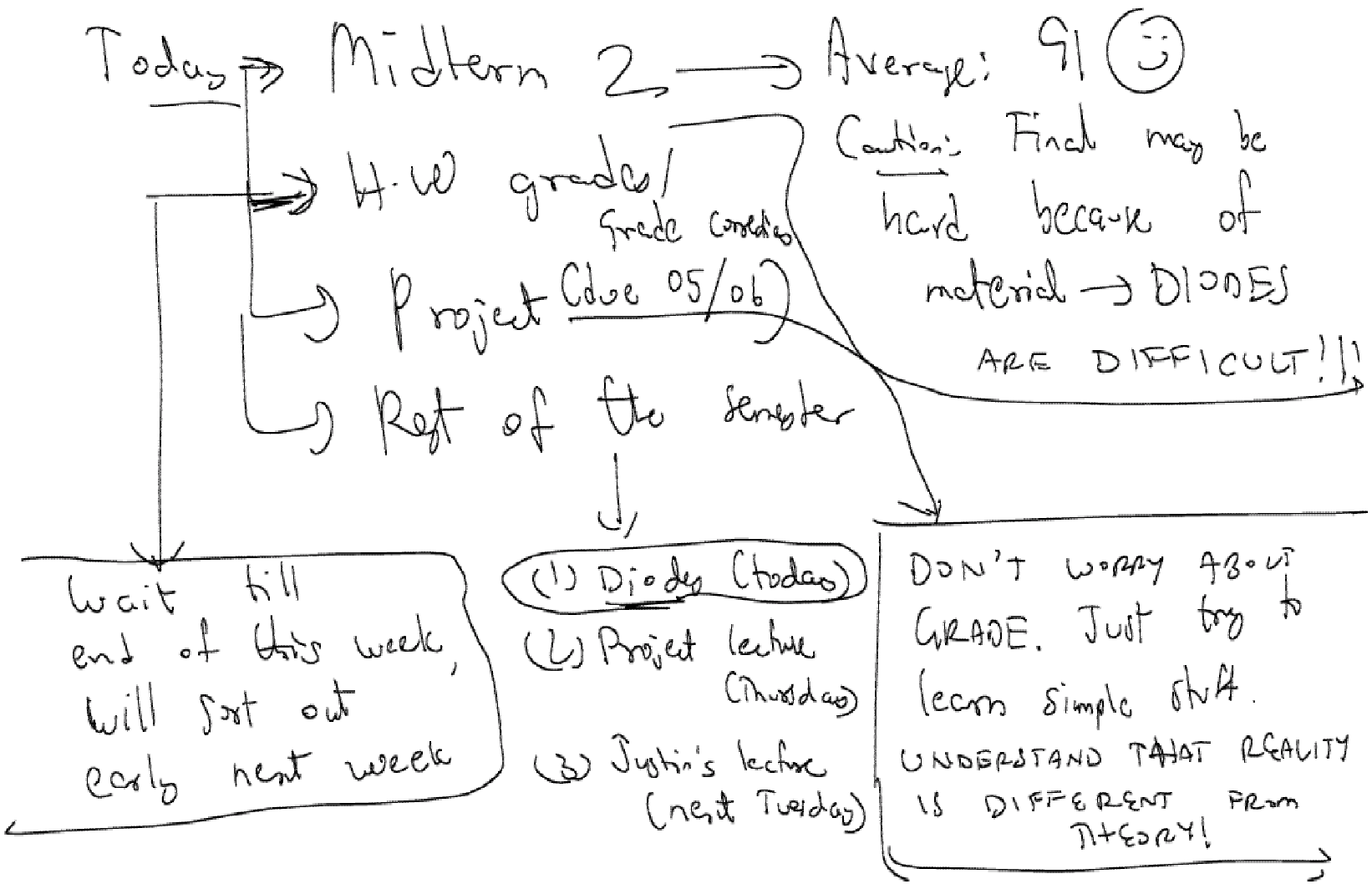
Lecture 24 - Diodes (cont'd.)

Administrivia → PROJECT LECTURE ON THURSDAY (04/21)

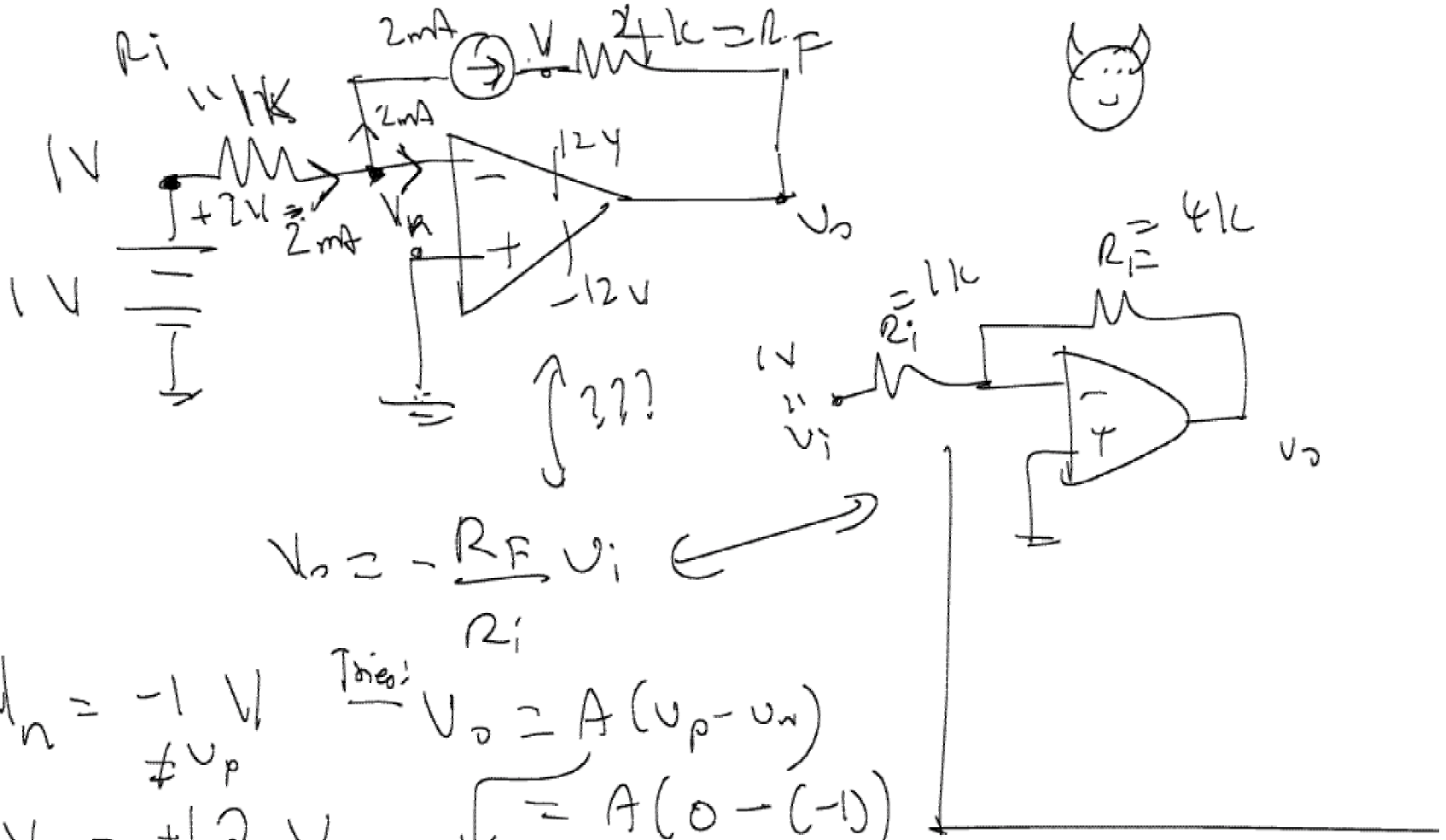
→ Jaleh's Friday 2-5 section

[If you are NOT enrolled in the section and want to attend it: email Jaleh (jaleh@berkeley.edu) by Wednesday, 5:00pm]


Today
Midterm 2
Average: 91
Caution: Final may be hard because of material → DIODES ARE DIFFICULT!!!
H.W grades/ Grade corrected
Project Cdue 05/06)
Rest of the Semester
Wait till end of this week, will sort out early next week
(1) Diodes (today)
(2) Project lecture (Thursday)
(3) Justin's lecture (next Tuesday)
DON'T WORRY ABOUT GRADE. Just try to learn simple stuff.
UNDERSTAND THAT REALITY IS DIFFERENT FROM THEORY!

Diodes → (1) How do LEDs work?
↳ Refer to reader p.326
↳ (2) Do you have to check if every diode in the circuit is in a valid operating range?
↳ YES!!!

Oh, total aside, midterm 2 comment!



$$V_o = -\frac{R_F}{R_i} V_i$$

$V_n = -1\ V \neq V_p$

$V_o = +12\ V$

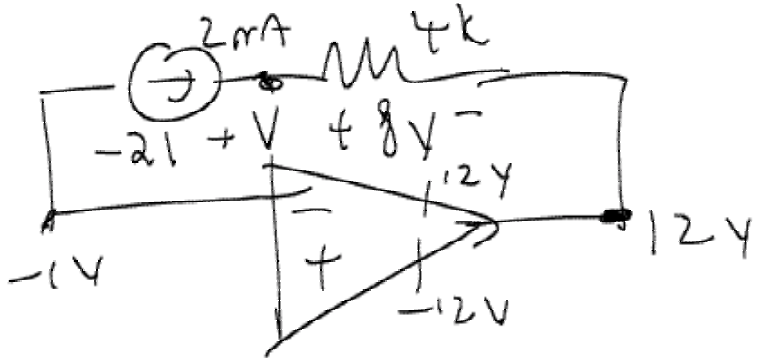
Tries: $V_o = A(V_p - V_n)$

$= A(0 - (-1))$

$10^6 = A \cdot 1 \longrightarrow 10^6$ ✗ $\therefore V_o = +12\ V$

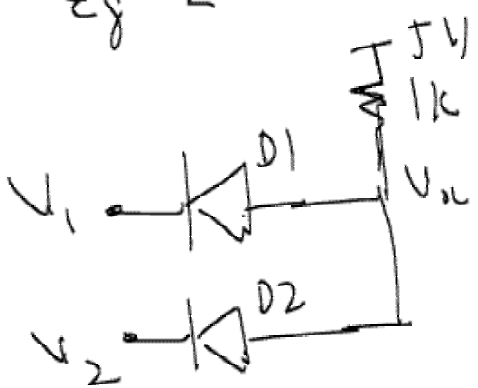
(Op-amp open loop gain)

$V_o = 12\ V$



$V = 20\ V$

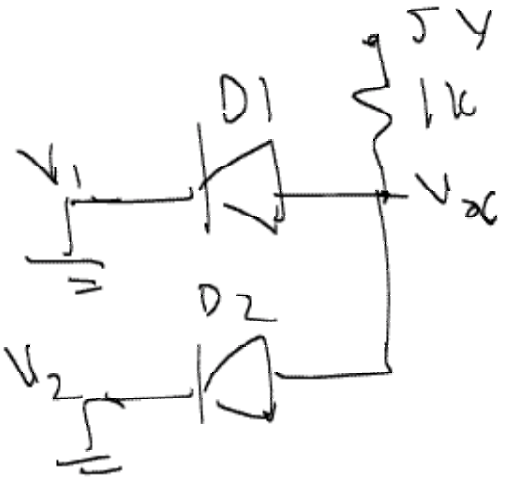
Finish up Eg 2 from lecture 21:



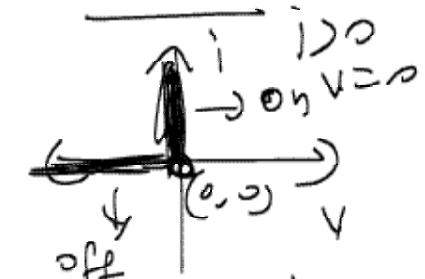
V_1	V_2	V_{DL}
0	0	0
0	5	0
5	0	0
5	5	5

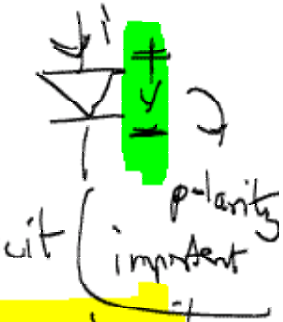
symmetry

Case (1): $V_1 = 0$, $V_2 = 0$

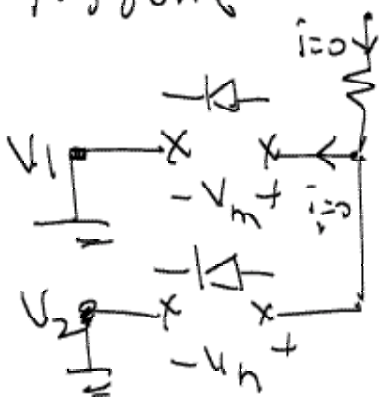


Recall:



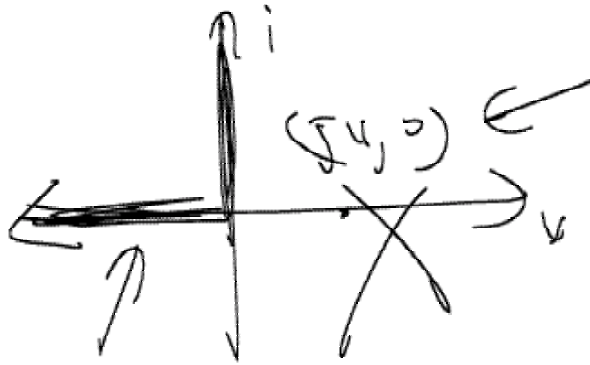


Assume both off ⟵ easy to solve circuit if diode is off!



$V_{ox} = 5\,V \Rightarrow V_n = 5\,V$ } Oops, not possible if diodes are off!

or $V_n = 5\,V$ }

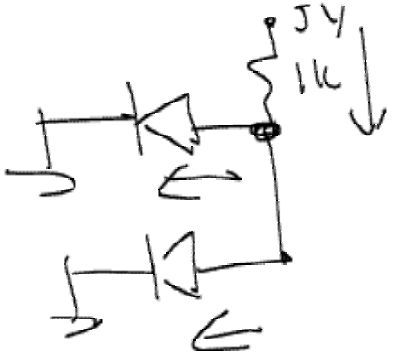


operating point

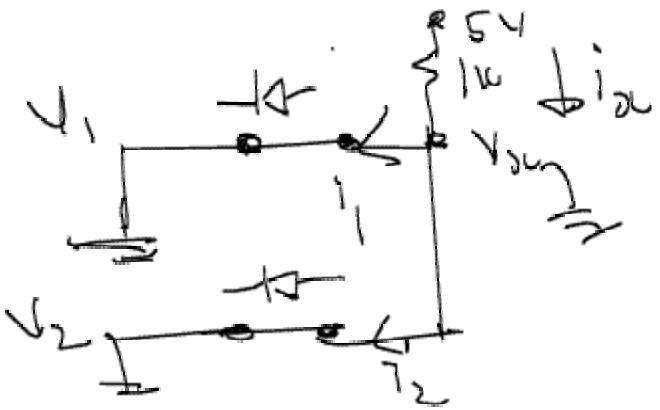
⇒ assumption is wrong

if diode is off, your operating point is here!

Diode(s) are on → but which one???



Tip (2): Look at direction of current flow in the circuit



$$i_R = \frac{5 - V_{out}}{1K} = 5\,mA$$

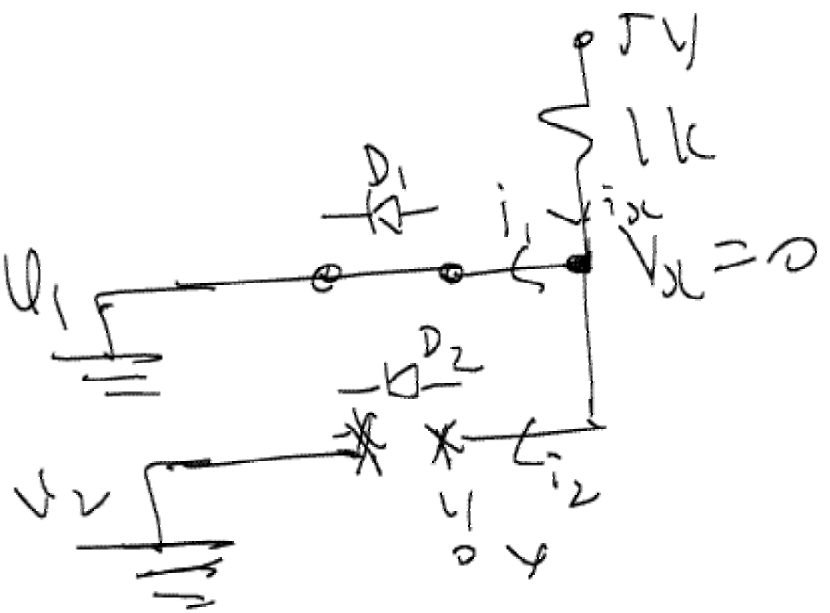
$$i_1 + i_2 = 5\,mA \quad (KCL) \quad -(1)$$

If diodes are on, $i_1 > 0$

$i_2 > 0$

But, these exists an (i_1, i_2) that satisfies (1) such that $i_1 > 0$, $i_2 > 0$ eg: $i_1 = 2mA$, $i_2 = 3\,mA$

N.B.ici Lets assume D_1 on, D_2 off



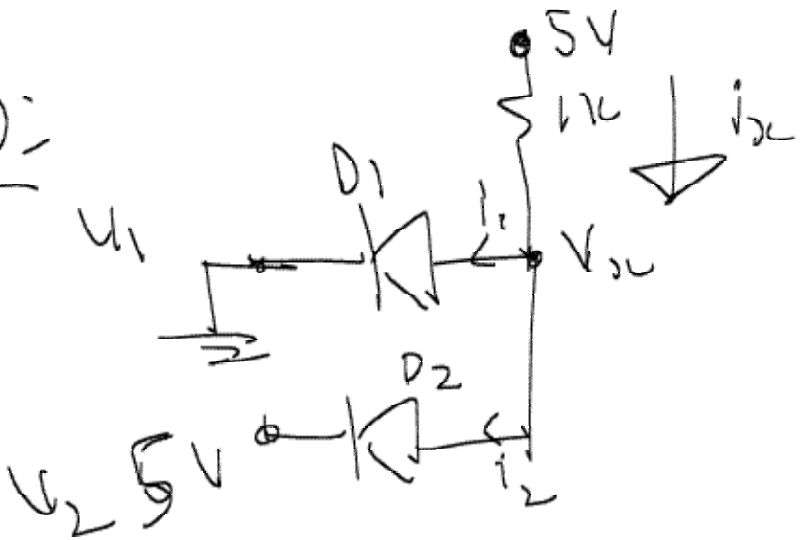
$V_x = 0$ V

$i_d = 5$ mA

$i_2 = 0$ mA

$i_1 = 5$ mA

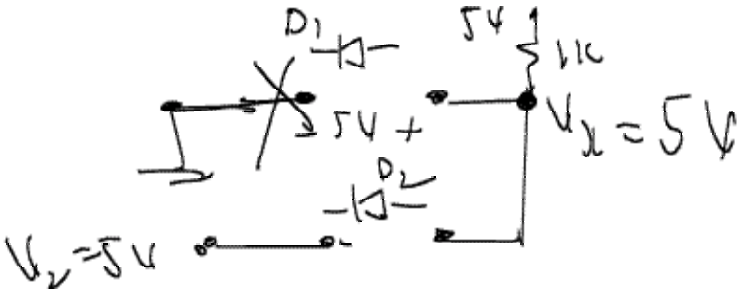
Case (2):

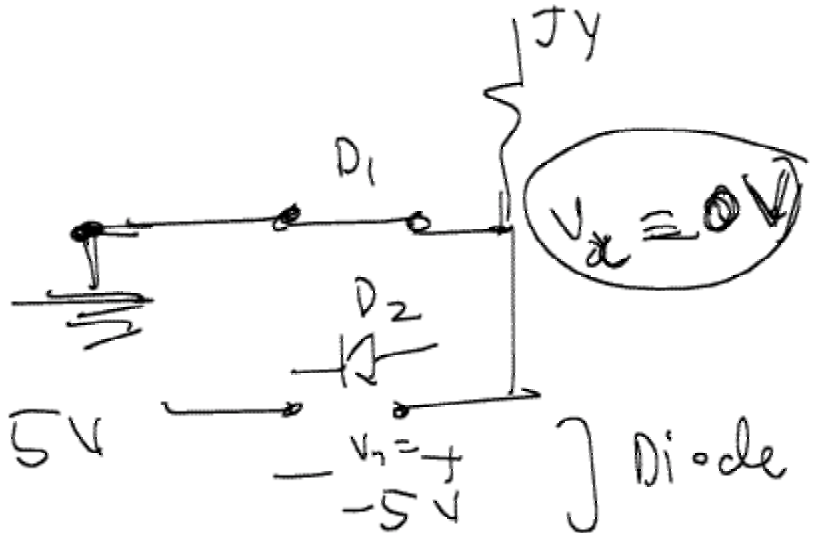


Tip(3): Try to find range of unknown node voltages

eg: $V_x \in [0, 5]$

Assume diodes off: ⟶ assumption is wrong

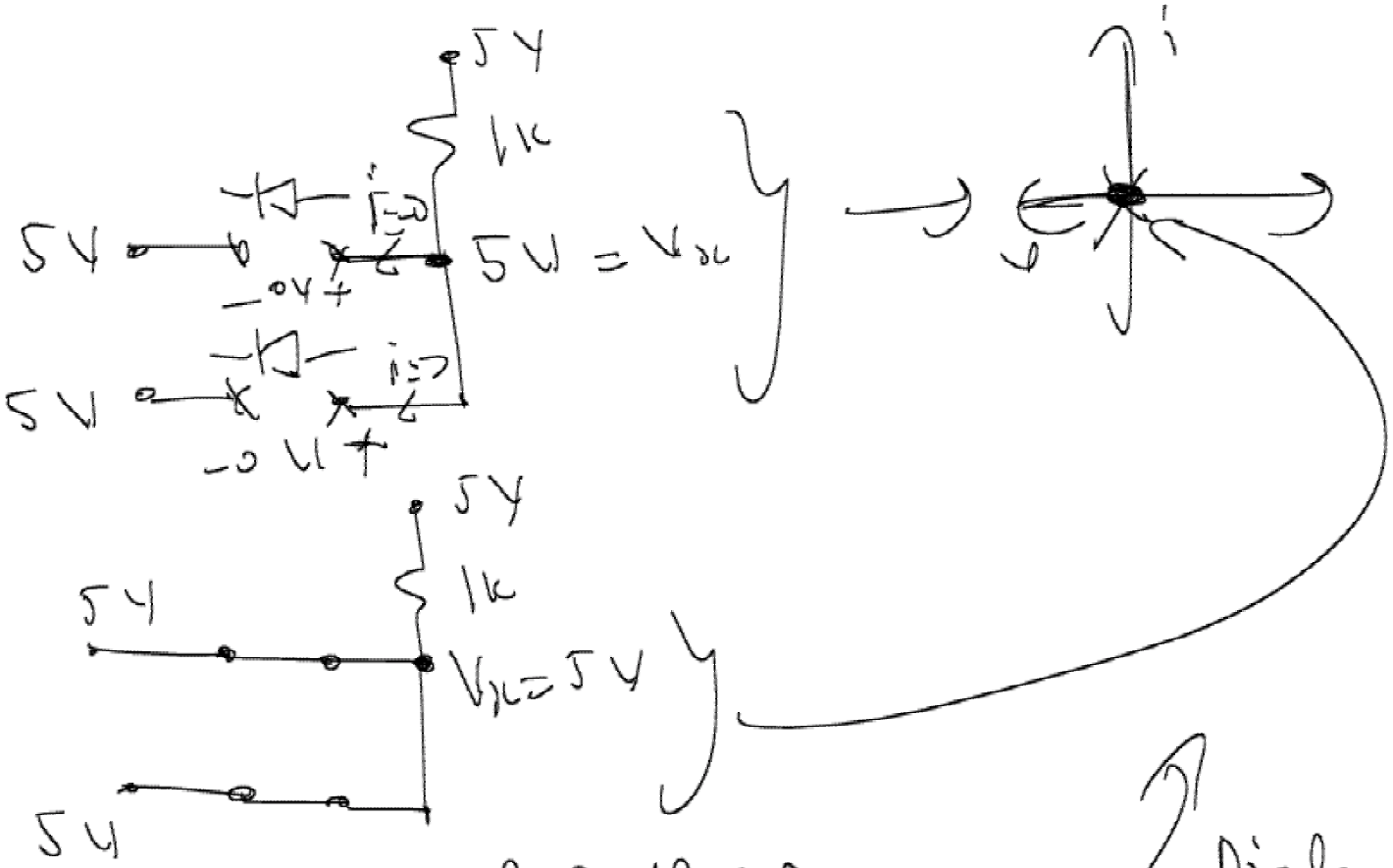




$V_n = +$] Diode is off $(V_n < 0)$

Case (3): $V_1 = 5$, $V_2 = 5$] Same as Case (2) by symmetry

Case (4): $V_1 = 5$, $V_2 = 5$



A	B	A·B
0	0	0
0	1	0
1	0	0
1	1	1

} Boolean Algebra

Mathematically:

Diode circuit implements AND

$V_{OL} = V_1 \cdot V_2$

Diode stuff is in reader.

CHALLENGE: Implement XOR Boolean function using diodes & resistors

i.e.:

V_1	V_2	$V_1 \oplus V_2$
0	0	0
0	5	5
5	0	5
5	5	0

$V_1 \oplus V_2$

$= V_1 \cdot \overline{V_2} + V_2 \cdot \overline{V_1}$