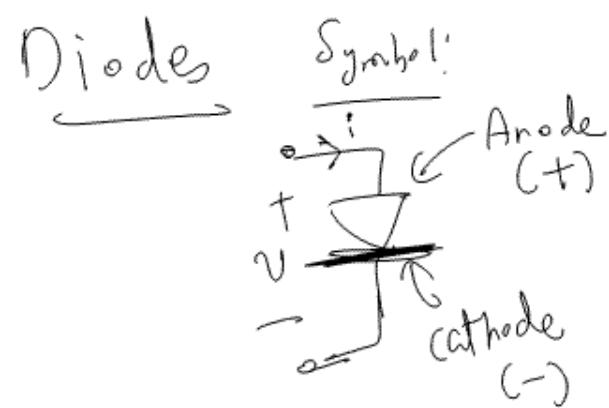


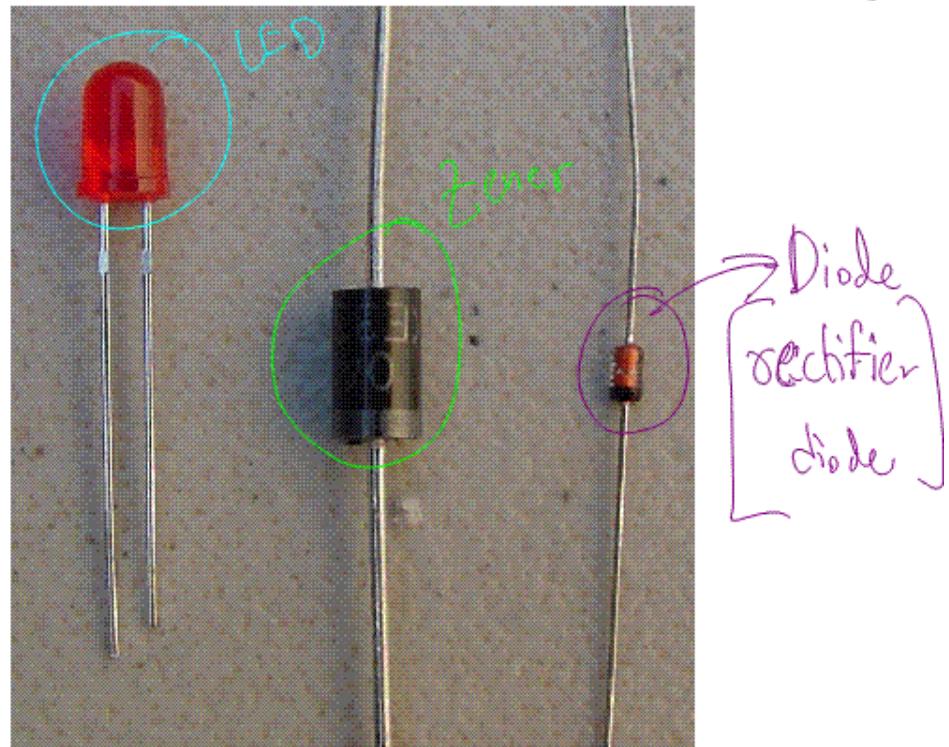
EE100 Lecture 16 — Diodes

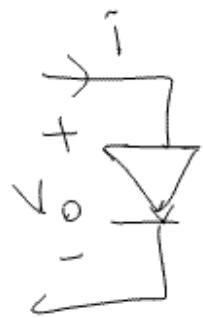
- Administrivia → Grade changes submitted during my July 20th office hours are not reflected online! → PLEASE RESUBMIT
(show me in office hours next Wednesday or check your grades with me after lecture today)
- My office hours next Wednesday will be in 140 Cooy (the lab) to help students with their project.
- Work on project out of lab → check EE40 lab schedule on Monday, Wednesday, Friday



Note: Anode is +ve
in FE because of
(conversion \Rightarrow) +ve charges
carry current.

Reality: (from Google Images ☺]





$$i = \begin{cases} I_s (e^{\frac{V_D}{V_m}} - 1) & \text{if } V_D > 0 \\ 0 & \text{if } V_D < 0 \\ \text{avalanche breakdown} & \text{if } V_D = V_{\text{breakdown}} \end{cases}$$

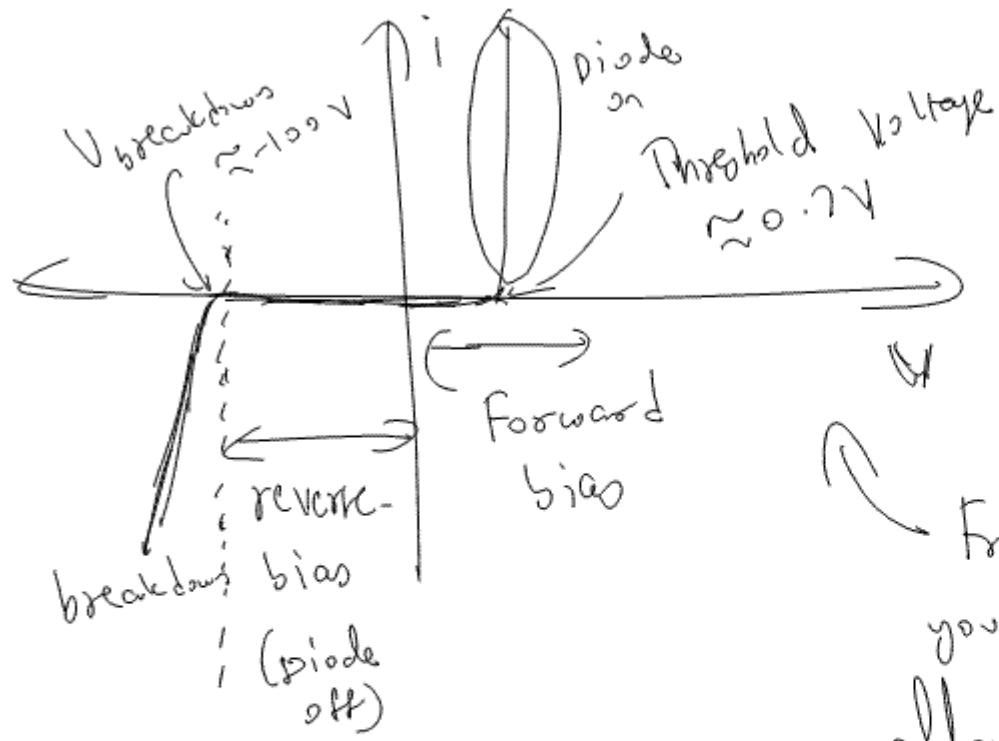
$I_s \triangleq$ saturation current $\approx 10^{-14} \text{ A}$

$V_m \triangleq$ Thermal voltage $= \frac{kT}{q}$, $k =$ Boltzmann's constant

$$\underbrace{V_m (@ 300K)}_{\text{room temperature}} = 0.026 \text{ V}$$

$q =$ magnitude of electron charge

$T =$ temperature (kelvin)

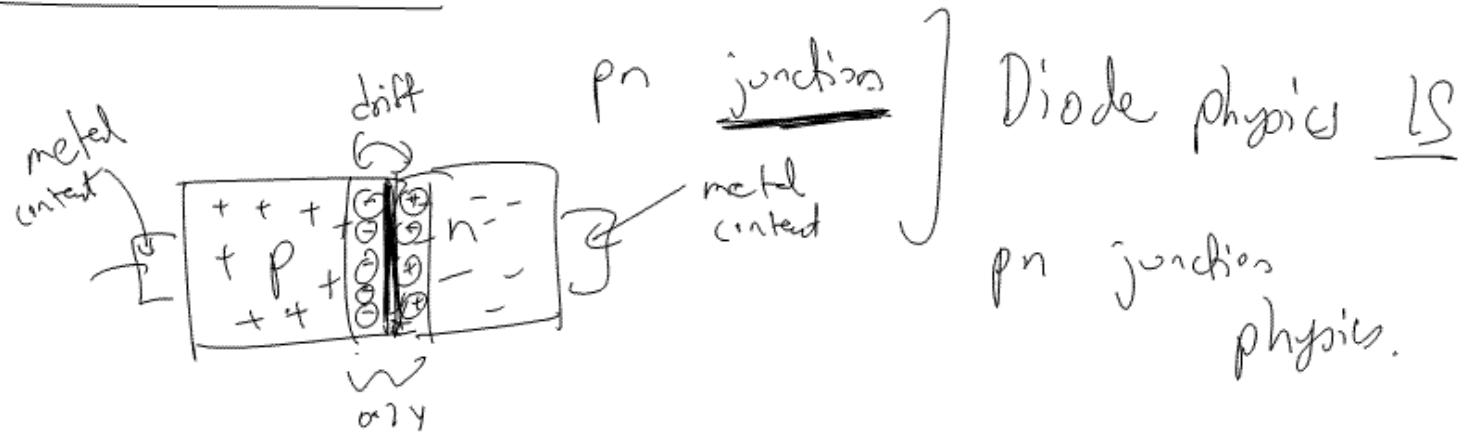


From the $i-V$ graph,
 you can see the diode
 allows current to flow in
 only one direction →



[Mechanical analog: check valve]

Semiconductor physics → A diode is made of



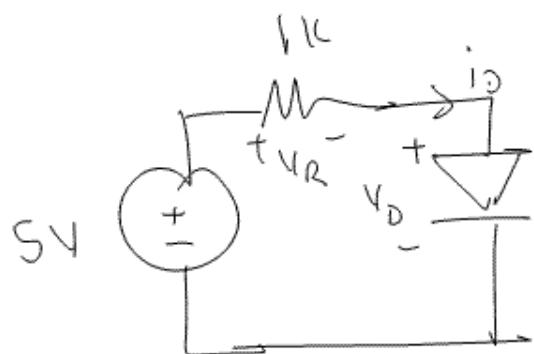
Different kinds of diodes:- (1) Regular diode ⇒ rectifier diode

(2) LED ⇒ light Emitting Diode.

(3) Zener diode ⇒ help in voltage regulation.

(10.2) Load-line method] Graphical way of
analyzing non-linear circuit

e.g:



(Q.) Find (i_D, v_D) ?

Sol. KVL: $\Sigma V = V_R + V_D$

$$\Sigma = i_D (1k) + V_D$$

$$\Rightarrow \Sigma = (i_D) (1k) + V_D$$

Two possibilities

for $i_D \Rightarrow$ depending on diode on (on off)

diode is

on since

current from 5V

is flowing from anode to cathode

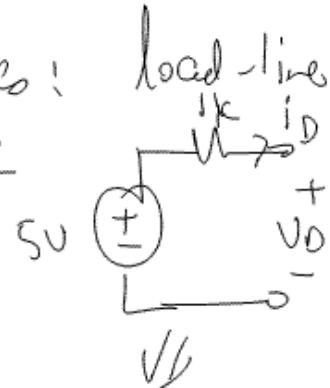
$$\Rightarrow \left\{ 5V = (I_0)(e^{\frac{V_D}{0.026}} - 1) (1K) + V_D \right\}$$

SOLVE USING CALCULATOR!

$I_0 = 0.696 V$ (1) DIFFICULT TO SOLVE

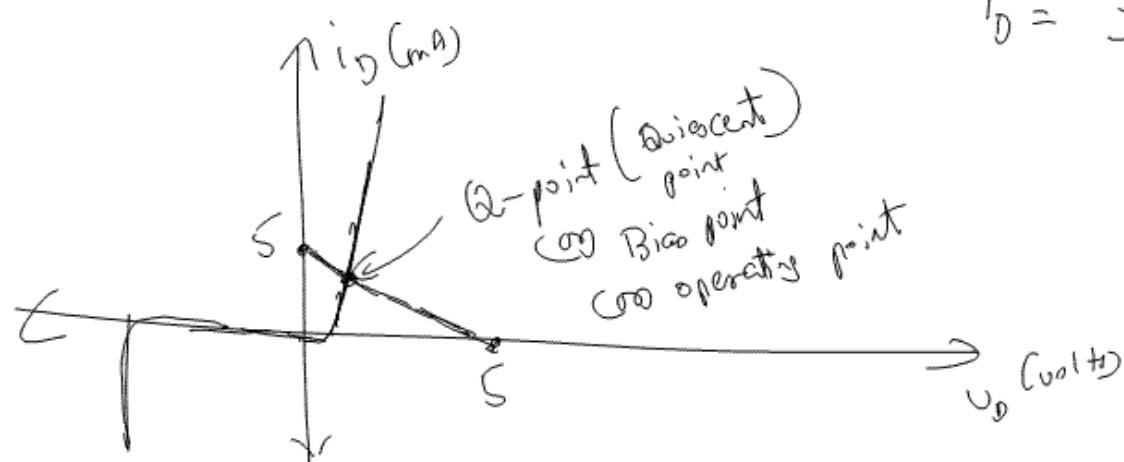
(2) Impossible when you have multiple diodes

In order to overcome analytic difficulties: load-line method; we plot the i-v graph of

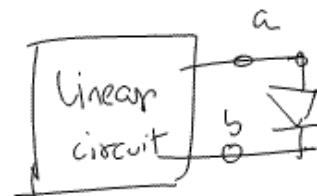


On the diode i-v charis.

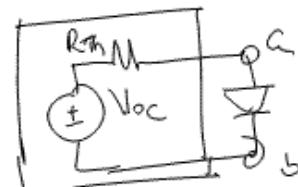
$$i_D = \frac{S - V_D}{T^k}$$



Notes: (1) If we have

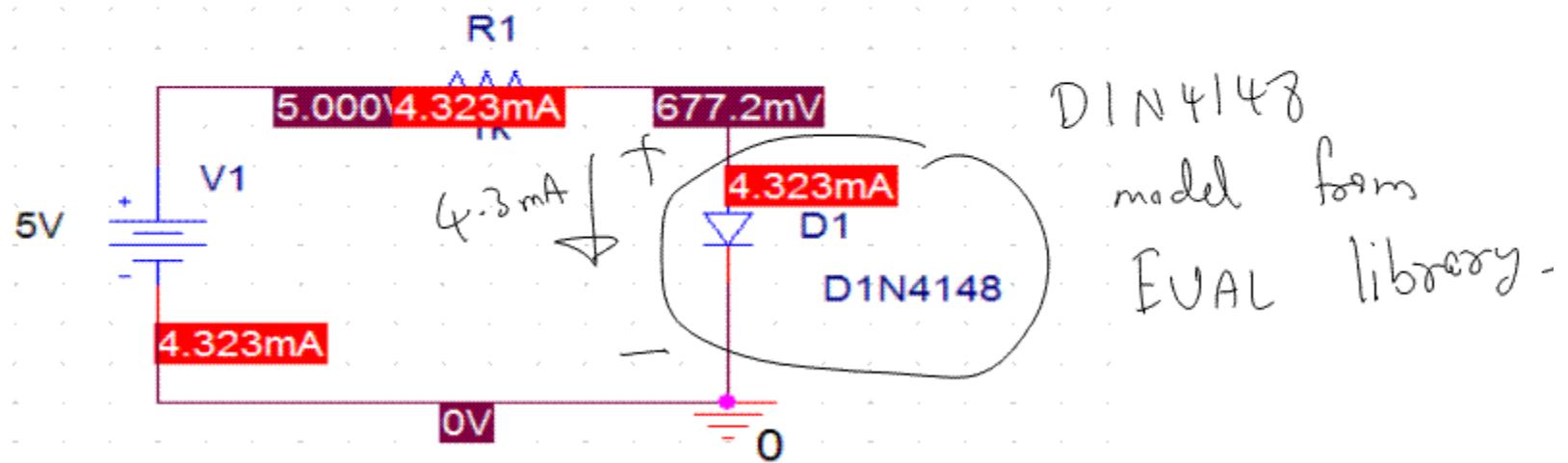


Find Thevenin equivalent
of linear circuit



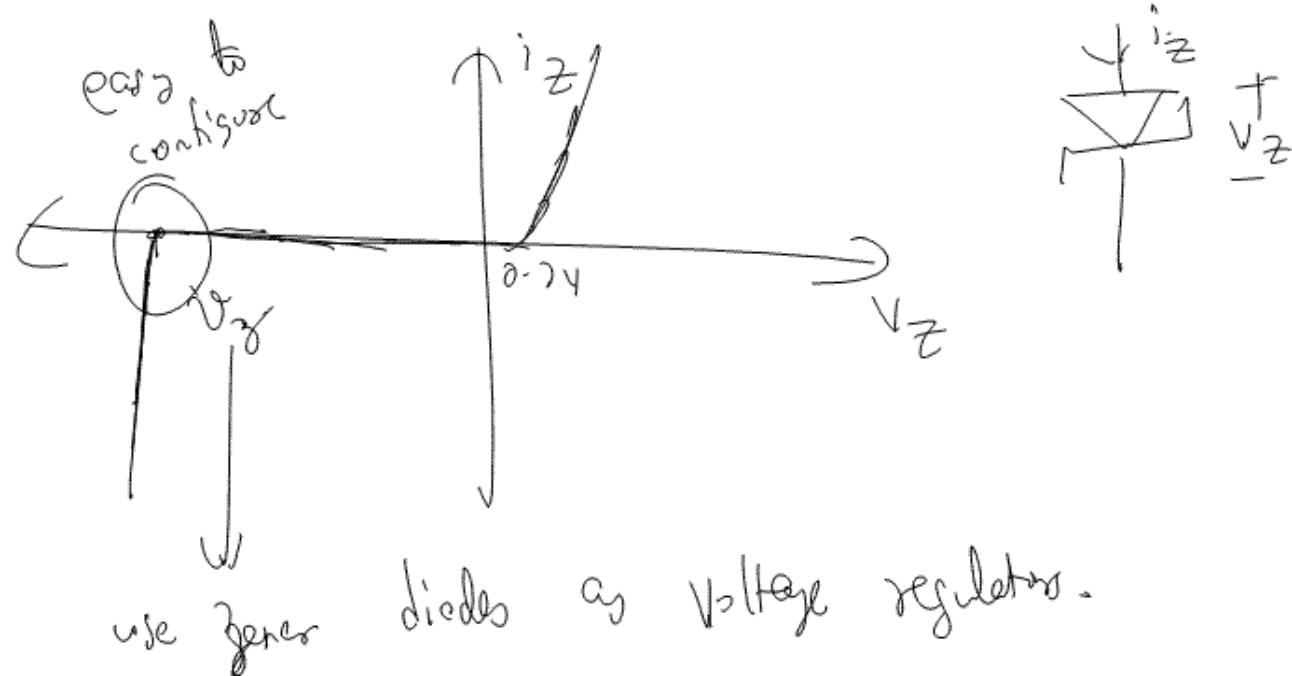
(2) Not very useful when you have multiple non-linear elements.

Before we go on, lets take a look at
PSPICE

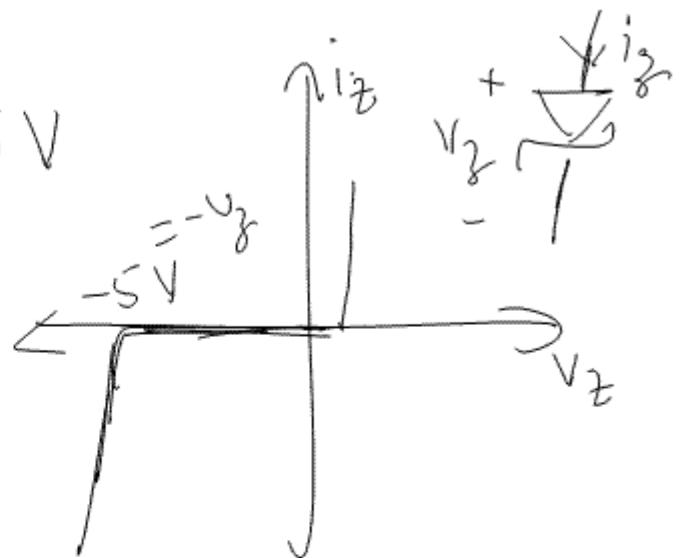
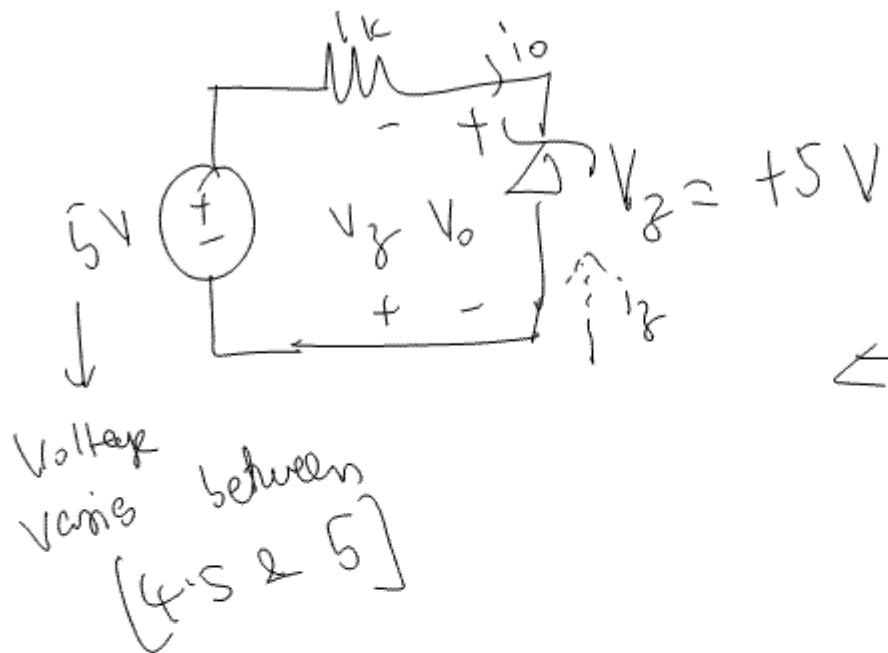


(o.3) Load-line analysis of Zener diode

A zener diode has been configured to work in the reverse-breakdown region.



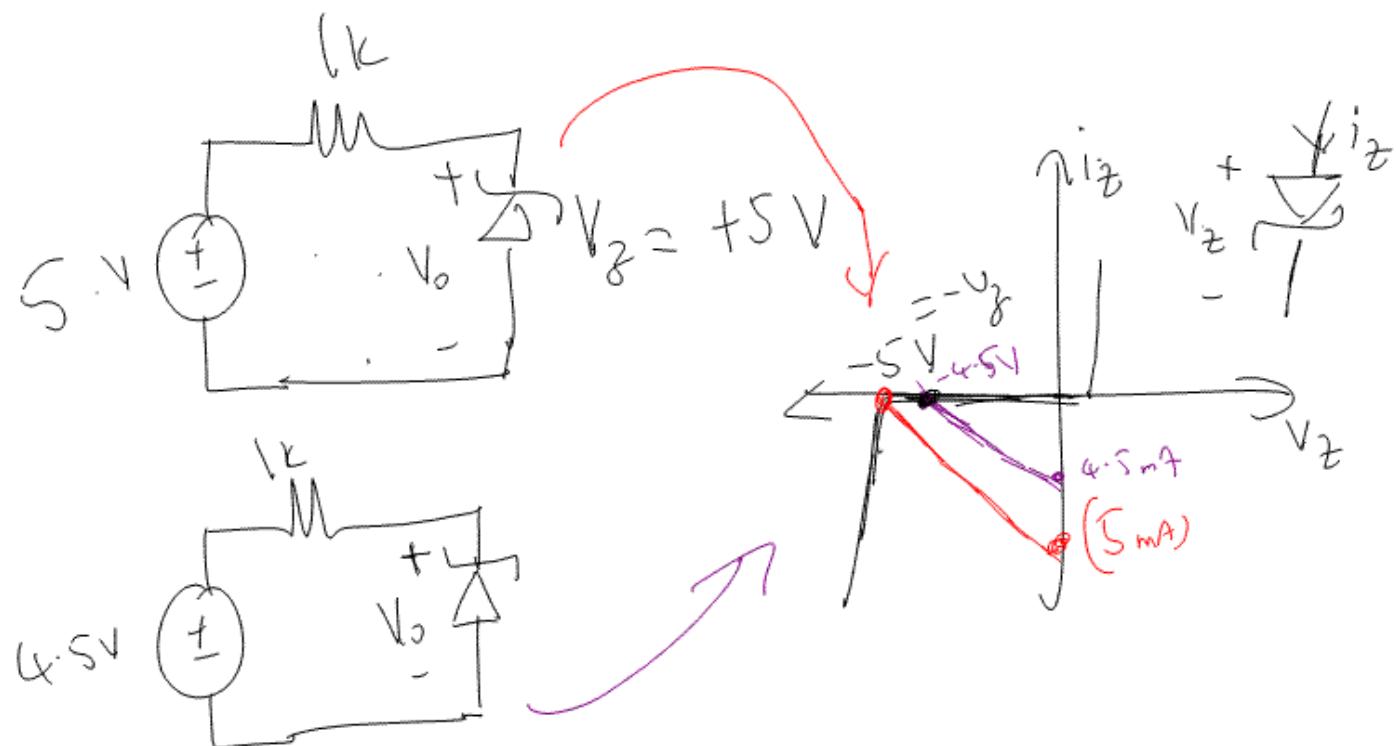
Q5.



- (Q5.) Find v_o for the circuit above when the input voltage drifts between $[4.5V, 5V]$

Step (1): Understand zener's work in reverse-bias

(2): Analyze circuit to make sure it is actually regulating voltage! (load-line method).

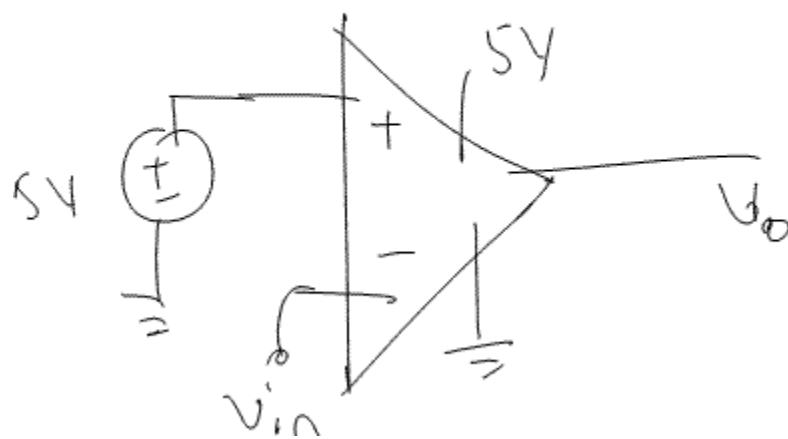


Oops, my genar is not regulating voltage!

Oh, sh, $(4.5V) \rightarrow (5V)$] Need amplifier



Diodes are passive
devices, they won't work here.



$$\left. \begin{aligned} V_o &= A(5 - V_{in}) \\ \text{one solution.} \end{aligned} \right\}$$

(10.4) Ideal diode model

(10.5) Piecewise linear model

(10.6) Rectifier circuits

(10.7) Wave-shaping circuit

} Application

} Finish
on Monday