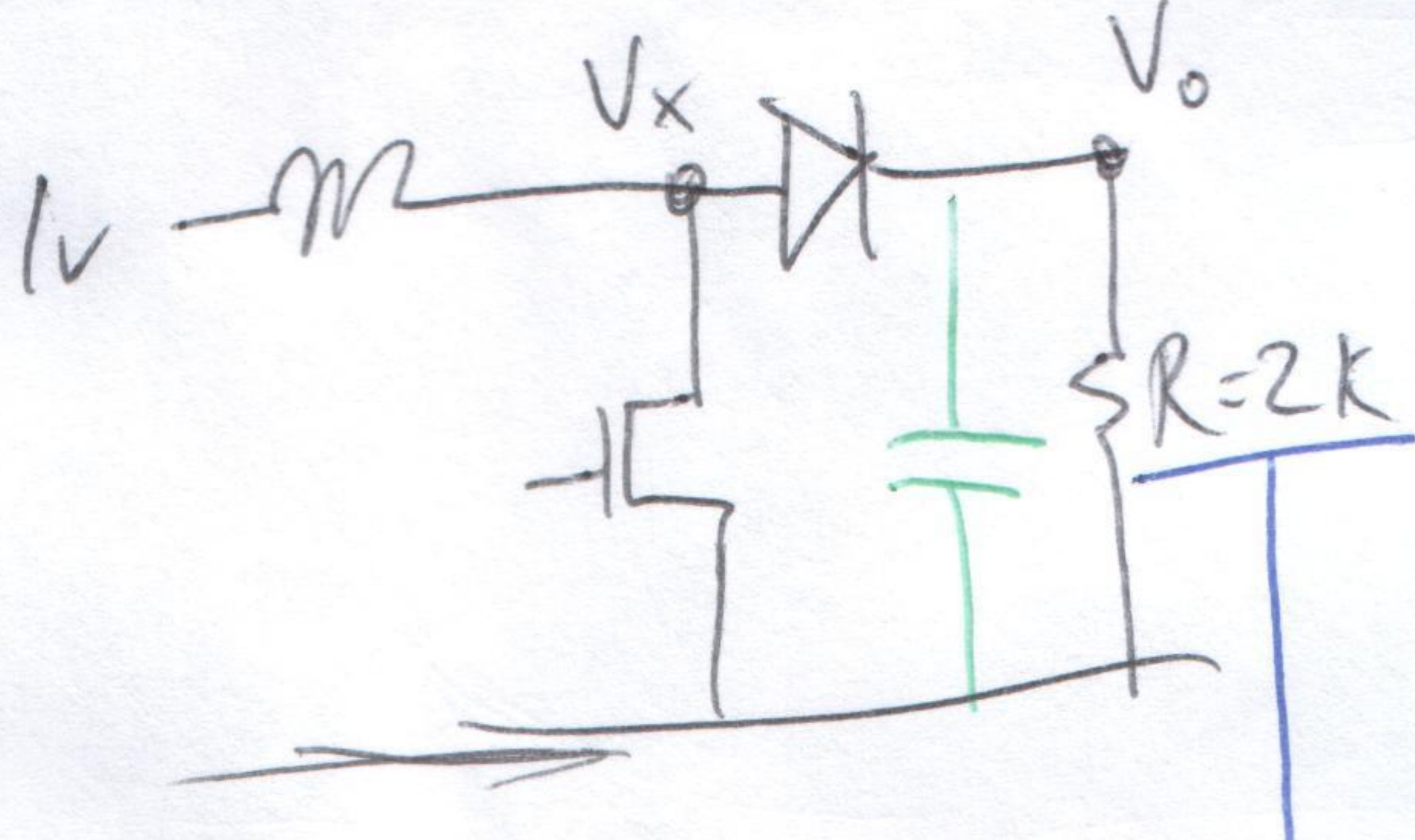
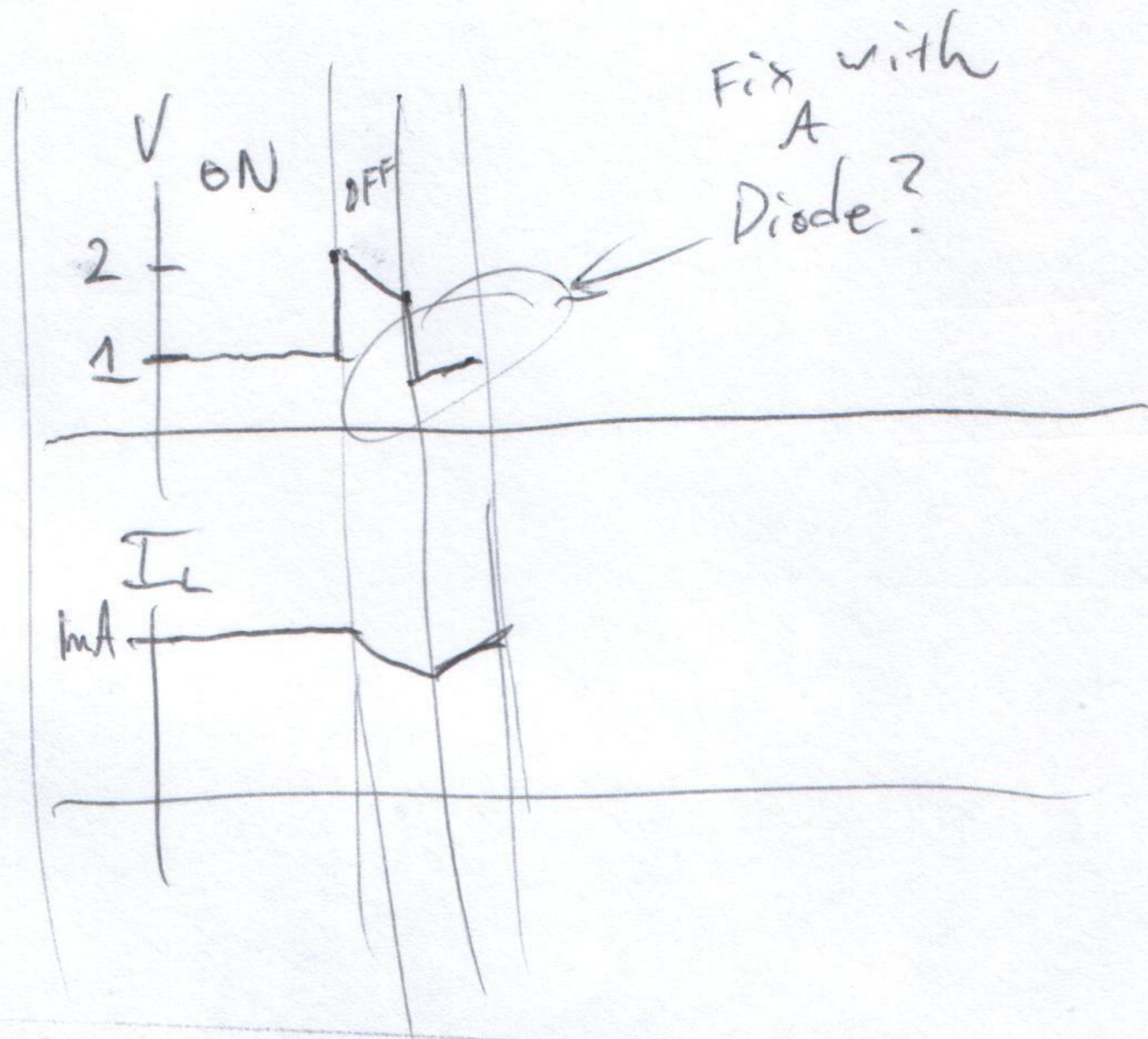
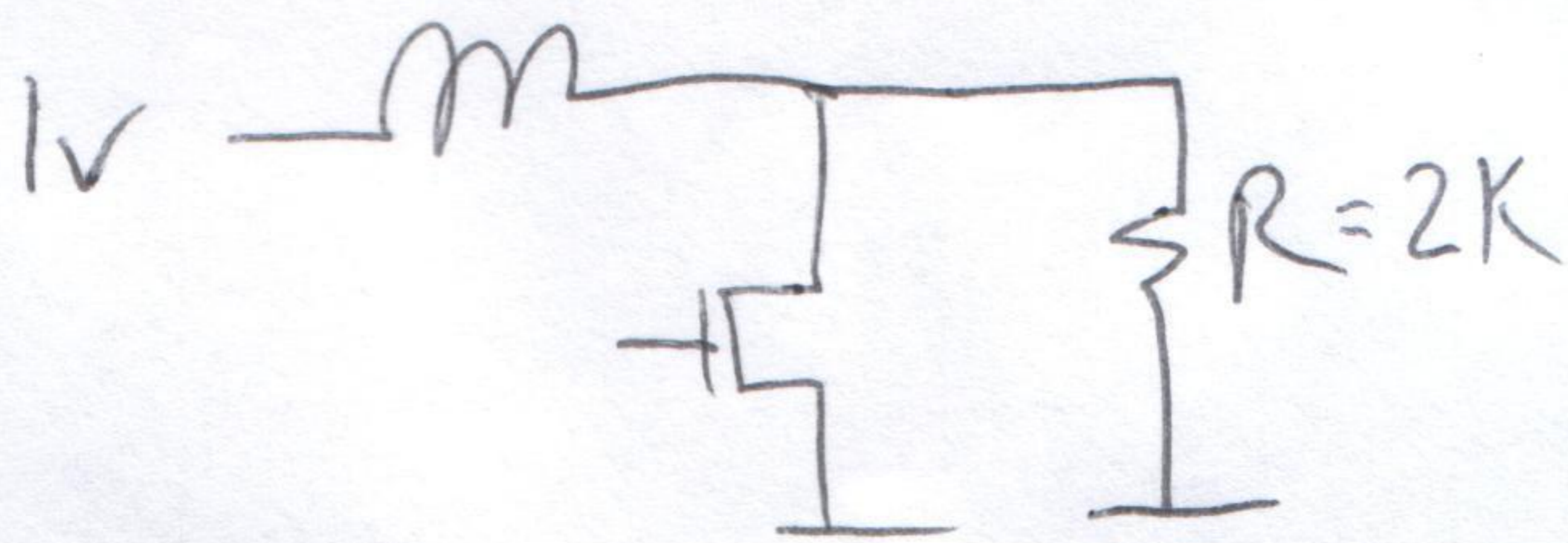
Switch Faster!



first switch: jump to 2V.  
next: jump to just below 1V.

Implication: Kind of AC-isl.

Solid-State-ify it.



Note: this resistor effectively sets the value of V<sub>out</sub> at max, and for this reason you need a regulator to make this a stable PSU.

$$V_{O_{MAX}} \approx R \cdot I_D (V_{OS} = V_{CC}, V_{DS} = V_{IN})$$

Midterm 2 Review Begins:

Chapters 4, 6, & 7, except for: 4.5-4.9  
6.9-6.12  
7.4  
~~7.6~~-7.9

What's ahead, after MT2:

- Subtleties of the MOSFET model  
(body effect, channel-length modulation)
- Complex logic gate design
- Trends in CMOS/future devices
- Bistable Circuits/Memory