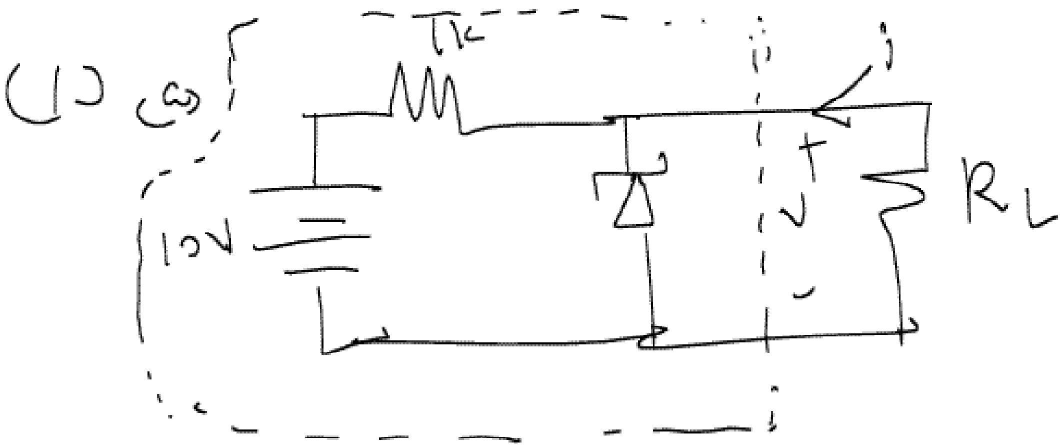
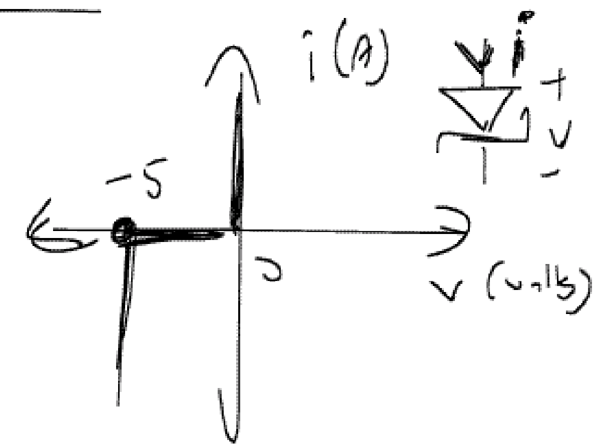
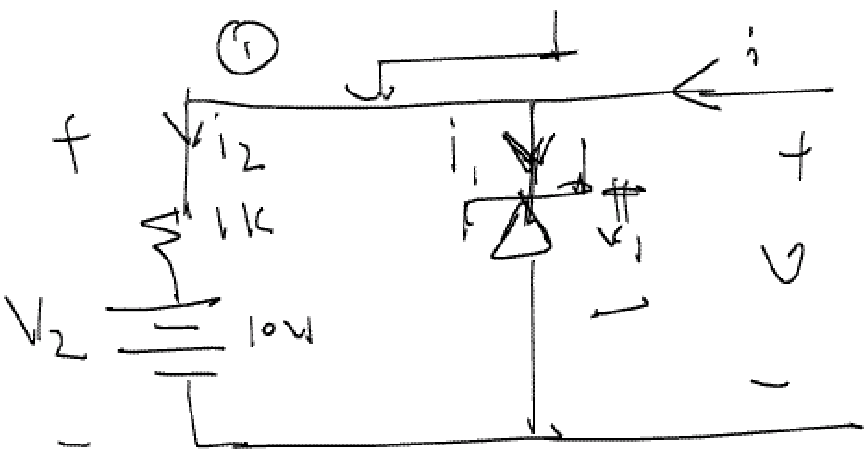
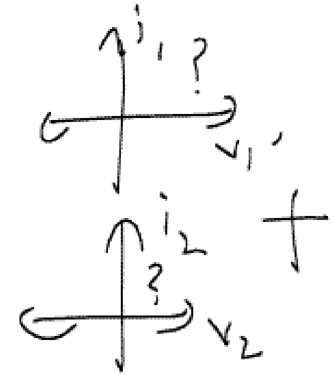
Thursday Night "Lecture / OH"



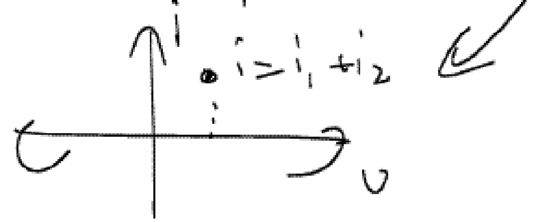


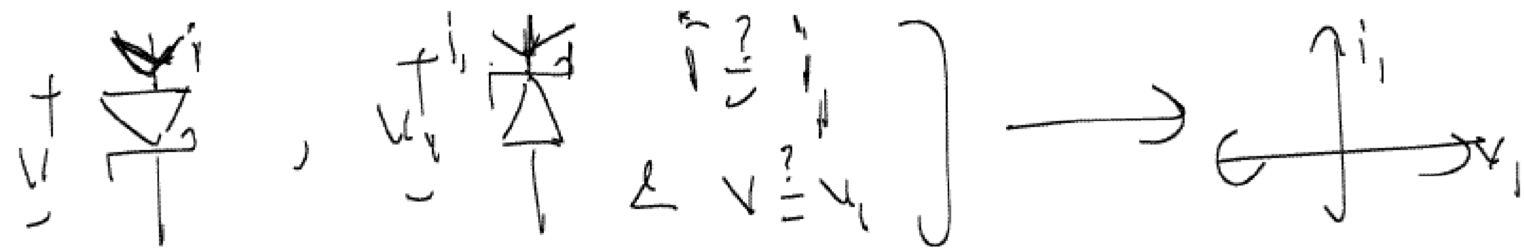




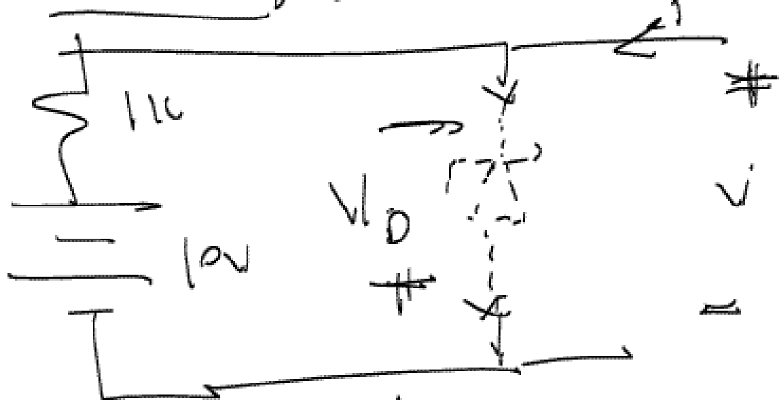
KCL: $i = i_1 + i_2$

KVL: $v_1 = v_2 = v$





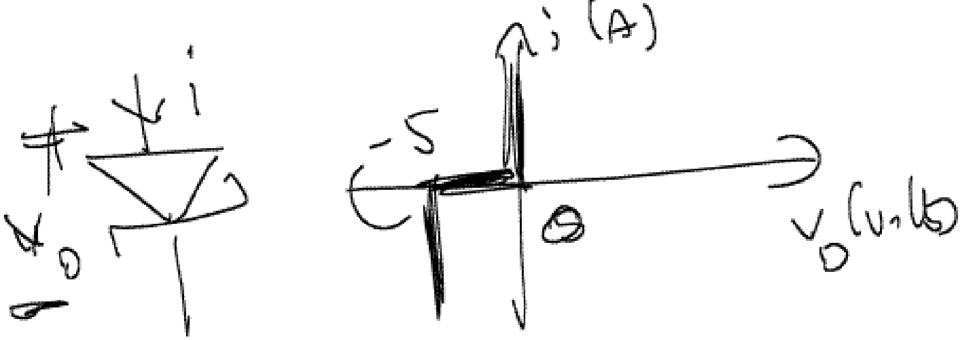
② Circuit analysis, remember zener will turn on if $V_Z = -5\,V$



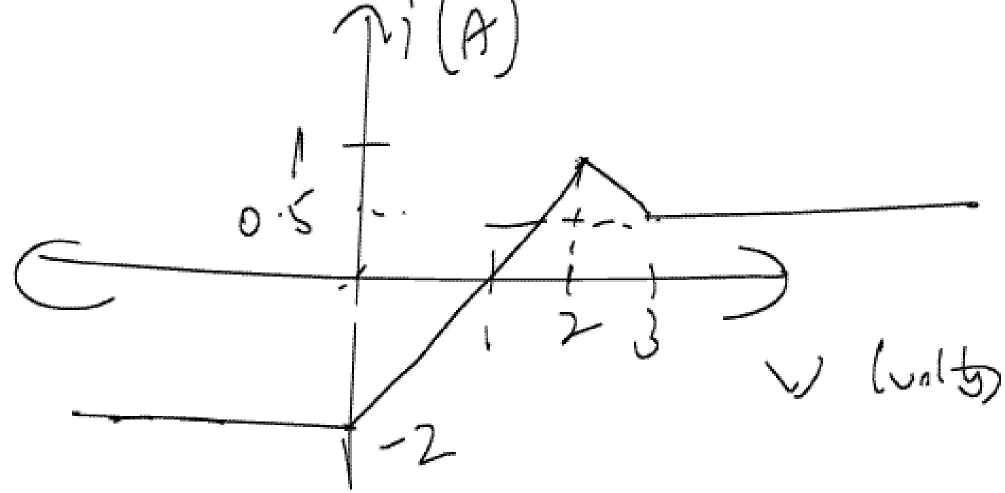
Assume diode is off i.e. $-5 < V_D < 0$

$V = -V_D$

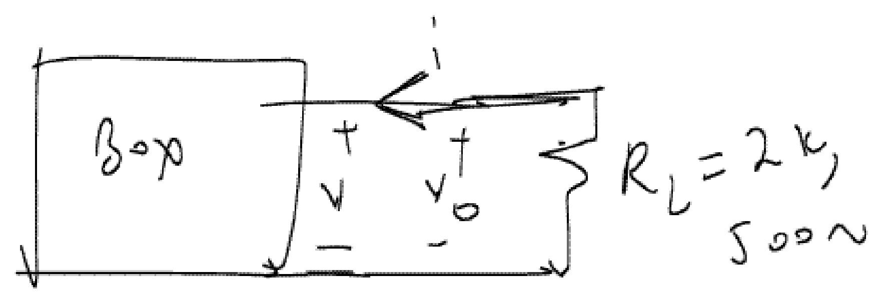
$\therefore \; 0 < V < 5$



Assuming:



(b)

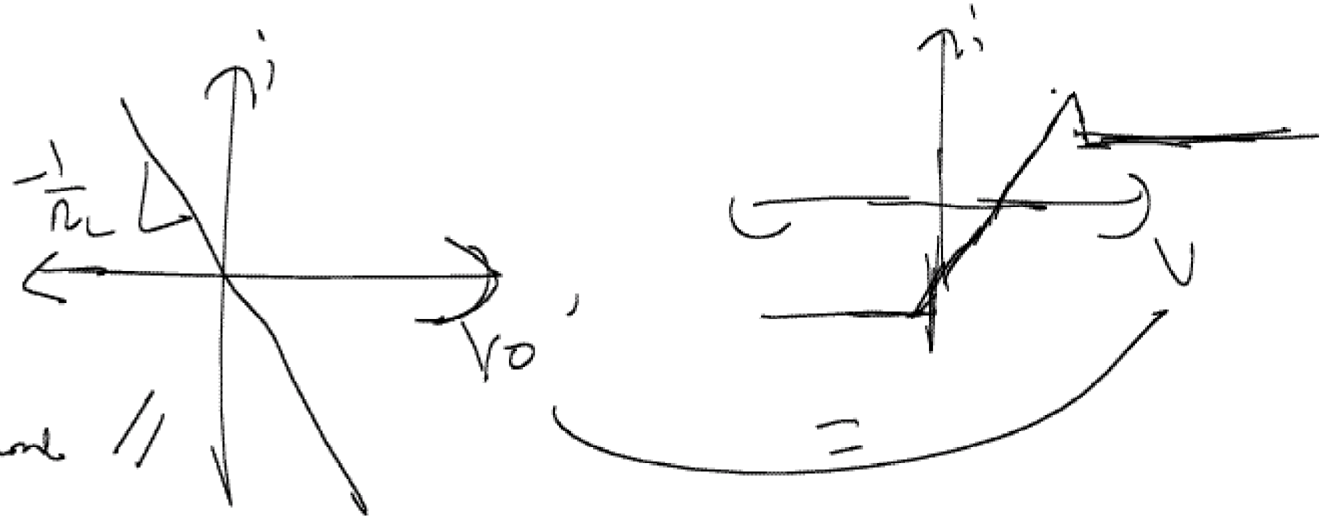


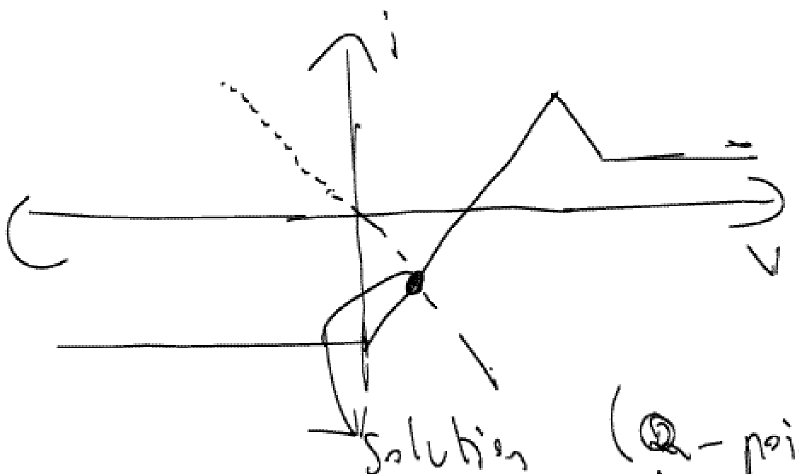
Best solution: Graphical: we know $i = f(v)$ for the box (derived in part (a))

$$i = \frac{-V_o}{R_L}$$ [Because i is leaving +ve terminal]

But, we know from KVL: $\therefore V = V_o$

∴ plot on the same x-axis

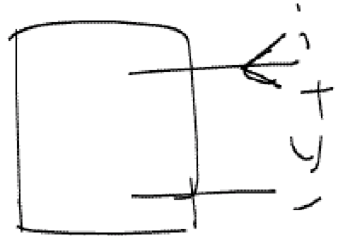


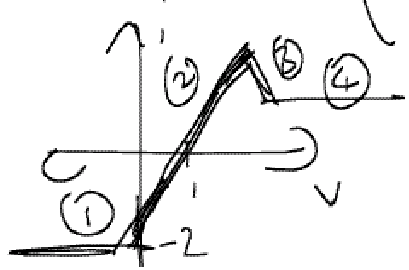


(Q-point)
↓
Quiescent

Load-line method

Hard: Circuit analysis : (Not recommended for faint of heart!)





write a mathematical expression for $i = f(v)$

i.e.. $i = \begin{cases} -2A & \text{if } v < 0 \\ \vdots \end{cases}$

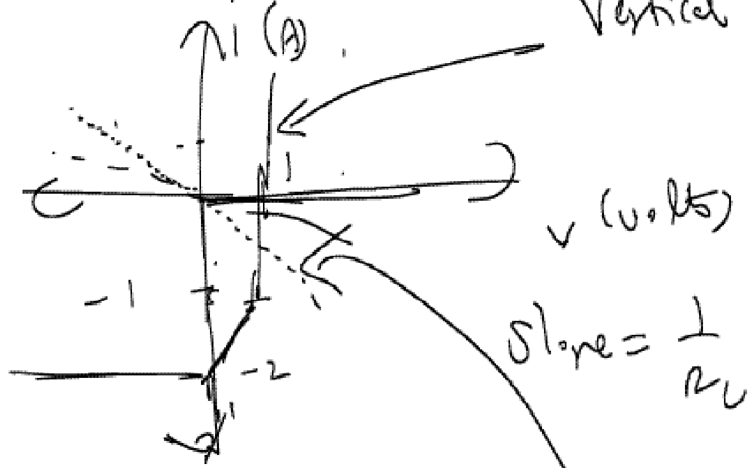
We know: $i = \frac{-v_o}{R_L}$ if $R_L = 2k$.

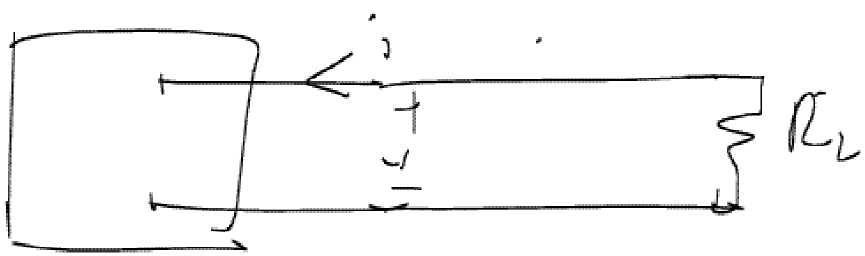
assuming BJT is in region ①

Consider $i = -2A$ (if $v_o < 0$, $(v_o = v)$)

$\therefore$ $-2 = \frac{-v_o}{2k} \Rightarrow v_o > 0$ contradiction

(Q:) What if i vs. v looks like:



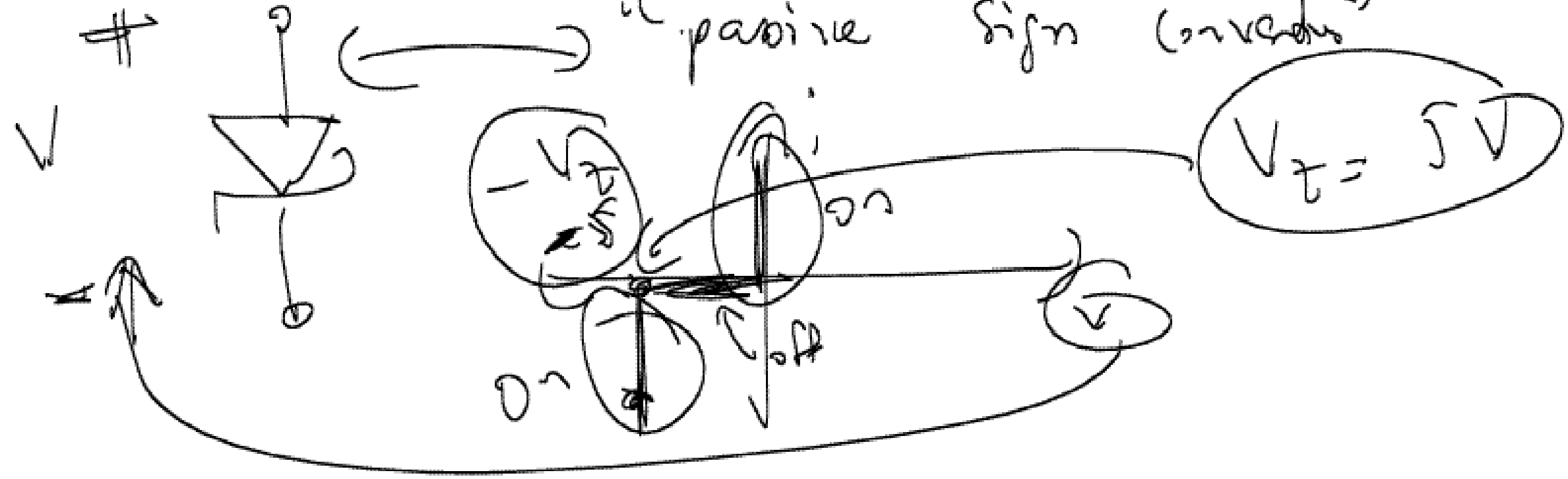


$V = 1\ V$

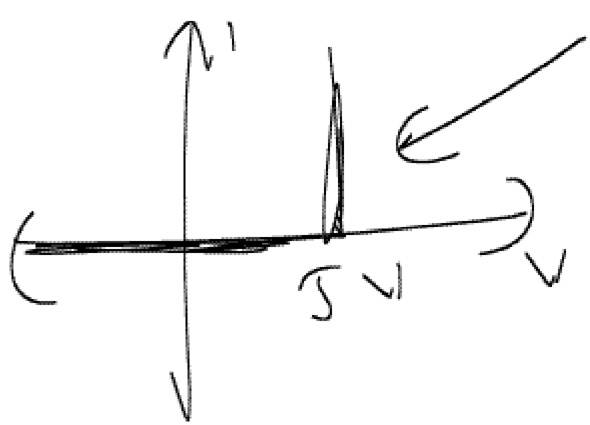
$R_L > 1\ \Omega$

(Q:) What values of R_L gives a constant $V = 1\ V$?

"passive sign convention"

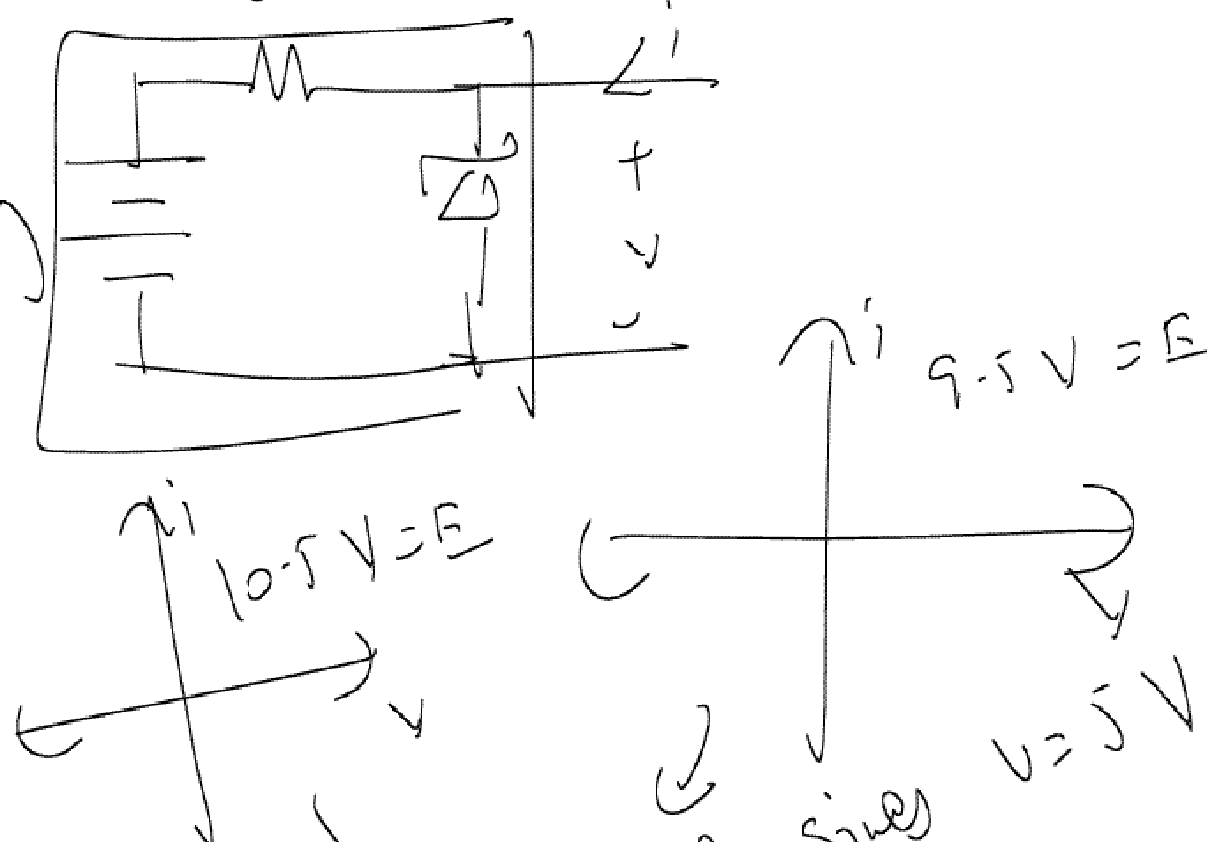


v is not positive because it is hard to get: very difficult



(c) E can vary by 5%.

⇒ $[9.5, 10.5]$



What R_L gives $v = 5\ V$

__Suggestion:__ Super-impose two graphs & figure it out. You have to choose worst case:

i.e.. if $R_L = m\ k\Omega$ (say)

If $E = 10.5V$, $V = 5V$

$E = 9.8V$, $V = 4.9V$

Does $R_L = m\ k\Omega$ work?? __No!__

Assume R is always positive unless otherwise ?

in other words, for constant $V = 5\,V$

$$\begin{cases} \text{if } E = 10.5,\ R < 3\ (\text{sq}) \\ \text{if } E = 9.5,\ R < 2 \end{cases}$$

pick this one.

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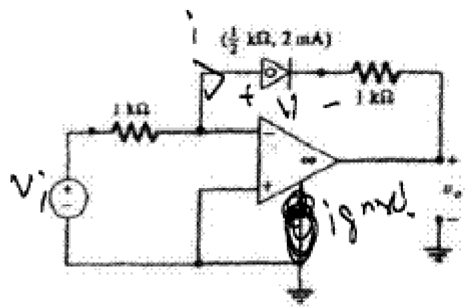
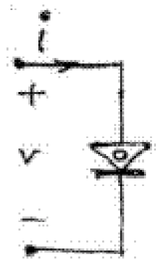
(2)





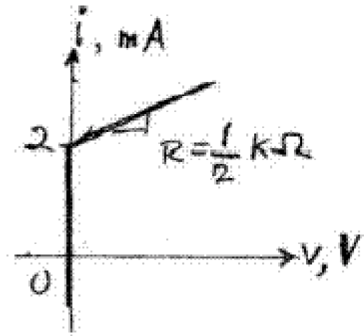
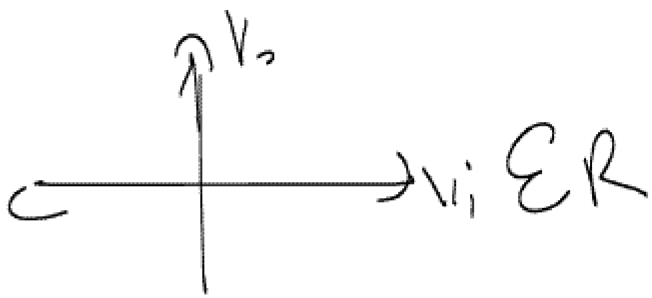
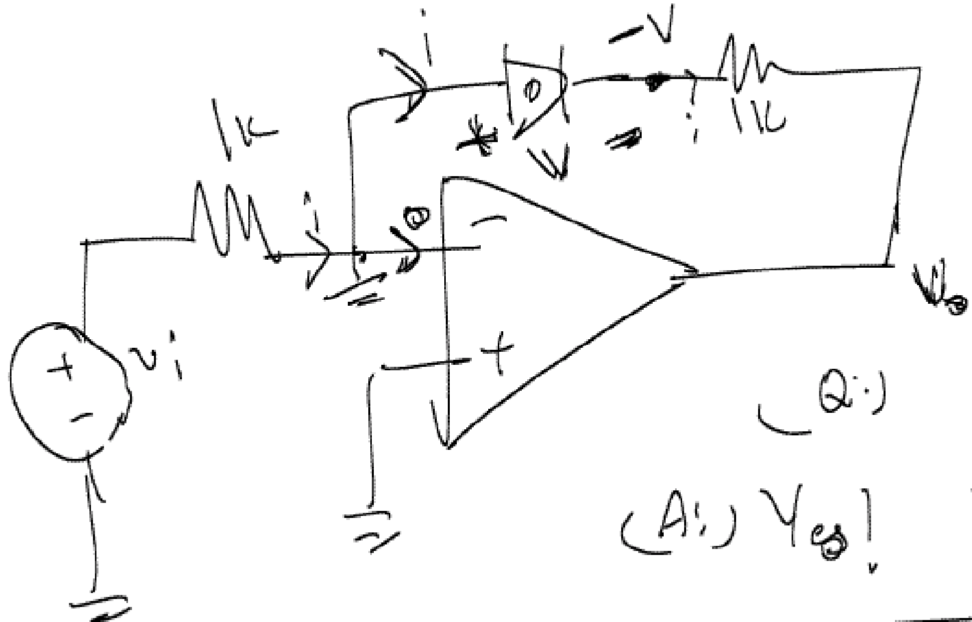
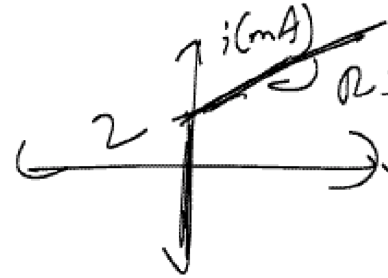


Figure 4

~~3. Sketch the i-v graphs for the circuit(s) below assuming the diodes are all ideal.~~







$R = \frac{1}{\Delta} = \frac{1}{2}k$

Q:) Can we set i vs. v_o?

A:) Yes! How?

Q:) Can we find i vs v_i?

A:) Yes!

$$i = \frac{v_i}{1000} \quad (1)$$

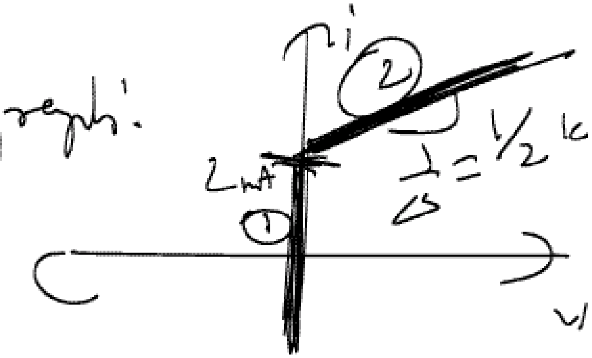
$$\frac{-V - V_o}{1k} = i \quad (2)$$

To set v_o vs v_i, we can use ① & ②

We can set em equal to each other:

$$\frac{-v-v_o}{1k} = \frac{v_i}{1k}$$, but we still need to eliminate v!

⇒ we use i vs. v graph:

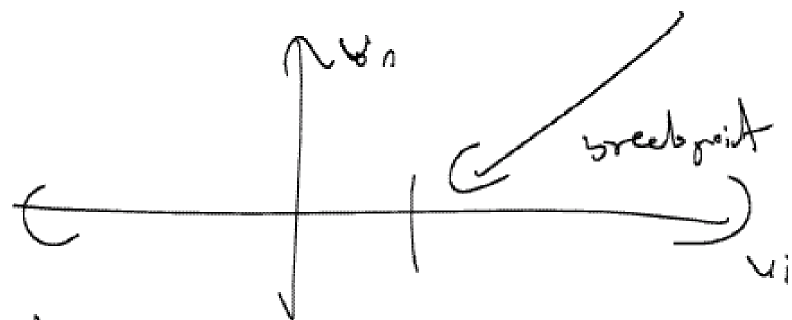


(Q:) For what value of v_i is $i < 2mA$, $v = 0$ (region ①)

& for what value of v_i we get region ② ?

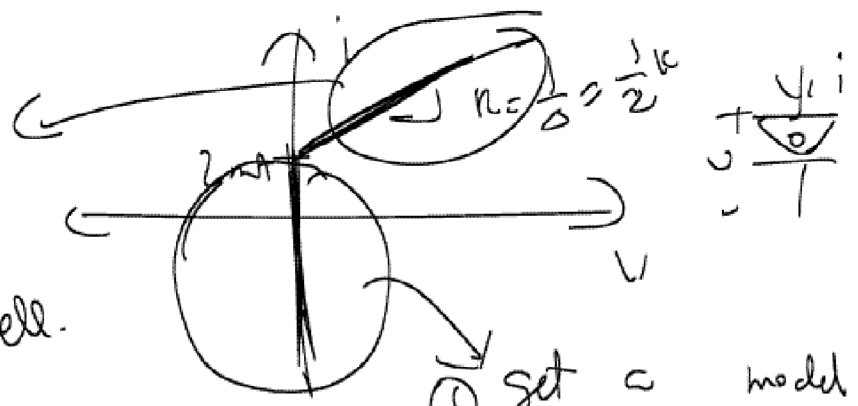
A: $V_i = 2$ V. How? Breakpoint is $i = 2mA$, $v = 0$ V

Figure out what v_i is if $i = 2mA$



Easy way to do this problem:

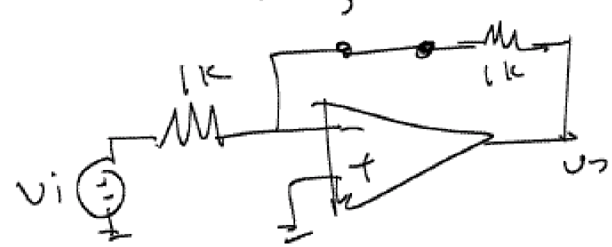
repeat ① for this region as well.



① get a model for the nonlinear diode in this region, substitute into the circuit & solve for v_o vs v_i

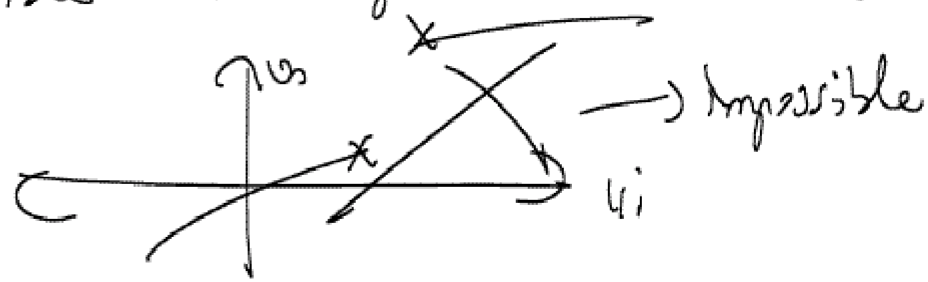
You know how to find the "breakpoint" in terms of v_i, use $i = 2mA$, $v = 0$ V

①:



→ solve!

(Q:) Physically impossible to get a discontinuity in V_o vs v_i:



(A:) No derivative term in circuit (i.e.. no Cs, no Ls). That is, not a dynamic system

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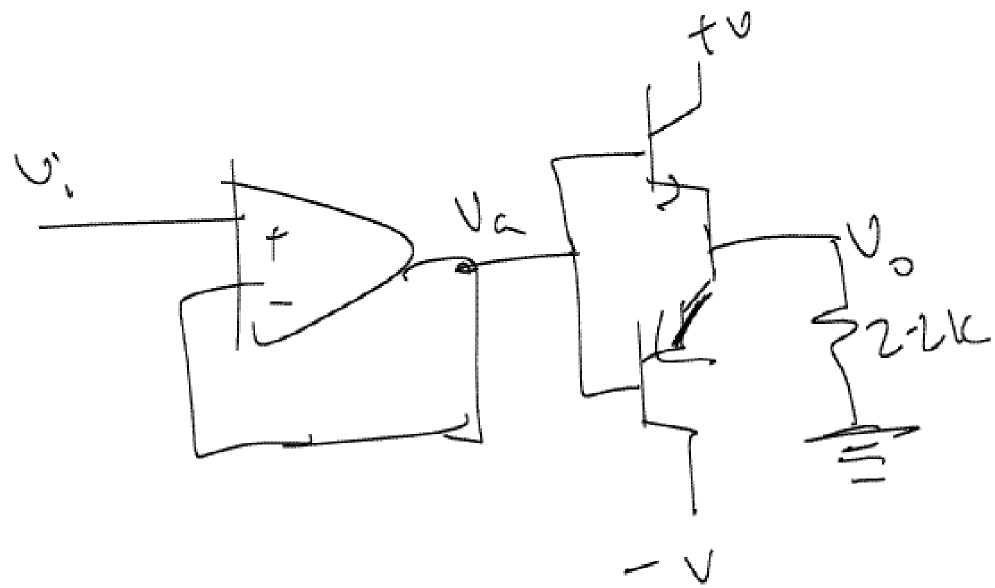
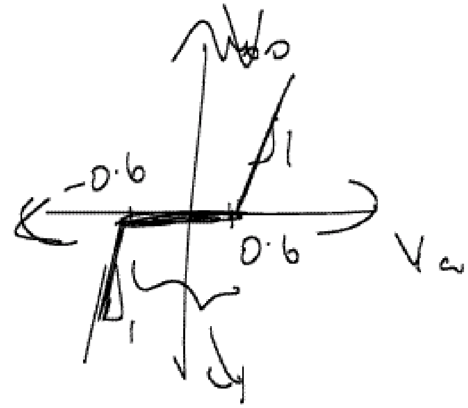
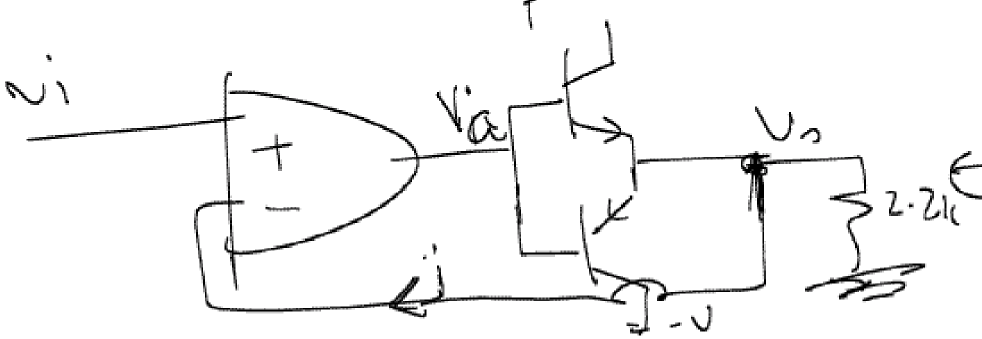
(3) ⇒ Easy, so thru Justin's lecture

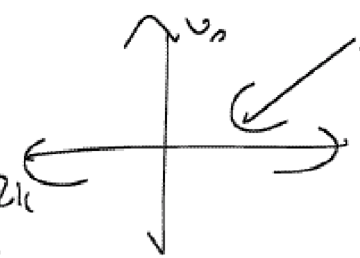
Ex: EE 128 problem ☺





deadband (cross-over distortion)





removes nonlinearity

how?

Hint: $I = ?$

Ask: what can V_o be if V_a is between $[-0.6, 0.6]$ & how does this affect the op-amp?

(Q:) Why is $V_i = V_o$? (DO NOT ASSUME OP-AMP IS IDEAL)

(TRY TO PROVE IT!)