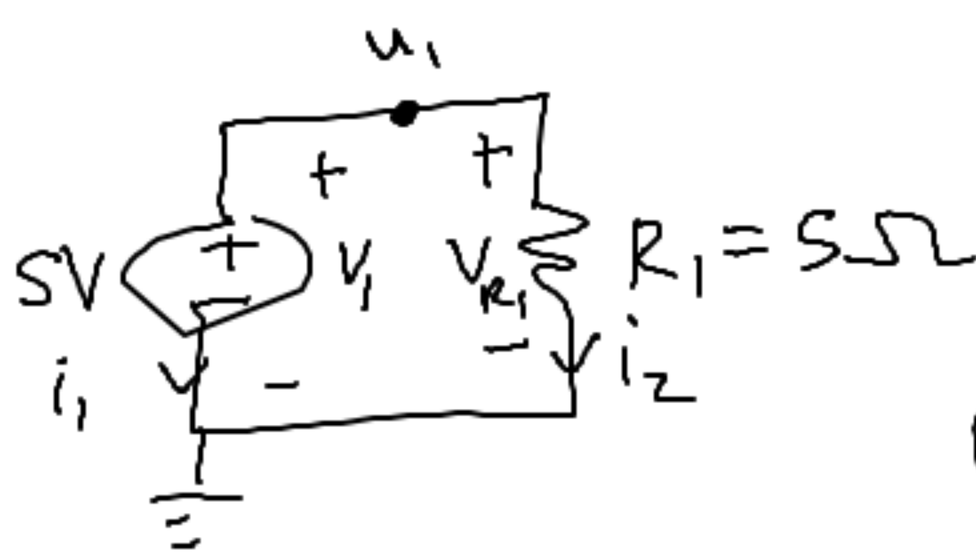
EECS16A DIS3C

Topics

① What's the relationship between passive sign convention & power

② Composing circuits



Q: Find power supplied/dissipated by volt. source, resistor

$P = I \cdot V$ $[W = \frac{J}{s}]$

(power of an element) = branch current · branch current

For any element

Resistors by Ohm's law

$V = IR$

$P = I^2 R, \quad P = \frac{V^2}{R}$

Resistors only!

$P_{V_s} = i_1 \cdot V_1$

$= (-1A)(5V) = \boxed{-5W}$ ← The voltage source dissipates negative power

KCL $i_1 + i_2 = 0$

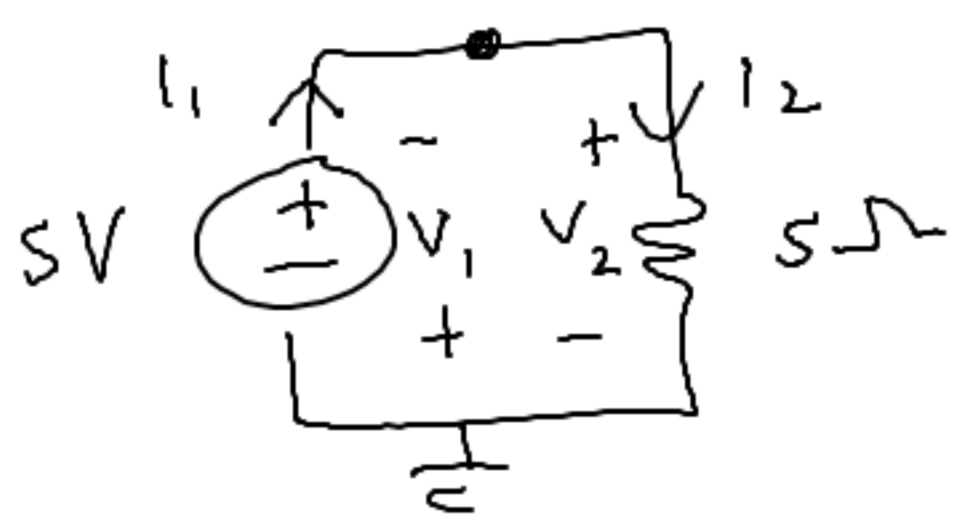
$\Rightarrow i_1 = -i_2 = -1A$

$5V = u_1 - 0 = V_{R_1} \Rightarrow i_2 = \frac{V_{R_1}}{R_1} = \frac{5V}{5\Omega} = 1A$

$P_R = V_{R_1} \cdot i_2$

$= (5V)(1A)$

$= \boxed{+5W}$ ← The resistor dissipates positive power



(b) Find P_{V_S}, P_R

$$P_{V_S} = (-5V)(1A) = \boxed{-5W}$$

$$P_R = (5V)(1A) = \boxed{5W}$$

$V_2 = 5V$ (because of V_S)

$I_2 = \frac{V_2}{R_2} = \underline{1A}$

What's I_1?

KCL @ u_1 : $i_1 = i_2 = 1A$

What's V_1?

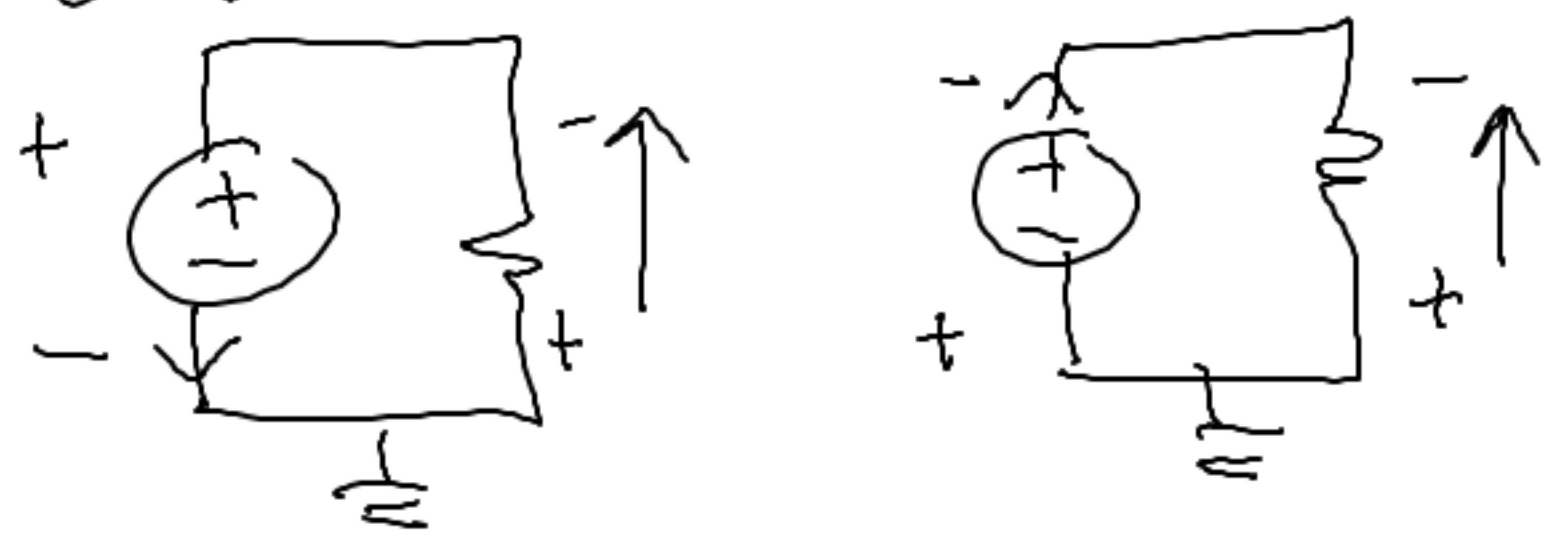
$V_1 = -5V$

(why? $= -V_S$)
flipped

Conclusion: Using passive sign convention will tell you which elements absorb/dissipate energy by having positive power <u>no matter</u> the <u>directions/ or polarity you start w/</u>

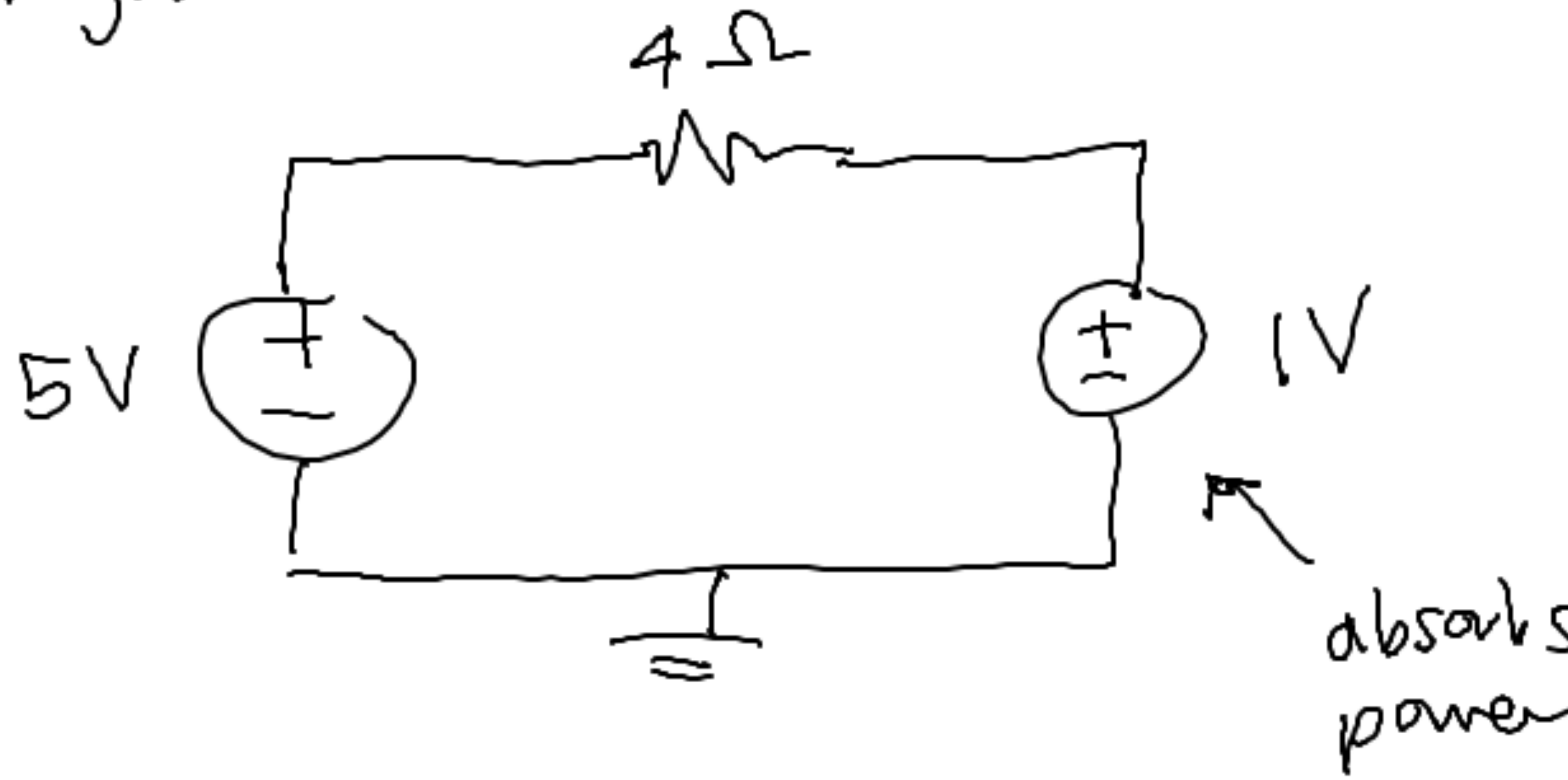
* Comment:
- Power is conserved $\sum P_i = 0$
- Sources do not always supply power
- Resistors always dissipate (passive elements)

Exercise



Also the same power?

When might a source not supply power?



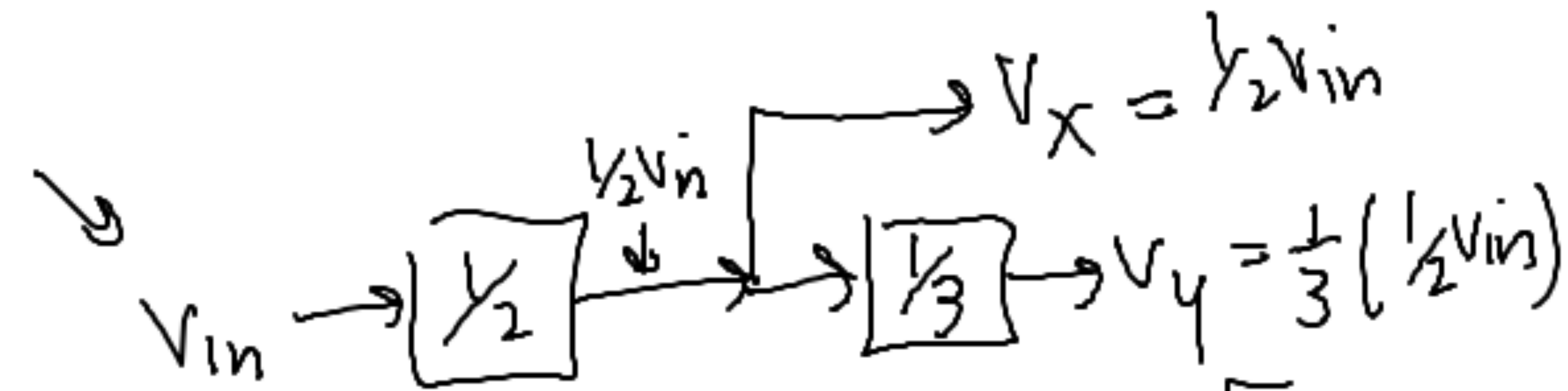
$P_{5V} < 0$ (supplies)

$P_{4\Omega} > 0$ (dissipate)

$P_{1V} > 0$ (dissipate)

2 Design Procedure

1. Think of a circuit that might do the job
2. Calculate how the circuit's behavior depends on choice of components/parameters
3. Choose values to get behavior you want
4. If it doesn't work, modify go back to step 1.

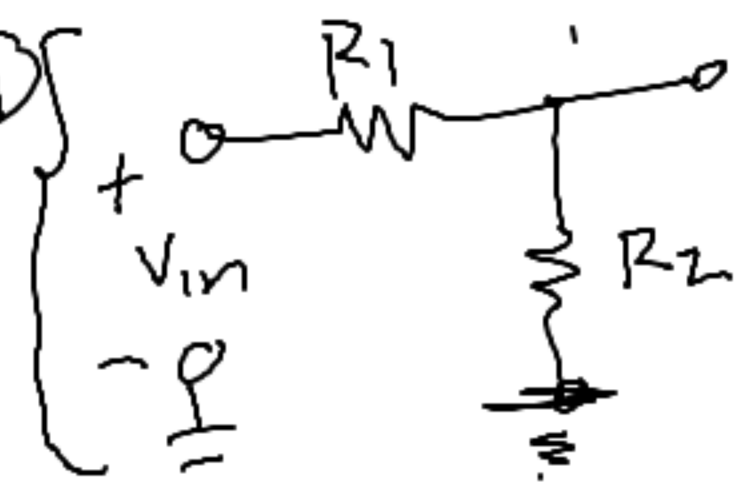


we want to make this

How?

(i) [½] takes V_{in}, outputs $\frac{1}{2}V_{in}$

$V_{out} = \frac{1}{2}V_{in}$

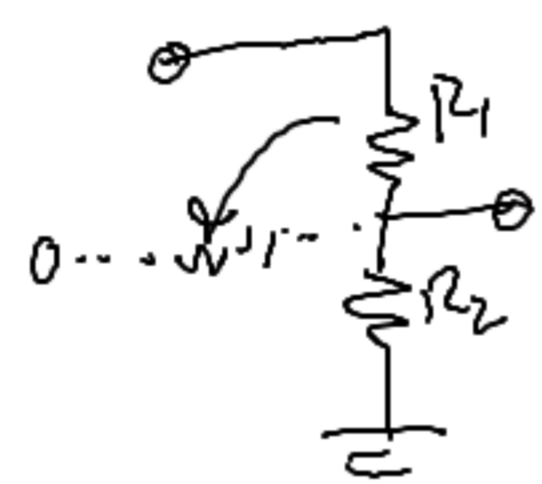
① 

② $V_{out} = \frac{R_2}{R_1+R_2}V_{in}$

③ $\frac{1}{2} = \frac{R_2}{R_1+R_2}$

⇓

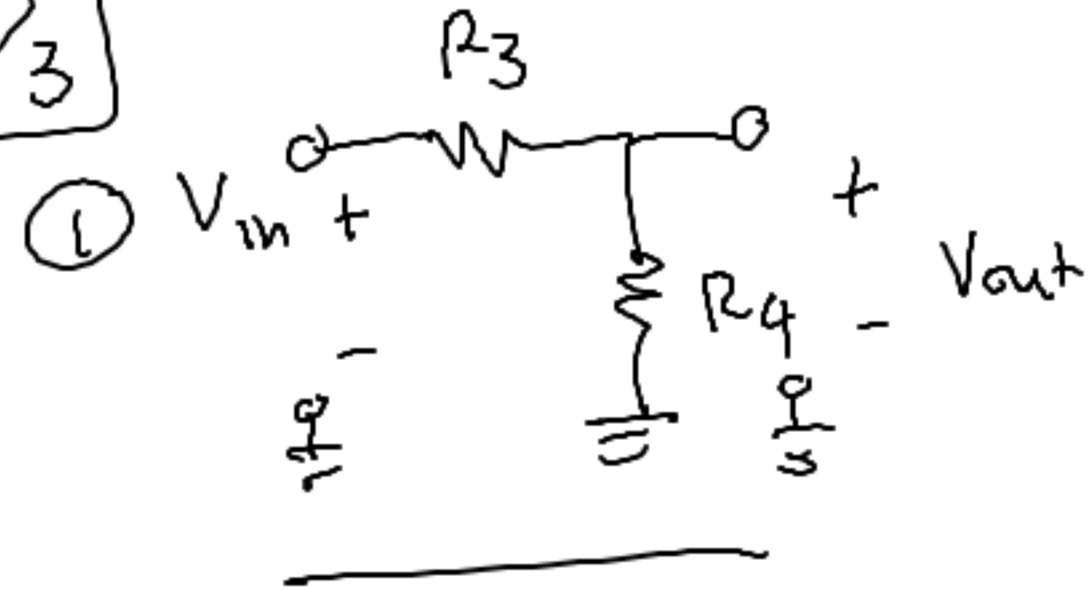
$R_1 = R_2$



Good things to memorize

1. Voltage dividers
2. Current dividers

(2) $\boxed{1/3}$

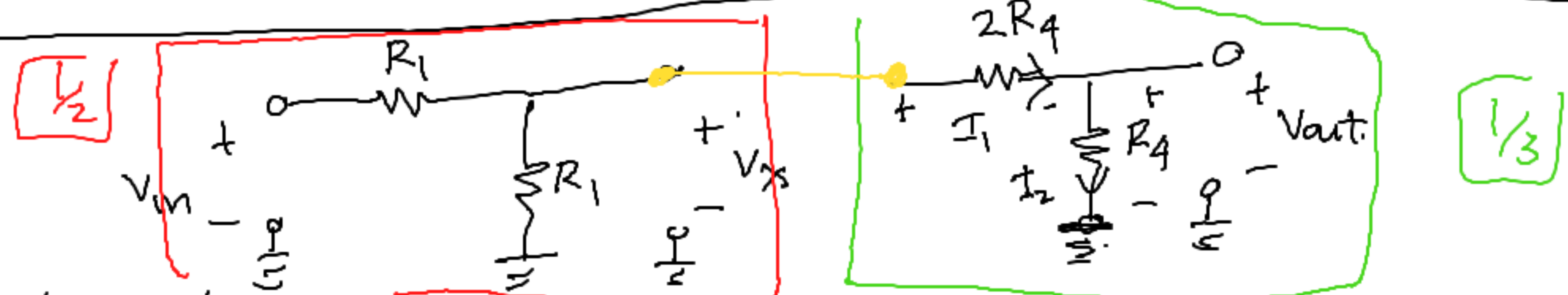


$V_{out} = \frac{1}{3} V_{in}$

(2) $V_{out} = \frac{R_4}{R_3 + R_4} V_{in}$

(3) $\frac{R_4}{R_3 + R_4} = \frac{1}{3} \Rightarrow 3R_4 = R_3 + R_4$

$2R_4 = R_3$



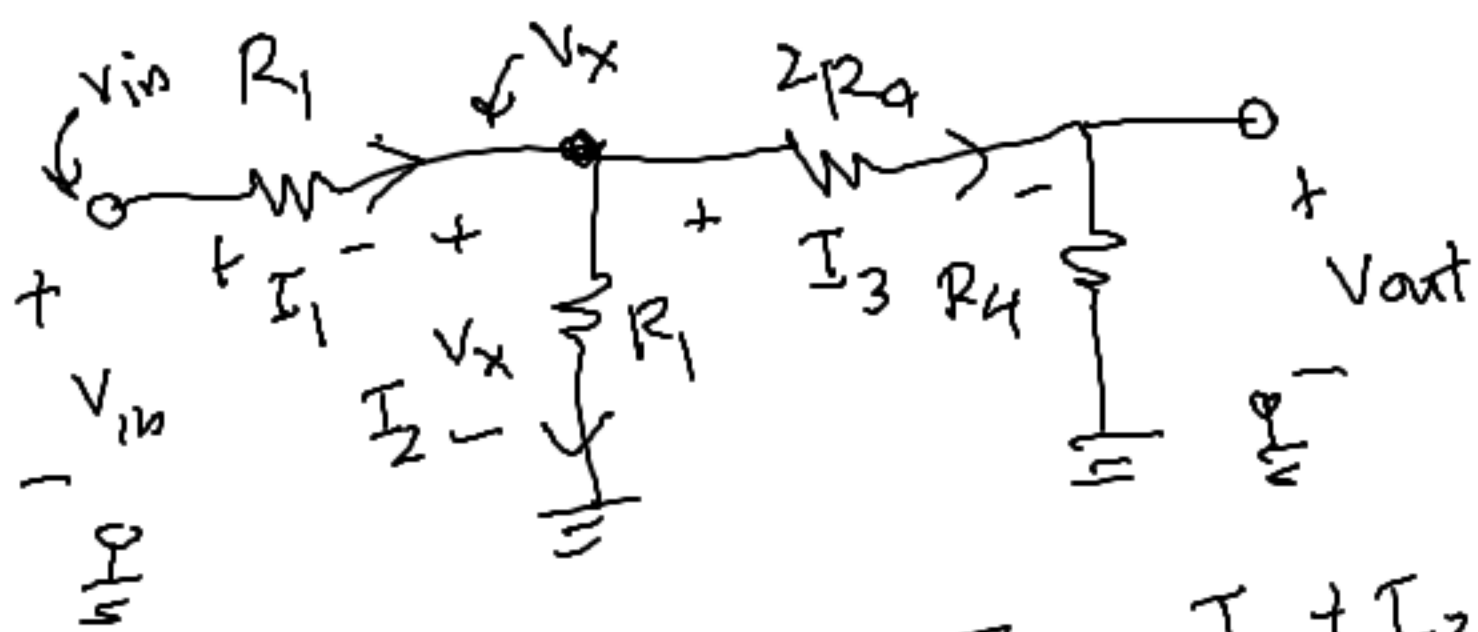
Does $V_{out} = \frac{1}{6} V_{in}$?

and does $V_{out} = \frac{1}{3} V_x$?

KCL @ V_{out} : $I_1 = I_2 \Rightarrow \frac{V_x - V_{out}}{2R_4} = \frac{V_{out}}{R_4}$

$I_1 = \frac{V_x - V_{out}}{2R_4}$ $\Rightarrow V_{out} = \frac{1}{3} V_x$ ✓

$I_2 = \frac{V_{out} - 0}{R_4}$



$$V_{out} = \frac{\frac{2R_4}{R_1} V_{in}}{2 + \frac{12 R_4}{R_1}}$$

→ Not 1/6.

(Find V_{out})

KCL @ V_x node: $\underset{(in)}{I_1} = \underset{(out)}{I_2 + I_3}$

$$I_1 = \frac{V_{in} - V_x}{R_1}$$

$$I_2 = \frac{V_x - 0}{R_1}$$

$$I_3 = \frac{V_x - V_{out}}{2R_4}$$

$$\frac{V_{in} - V_x}{R_1} = \frac{V_x}{R_1} + \frac{V_x - V_{out}}{2R_4}$$

$$\frac{V_{in}}{R_1} - \frac{V_x}{R_1} - \frac{V_x}{R_1} - \frac{V_x}{2R_4} = \frac{-V_{out}}{2R_4}$$

$$\frac{2R_4}{R_1} V_{in} - \frac{4R_4}{R_1} V_x - V_x = -V_{out}$$

($V_{out} = \frac{1}{3} V_x$)

$$\frac{2R_4}{R_1} V_{in} - \left(\frac{4R_4}{R_1} + 1\right)(3V_{out}) = -V_{out}$$

$$\frac{2R_4}{R_1} V_{in} = 2V_{out} + \frac{12 R_4}{R_1} V_{out}$$

Takeaway: Can't just stick two circuits together
Composition doesn't work (yet)

Extra demo! + Some notes on problem 3 (practice)

Can't just stick circuits together and expect perfect behavior

Partial sol: Choose resistors on the next block (R_4) to be large relative to resistors in the previous block (R_1)

Consequence: Increase resistor values/magnitudes to infinity

Is there a solution? **Yes** (later lectures)

Prob 3: Power, units, power transfer

$\exists [V] = [\frac{J}{C}]$ $[W] = [\frac{J}{s}]$ $[A] = [\frac{C}{s}]$

Q: Under what conditions do we transfer the most power?