# EE 320 Electronics

2/22/13 Lecture 9

2.45 & 2.51

2.45 p-type $1\,\Omega\cdot cm$

boron impurities (acceptor)

$$1\,\Omega cm = \rho \approx \frac{1}{q \cdot \mu_p \cdot N_{Ai}}$$

solve for $N_{Ai}$

$$0.25\,\Omega\cdot cm = \frac{1}{q(\mu_p)(N_{Ai} + N_{AF})}$$

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1)

2.51)

$$N_A(x) = 10^{14} + 10^{18} e^{-x/1\mu m}$$

$-10^{-4} x \cdot cm$

$= -\frac{x \cdot cm}{10^4}$


$1\mu = 10^{-6} m$

$10\mu = 10^{-5} m$

$100\mu = 10^{-4} m$

$\frac{1}{100\mu} = 10^4$

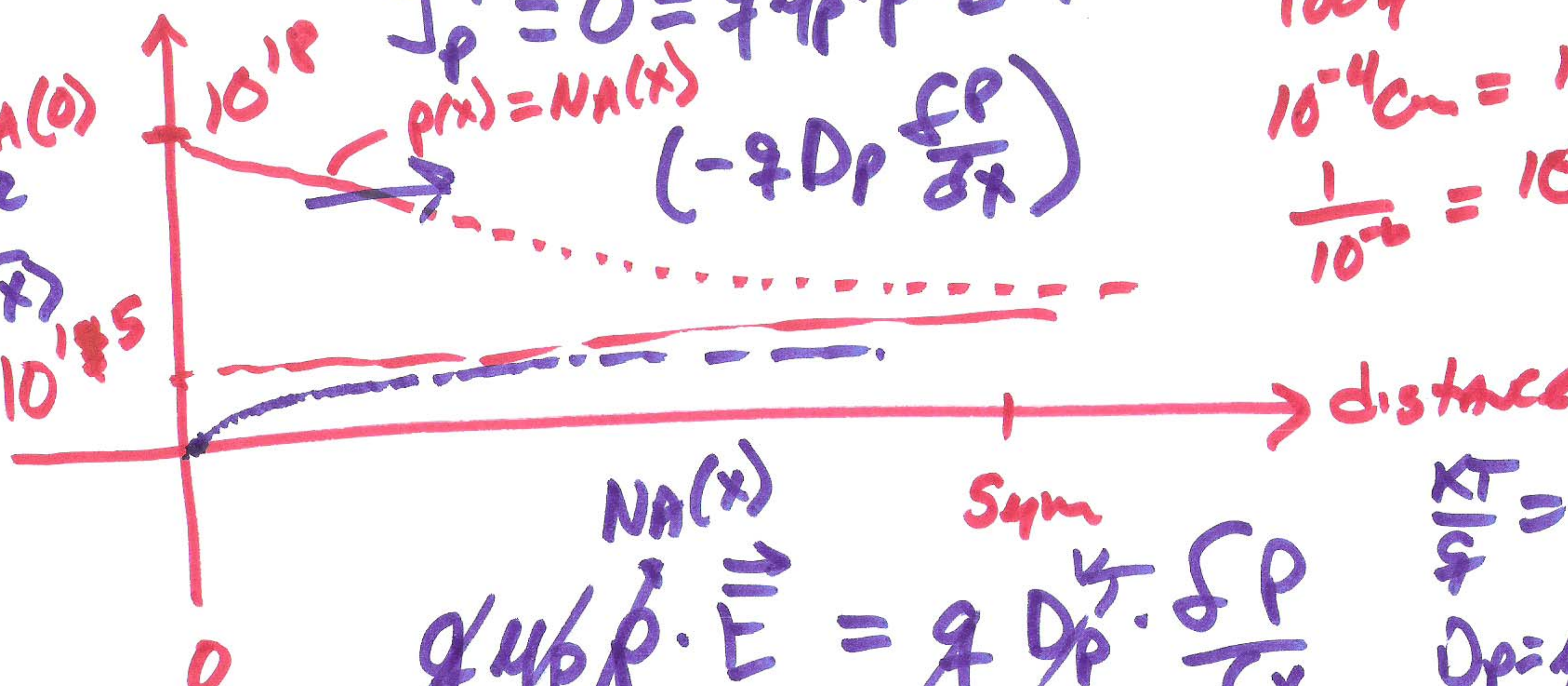
$10^{-4} cm = 10^{-6}$

$\frac{1}{10^{-6}} = 10^4$

$J_p^T = 0 = q\mu_p \cdot p \cdot \vec{E} + \left(-qD_p \frac{\delta p}{\delta x}\right)$

$p(x) = N_A(x)$

$n(x) = \frac{n_i^2}{p(x)}$




$$\underbrace{\cancel{q}\mu_p \overset{N_A(x)}{p} \cdot \vec{E}}_{\text{drift}} = \underbrace{\cancel{q} \overset{V_T}{D_p} \cdot \frac{\delta p}{\delta x}}_{\text{diff.}}$$

$\frac{KT}{q} = V_T$

$D_p = \mu_p \cdot V_T$



2)

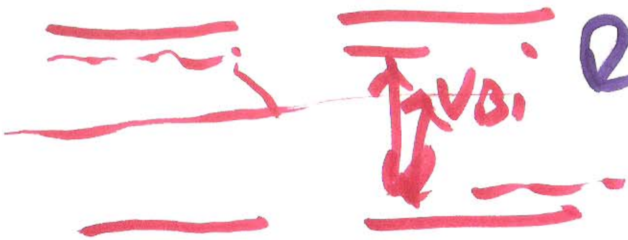
# Schottky Diodes

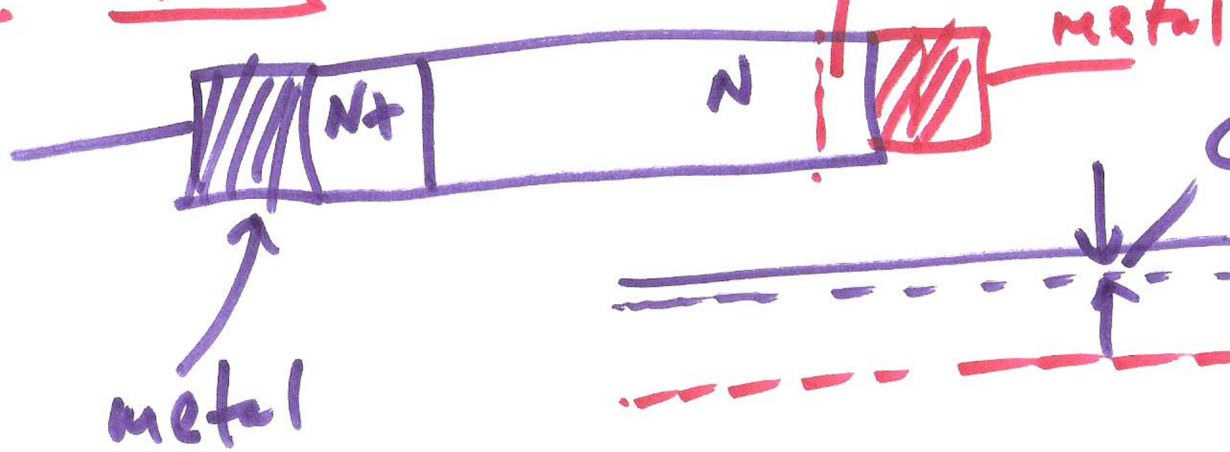
Whenever you connect metal to a semiconductor the semiconductor must be heavily doped.

Result is An ohmic contact.

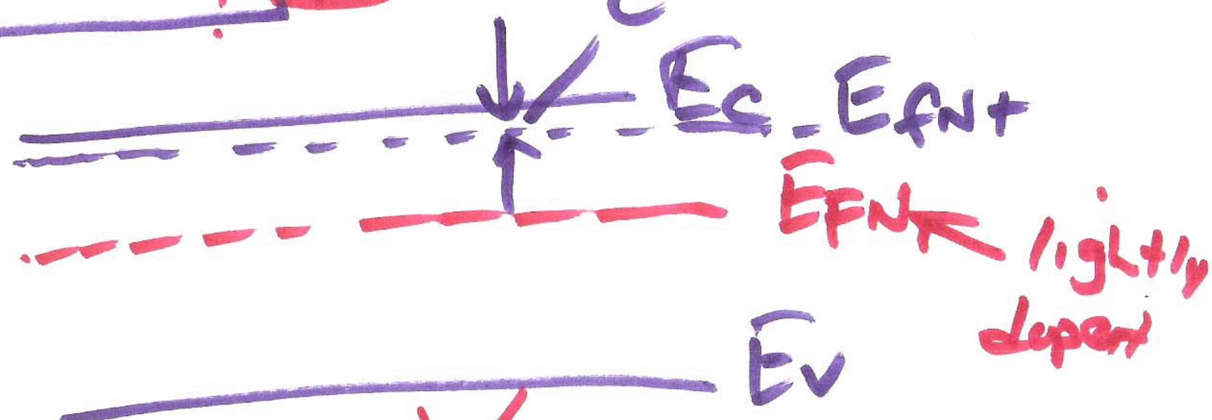
rectifying contact,

diode



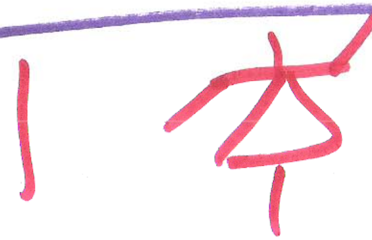



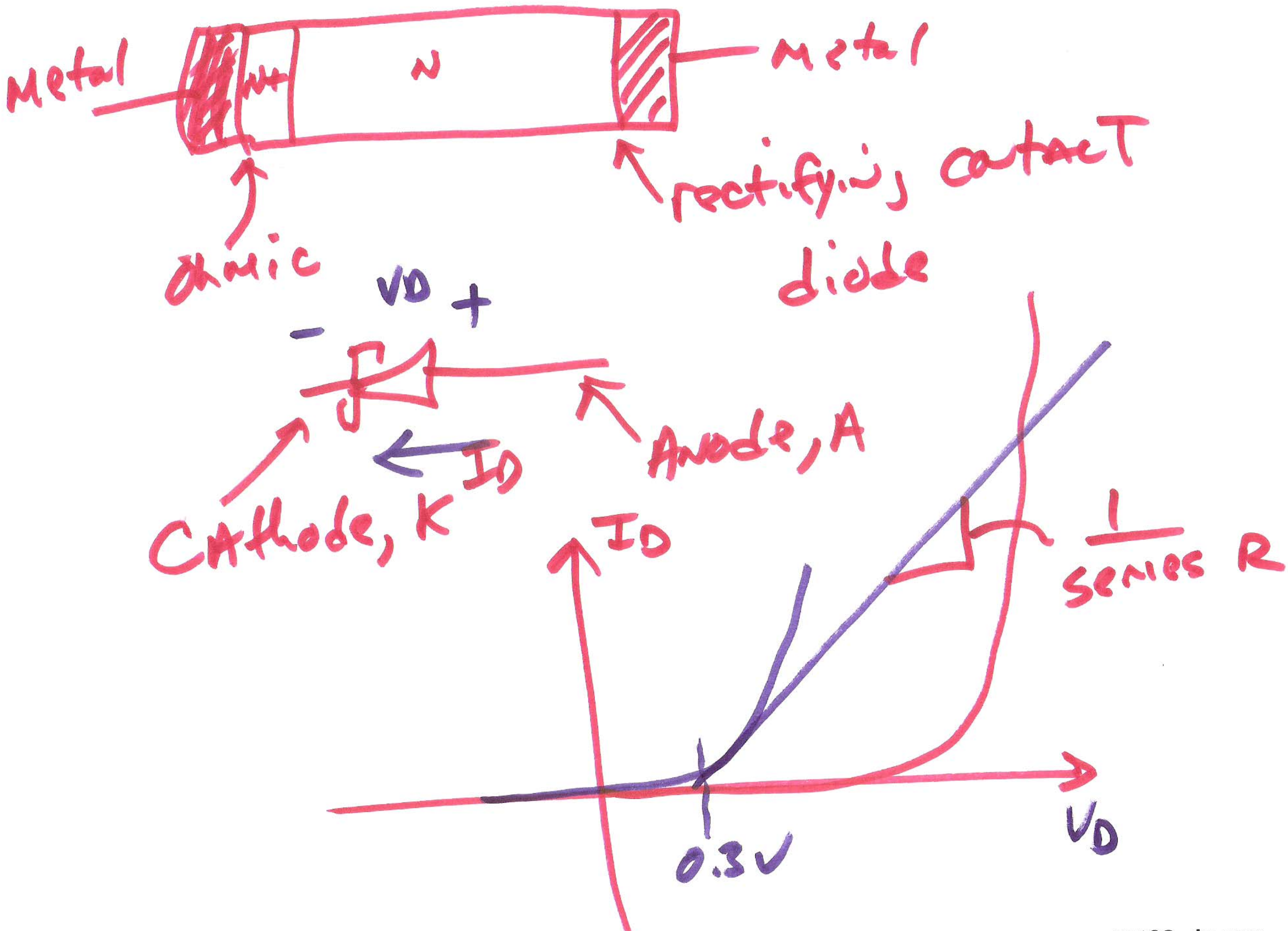

schottky



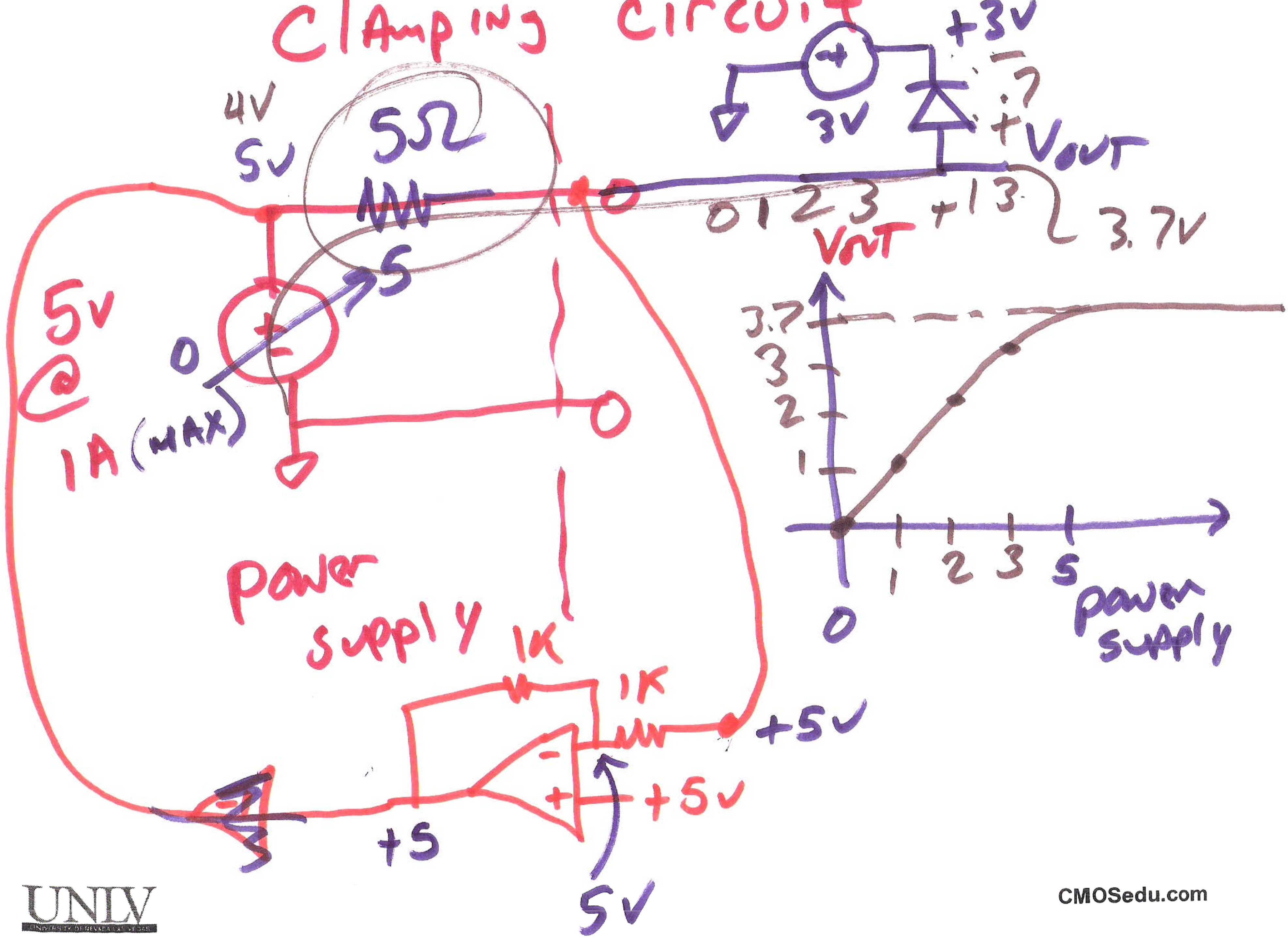

Cu & Al

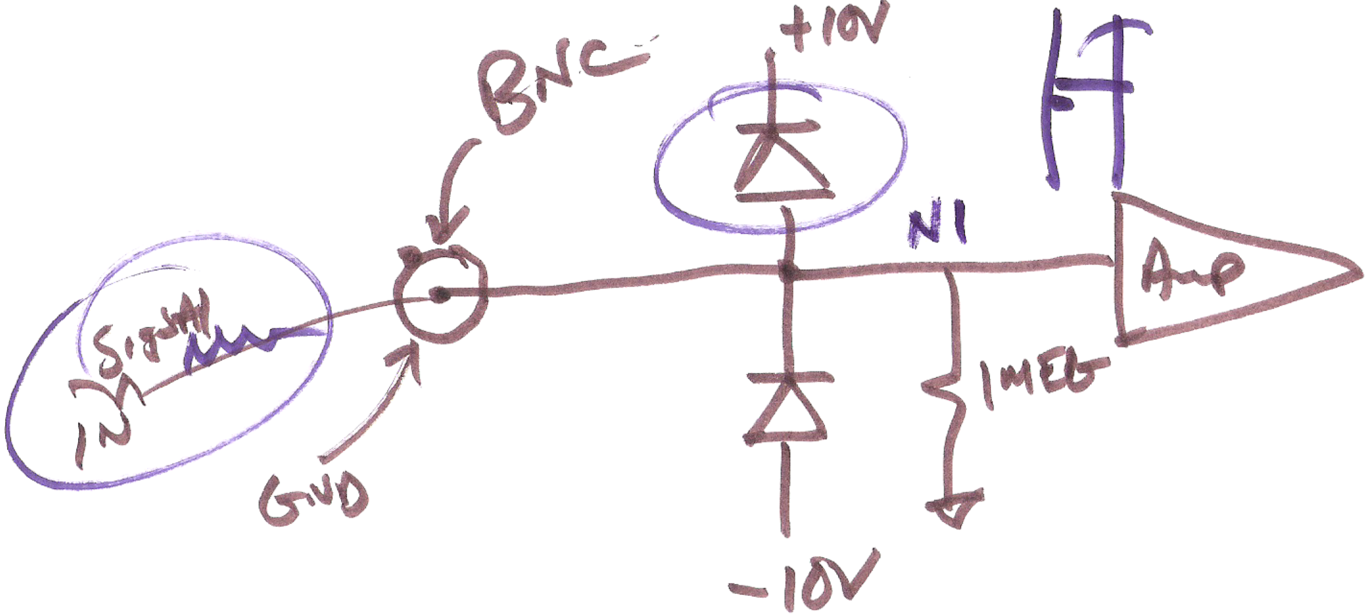
zener

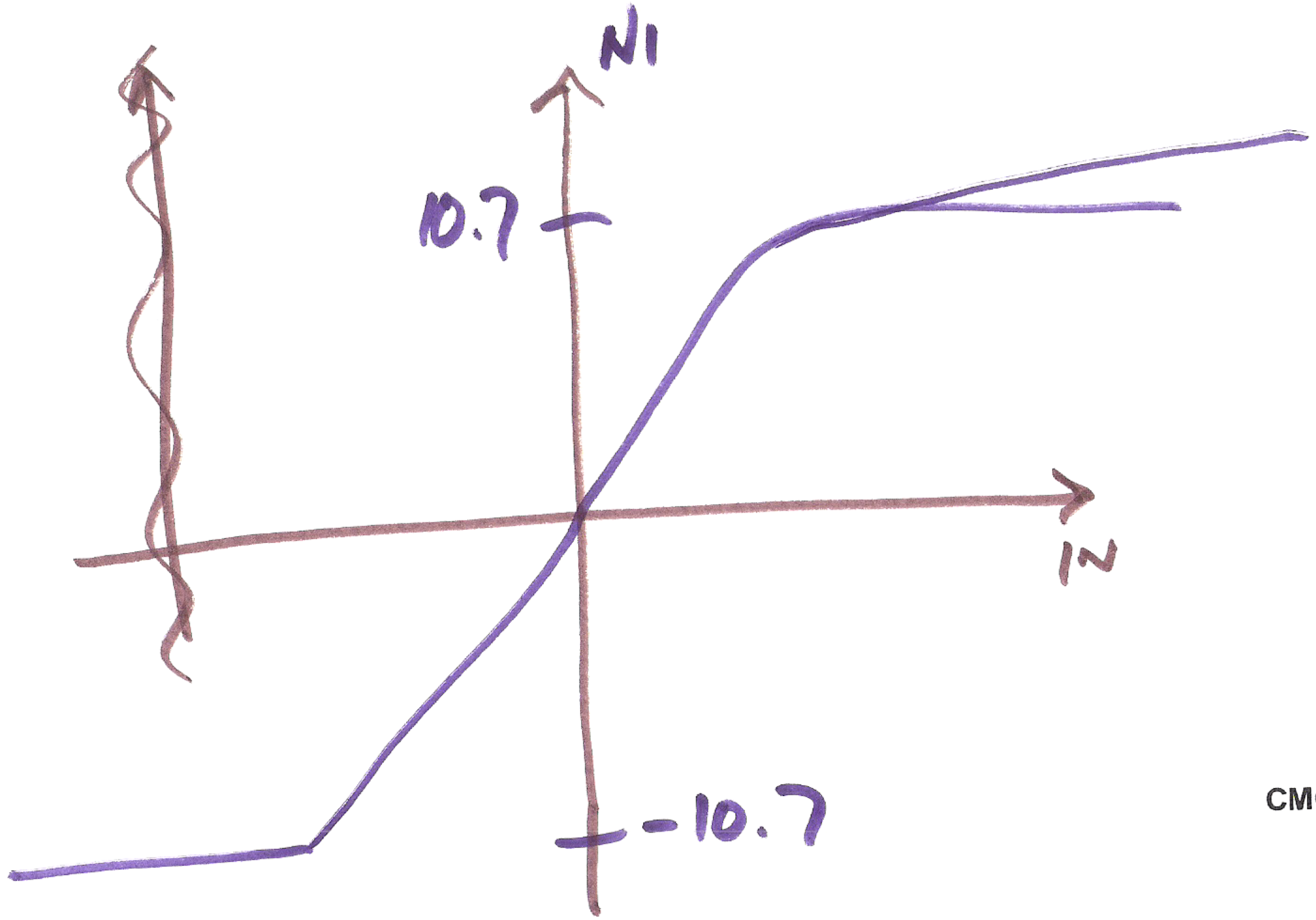



Metal
N+
N
Metal
ohmic
rectifying contact
diode
VD
-
+
Anode, A
Cathode, K
ID
ID
1
series R
0.3V
VD

# Clamping circuit





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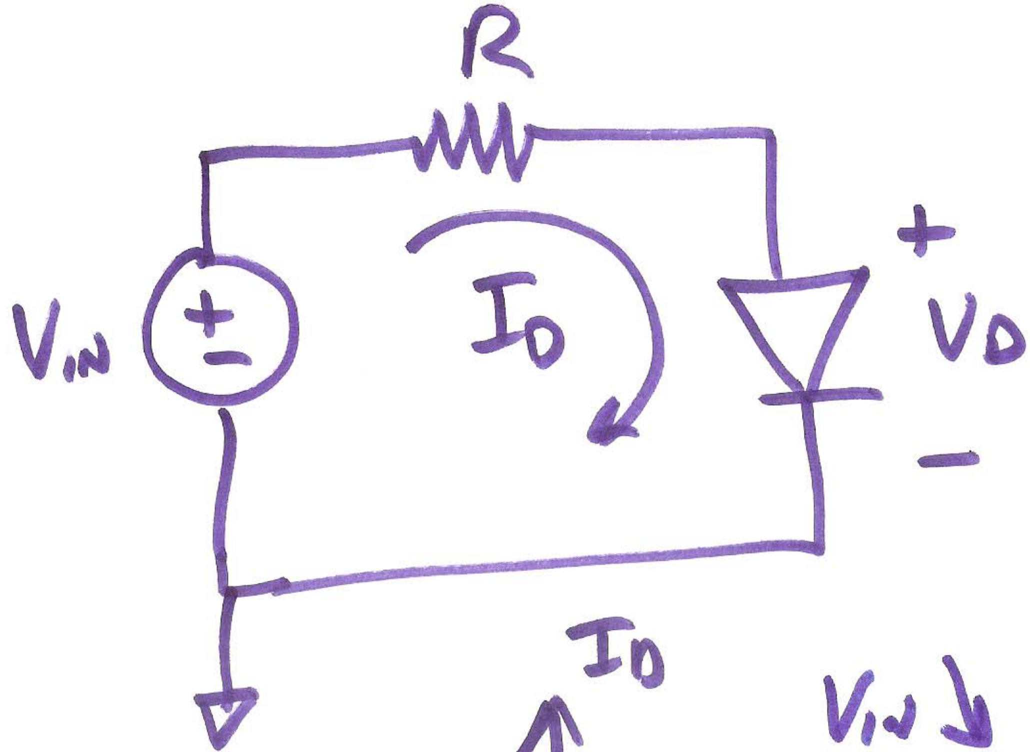
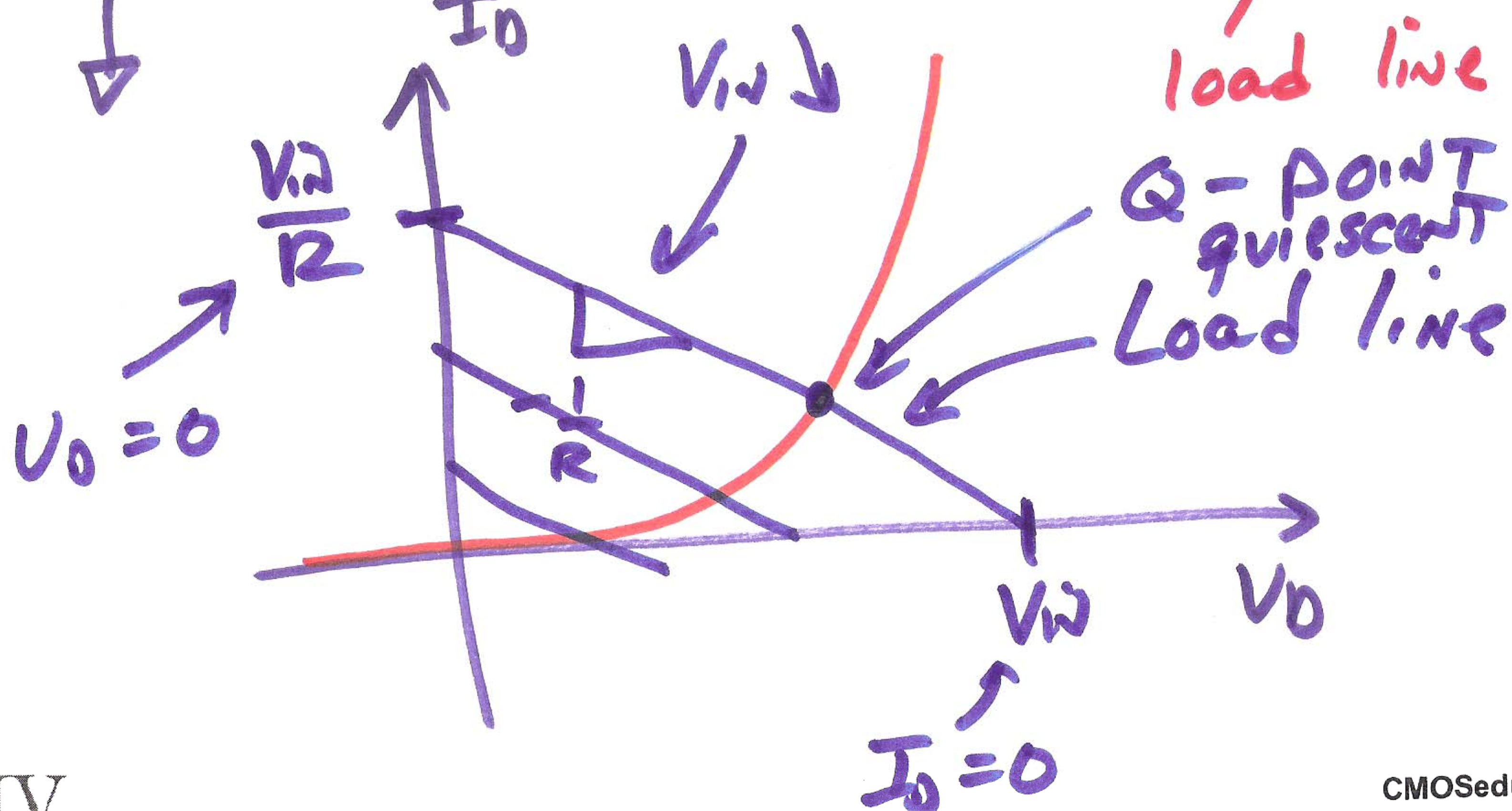



$$I_D = I = \frac{V_{IN} - V_D}{R}$$

$$I_D = \frac{1}{R} \cdot V_{IN} - \frac{V_D}{R}$$

load line

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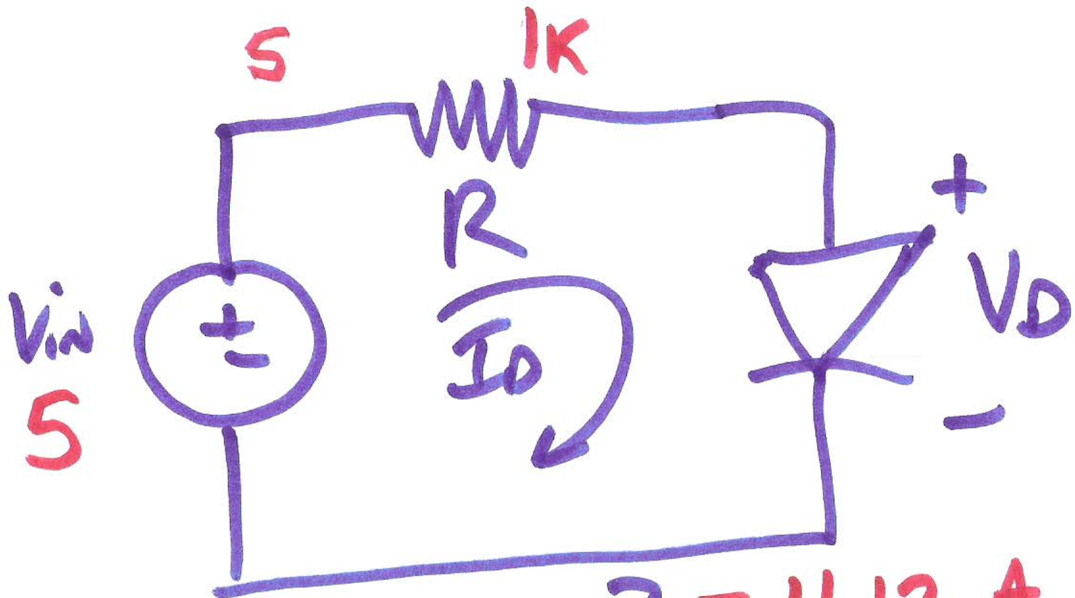


$$I_D = I_S\left(e^{V_D/NV_T} - 1\right)$$

for forward bias

$$V_D \simeq NV_T \ln \frac{I_D}{I_S}$$

$I_D = ? = 4.12\text{mA}$

$V_D = ?$

$$V_{IN} = I_D \cdot R + V_D$$

$$\overbrace{V_{IN}}^{\text{Left}} = \overbrace{I_D \cdot R + NV_T \ln \frac{I_D}{I_S}}^{\text{Right}}$$

| Left | Right | $I_D$ | Diff |
|---|---|---|---|
| | | 4.3mA | |
| | | 4.12mA | |

$5 - 4.12\text{mA} \cdot 1\text{K}$

$= V_D$

$= \underline{\underline{.88\text{V}}}$

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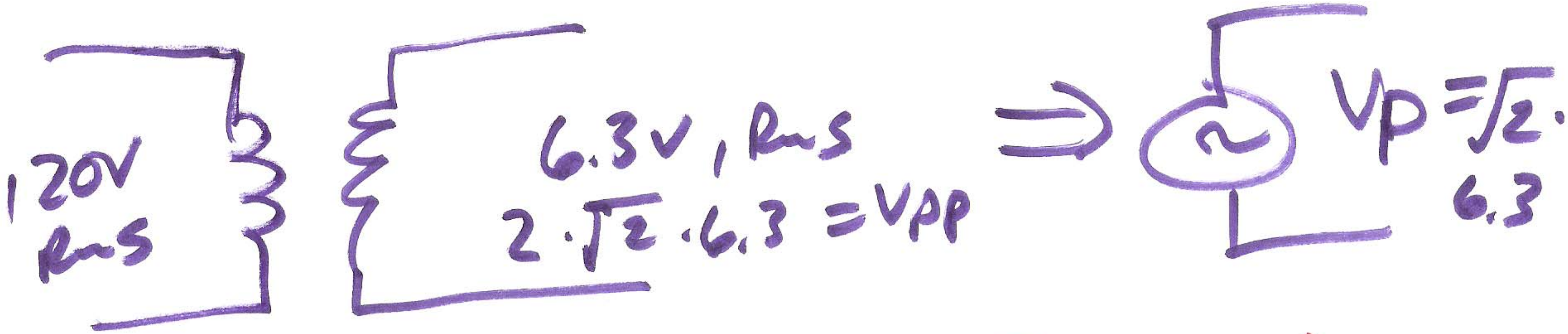
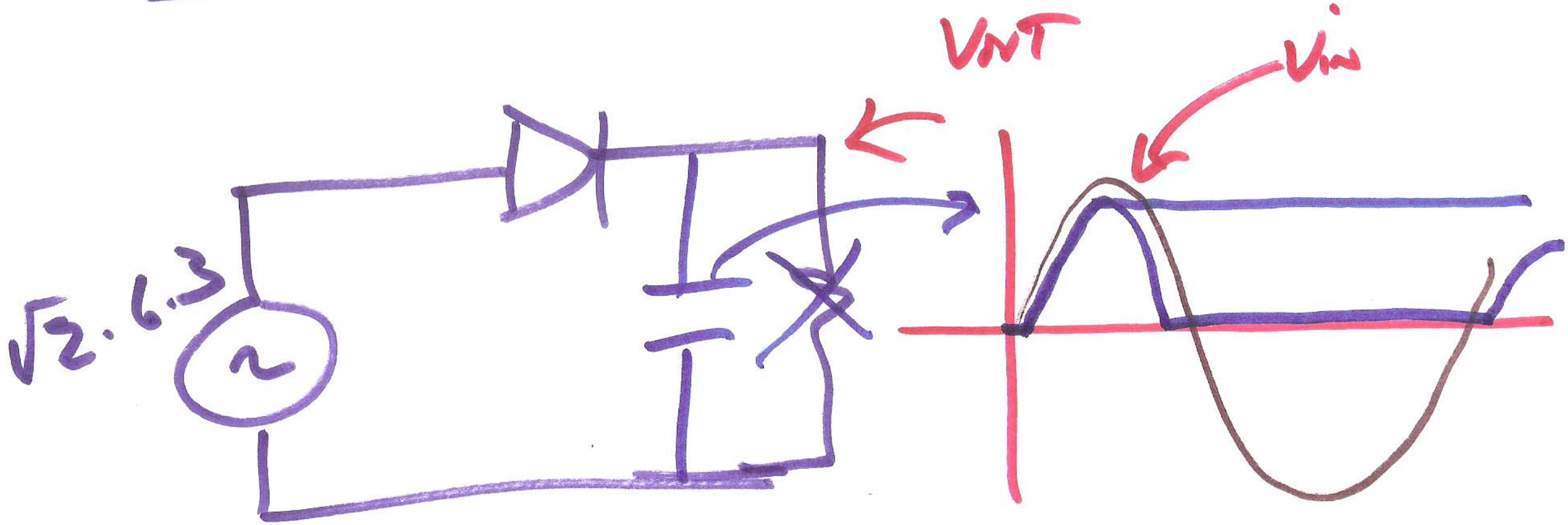
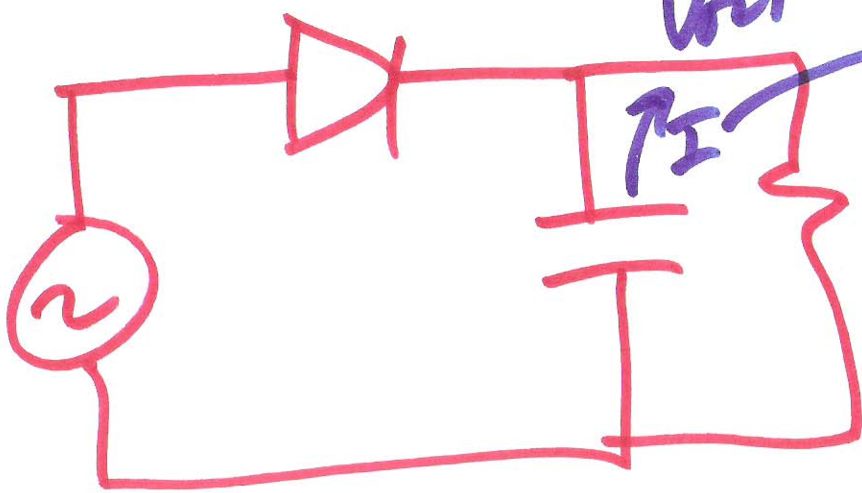
8)


120V RMS
6.3V, RMS
$2\cdot\sqrt{2}\cdot 6.3 = V_{PP}$
$V_P = \sqrt{2}\cdot 6.3$

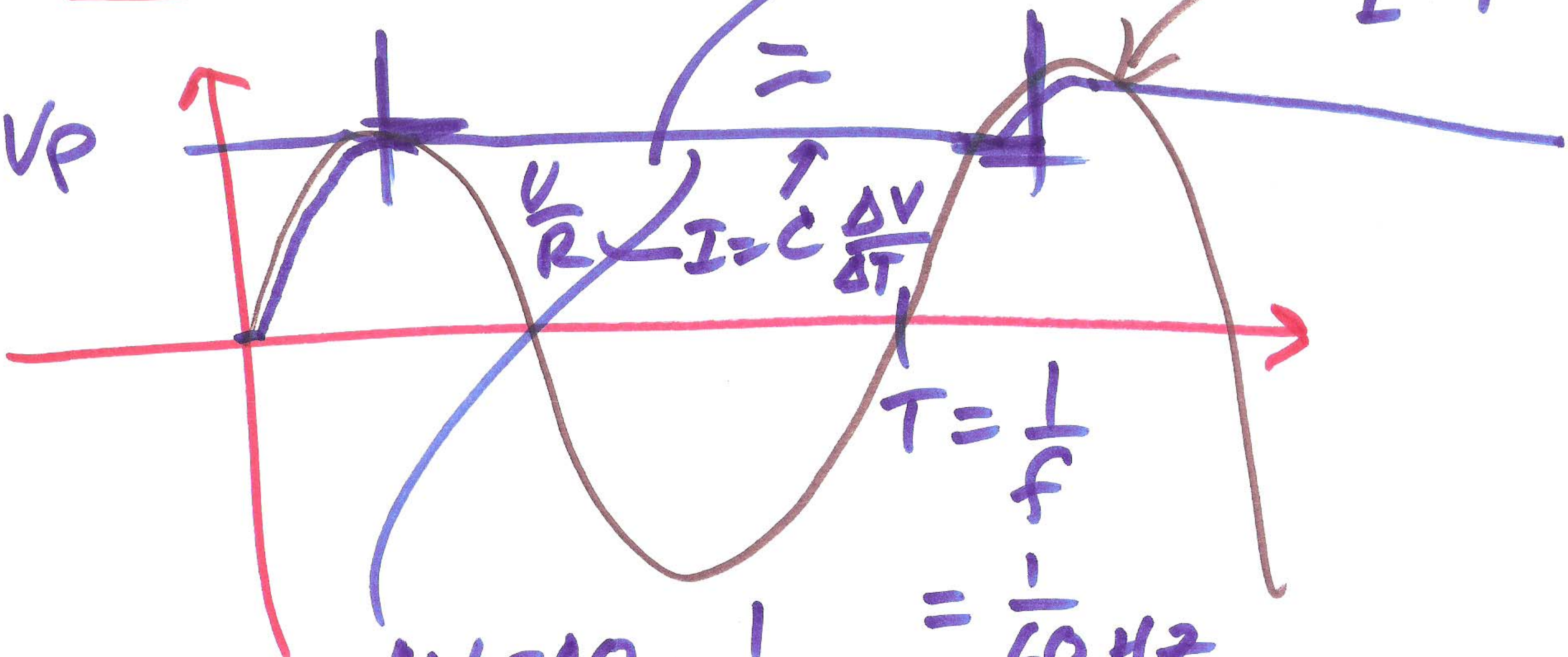

$\sqrt{2}\cdot 6.3$
VOUT
Vin




$\frac{V_P}{R}$ = Const current I for T

droop $\Delta Q = \frac{V_P}{R} \cdot T$

$I \cdot T$




$=$

$\frac{V}{R}$ — $I = C\frac{\Delta V}{\Delta T}$

$T = \frac{1}{f}$

$= \frac{1}{60\,Hz}$

$\Delta V = \Delta Q \cdot \frac{1}{C}$