Lecture 26 EE 320

May 7, 2014

Review past exams, H.W.s, & Quizzes

Review Op-Amps.

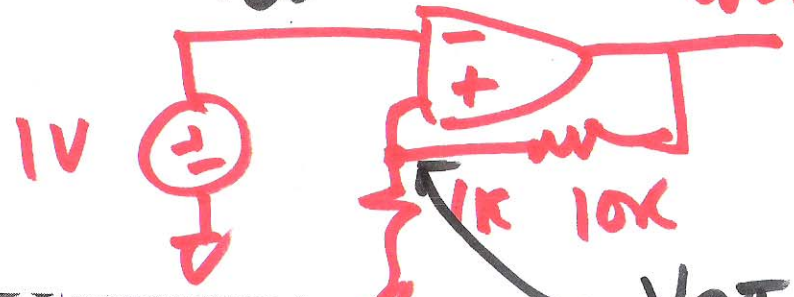
Topologies

imperfections [offset voltage; finite gain.

$A_{OLDC} = 100$

$V_{OS} = 10\,mV$

$V_{OUT} = ?$



$V_{OUT} = A_{OLDC}(V_+ - V_-)$

$= 1V$

$V_{OUT} = \frac{1K}{1K + 10K} = V_+$

f_{UN} = GAIN · BW = unity-gain frequency

$A_{OLDC} = 1{,}000$

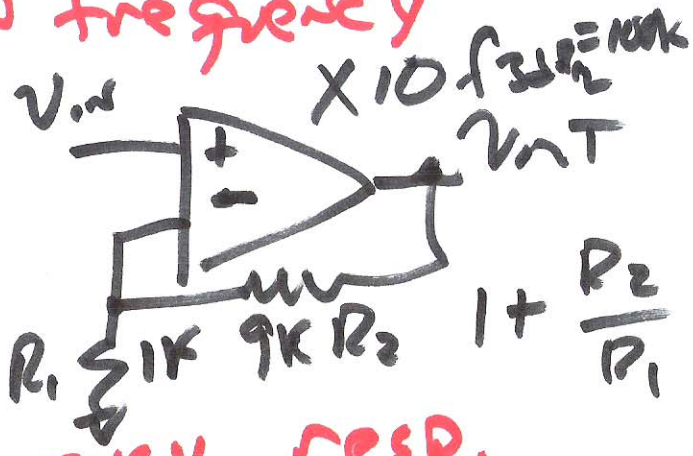
10^3

$20\log 10^3$

$10^6 = 10^3 \cdot f_{3dB,CL}$ $\quad f_{UN} = 1MHz$

$f_{3dBCL} = 10^5$

$= 100K$



Sketch the frequency resp. of the op-amp

$A_{OL}(f)$

$10^6 = 7 \cdot f_{3dB,CL}$

60dB = 1,000

40dB

20dB

1 = 0dB

-20dB/dec

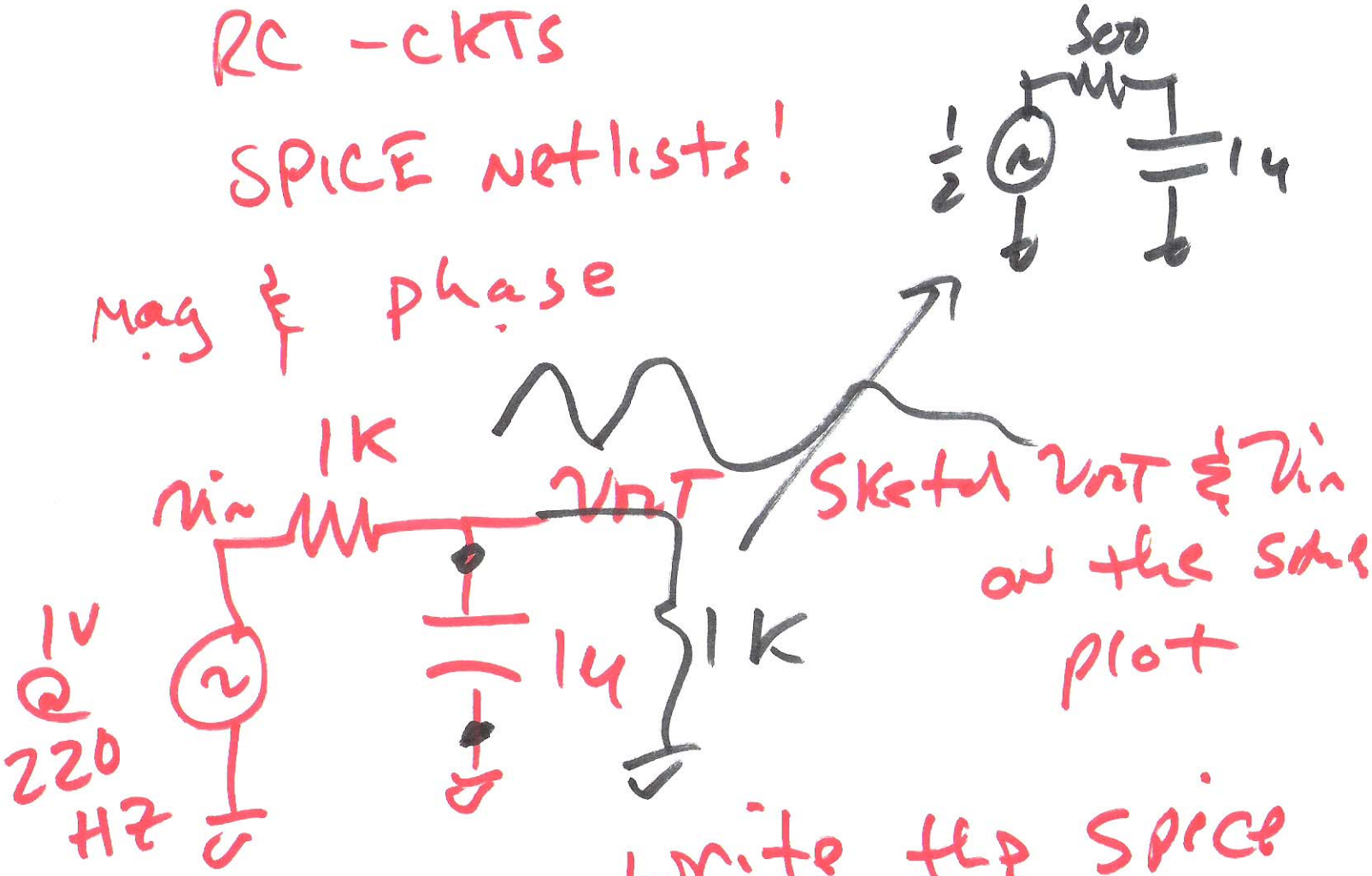
1K 10K 100KHz f_{UN} 1MHz f

$$A_{OL} = \frac{1{,}000}{1 + j\frac{f}{1k}}$$

RC-CKTS

SPICE netlists!

Mag & phase



Write the SPICE NETLIST

```
Comment line
Vin Vin 0 DC 0 SIN 0 1 220
R1 Vin Vout 1K
C1 Vout 0 1u
.TRAN 10ms
.END
```

Semiconductors

N-type

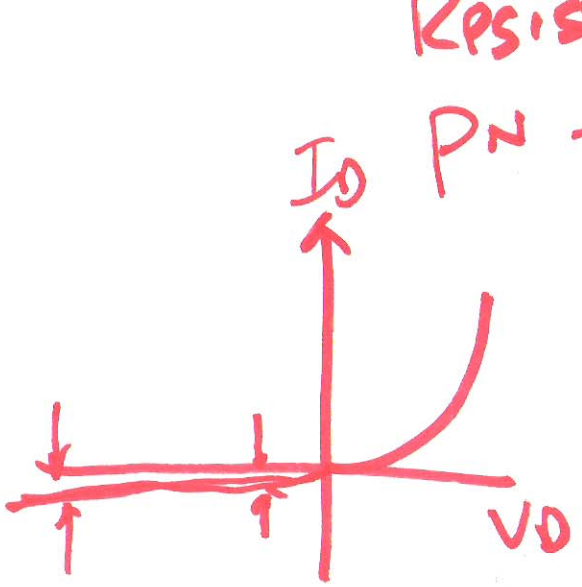
E_C

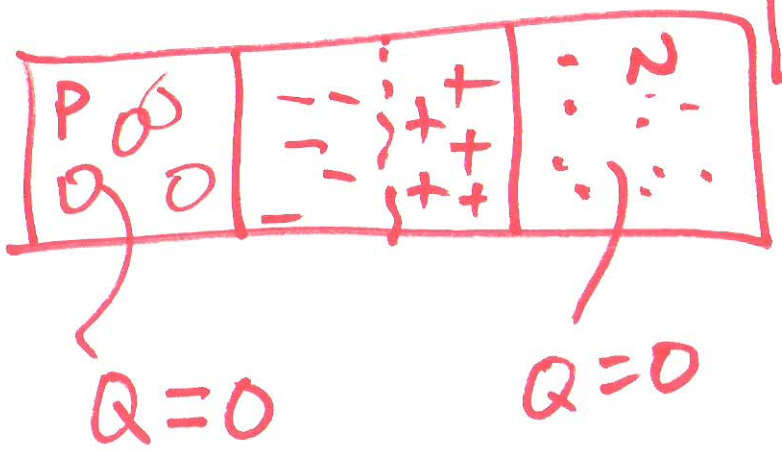
$E_{f,N}$

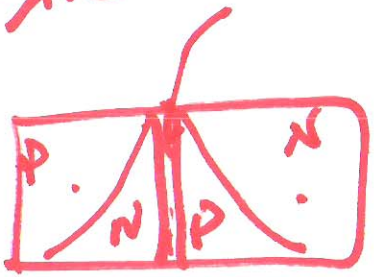
E_V

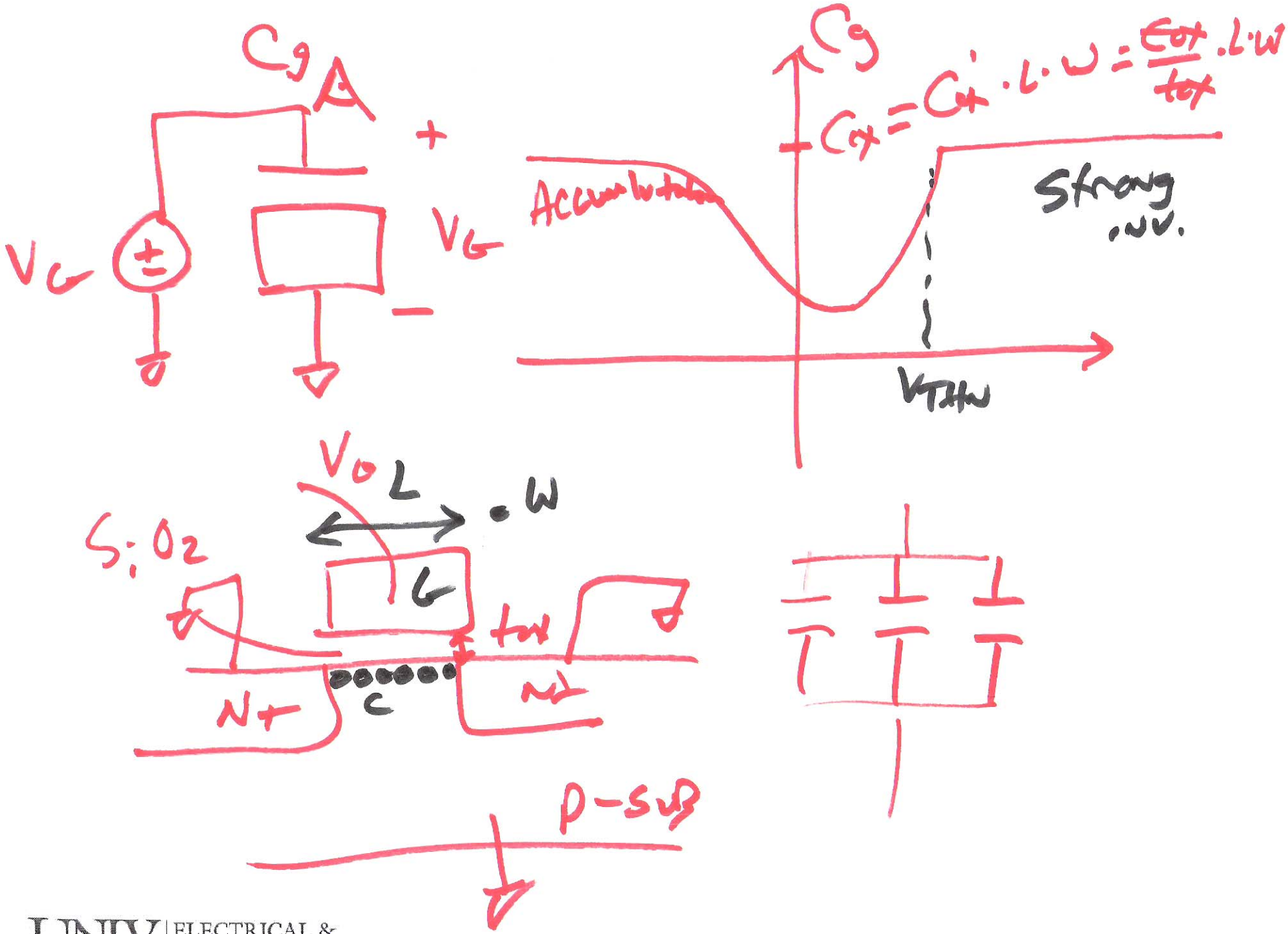
Resistor problem

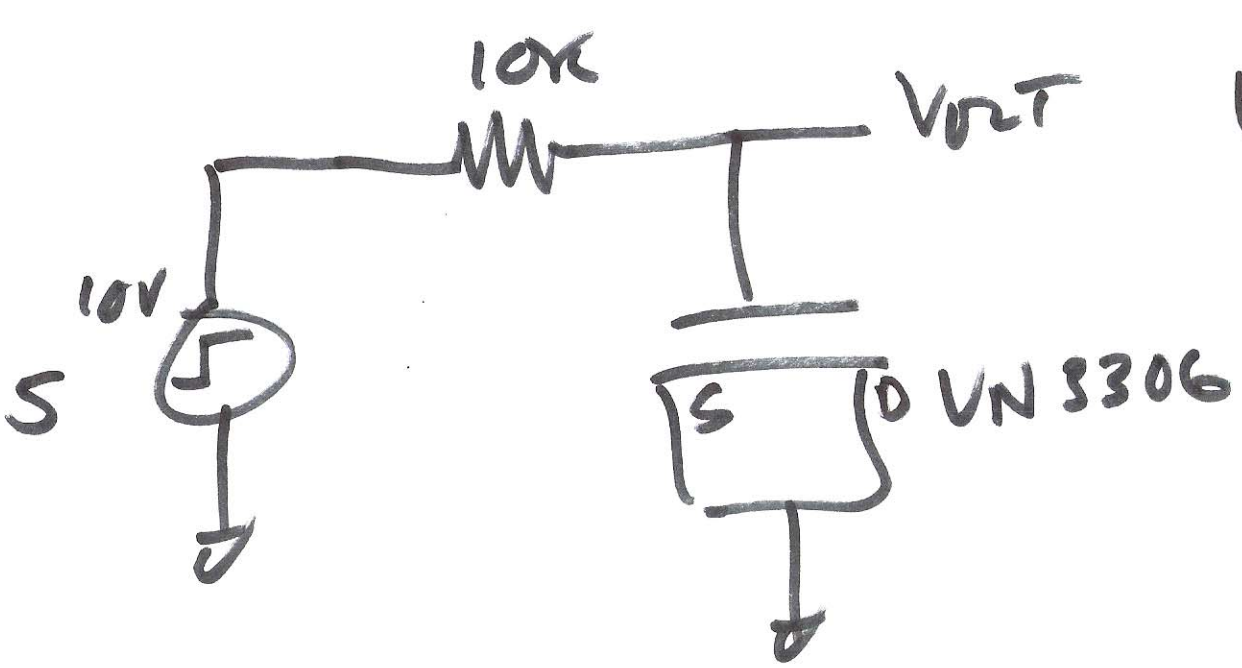
PN - junction (diode)



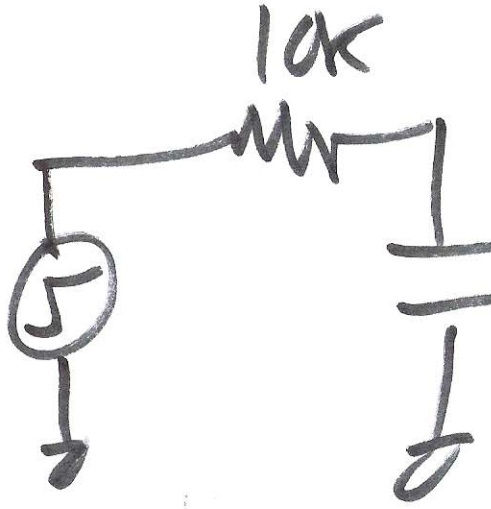





C_g
A
+
V_G
−
V_G
C_g
$C_{ox} = C'_{ox} \cdot L \cdot W = \frac{\epsilon_{ox}}{t_{ox}} \cdot L \cdot W$
Accumulation
Strong
Inv.
V_{TH}
V_{OL}
L
W
SiO_2
G
t_{ox}
$N+$
C
$N+$
P-sub

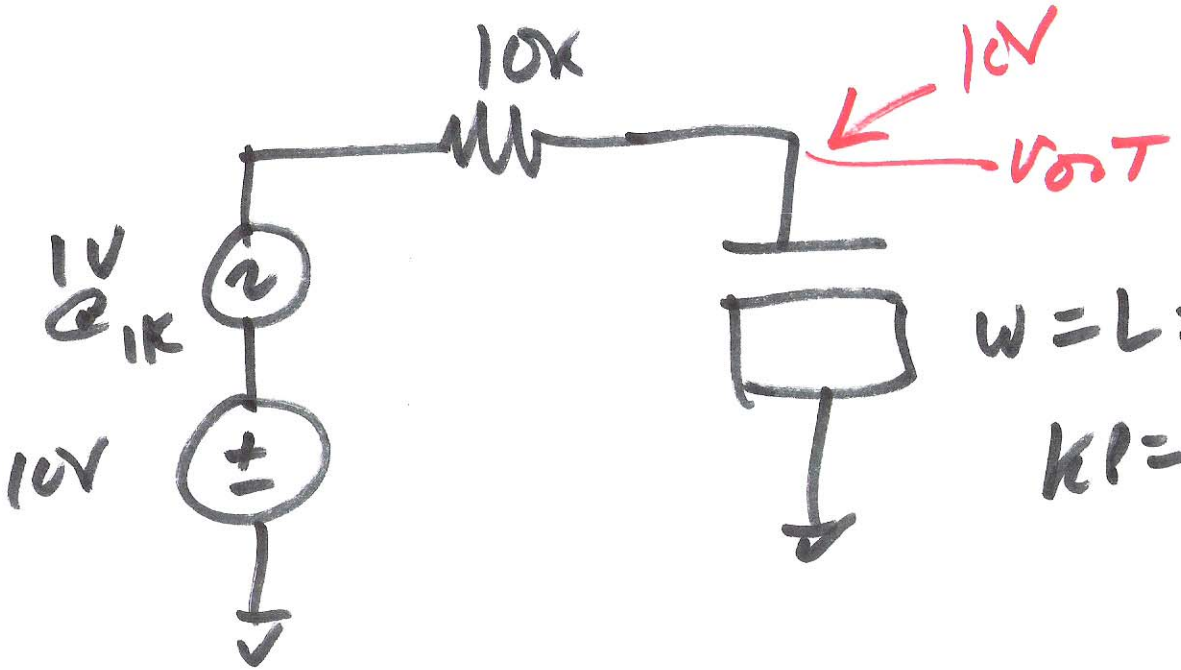


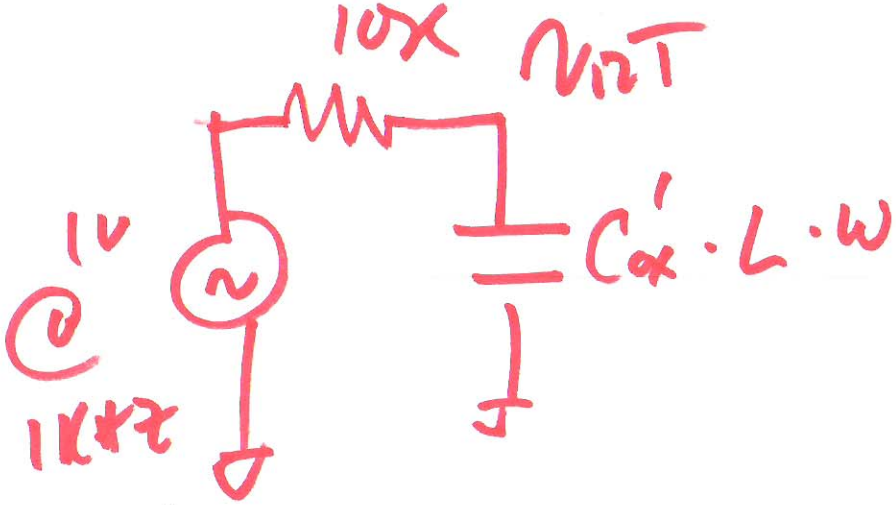
VARIATION

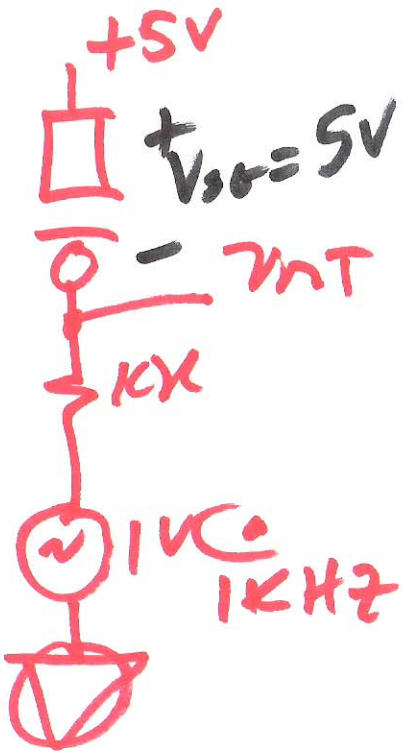


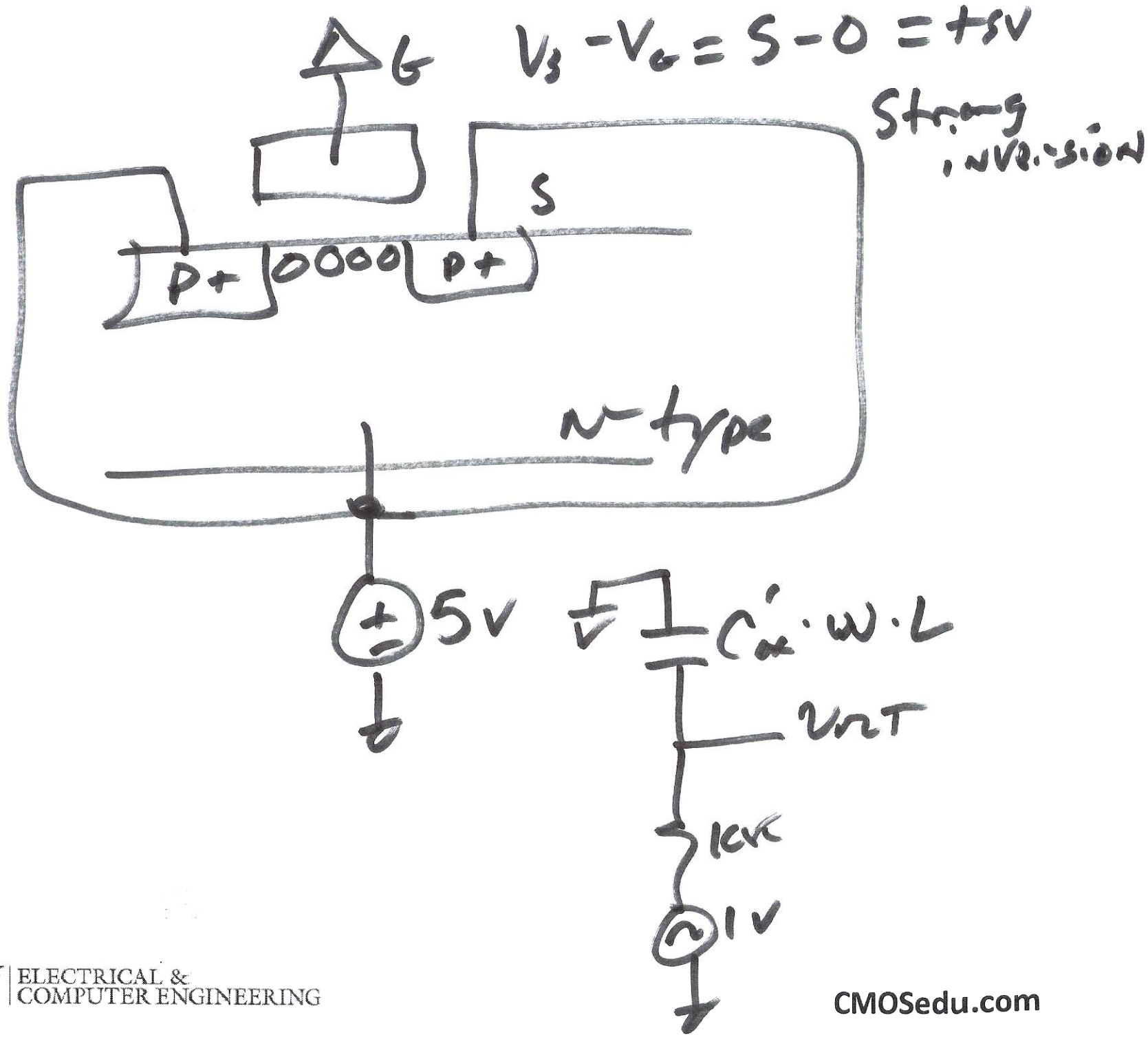
$t_d = 0.7RC$ } derive these

$t_r = 2.2RC$ }


10K
1V
VOUT
1V
@1K
10V
W = L = 100 μm
KP = 120 μA/V
Cox = 7.5 fF/μm²


10K
VOUT
1V
@
1KHz
Cox · L · W

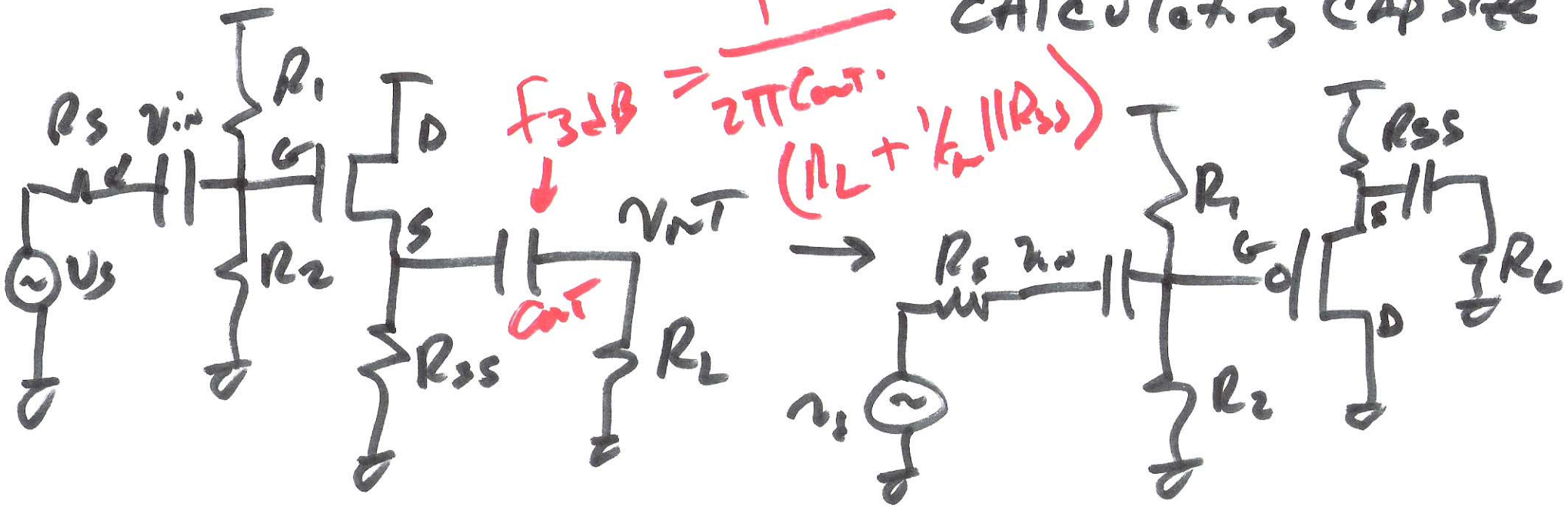

+5V
+ VDD = 5V
VOUT
KX
1V @ 1KHz


G
$V_S - V_G = 5 - 0 = +5V$
Strong
INVERSION
S
P+
0000
P+
N-type
5V
$C'_{ox} \cdot W \cdot L$
$2n_iT$
1GΩ
1V

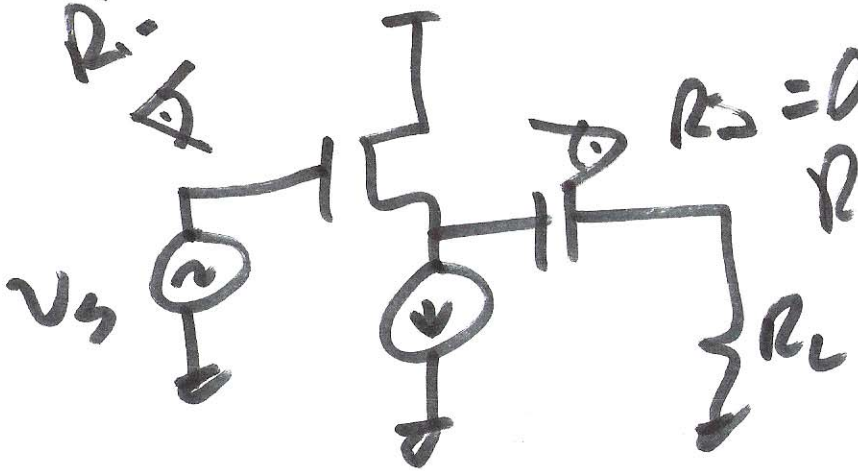
GAINS, INPUT Res., OUTPUT Res.

Calculating CAP size

$$f_{3dB} = \frac{1}{2\pi C_{out}(R_L + 1/g_m \| R_{ss})}$$



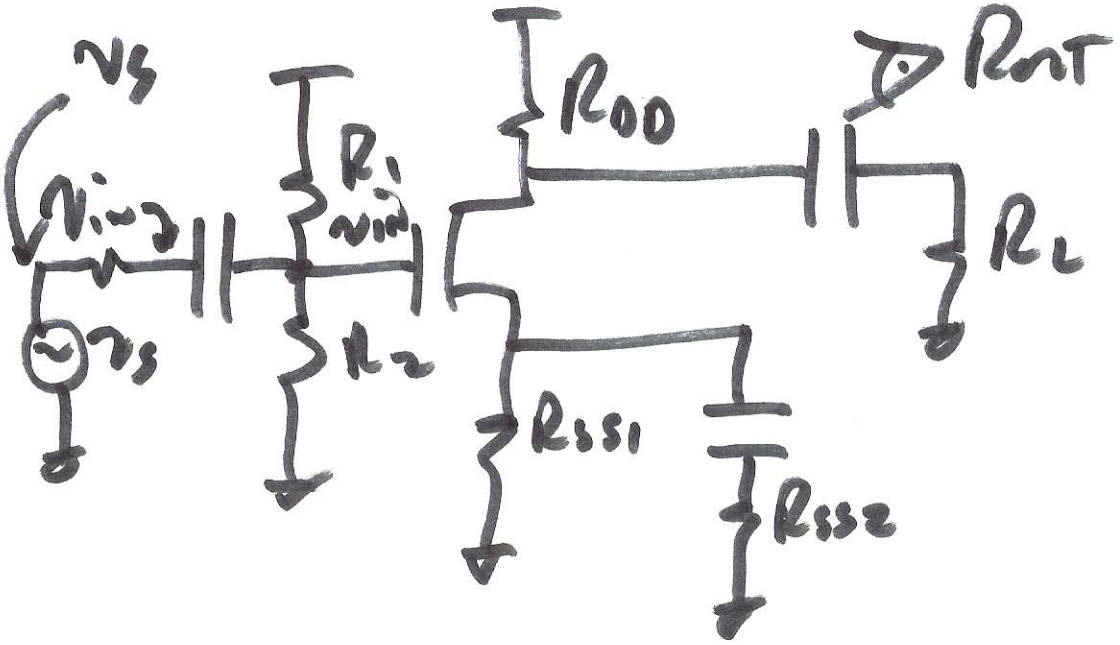
Derive g_m

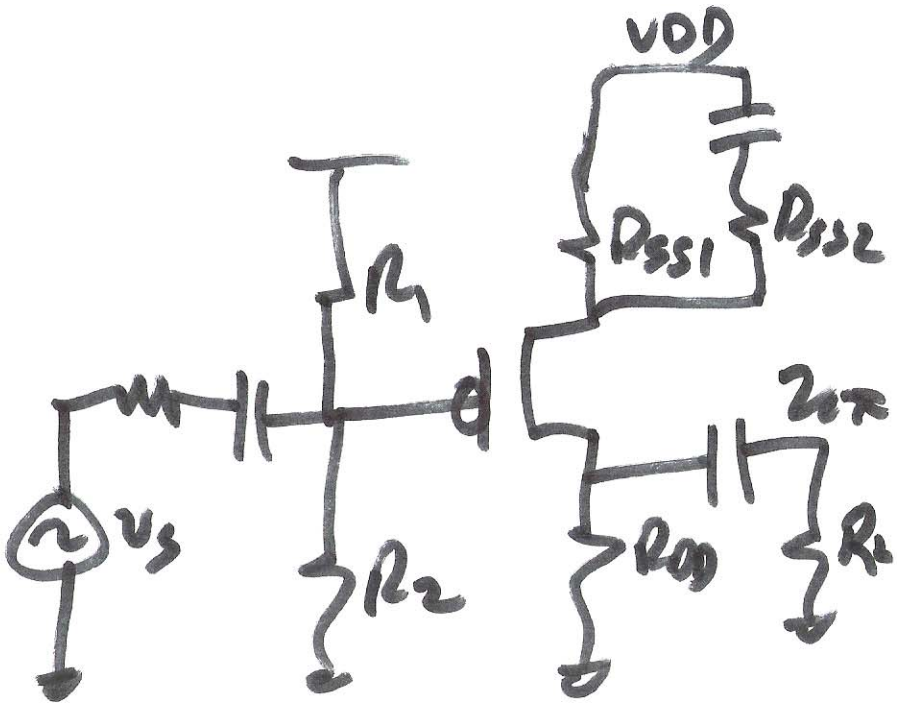


$R_{out} = 1/g_m$

S.F.

C. S.





$$R_{in} = R_1 \| R_2$$

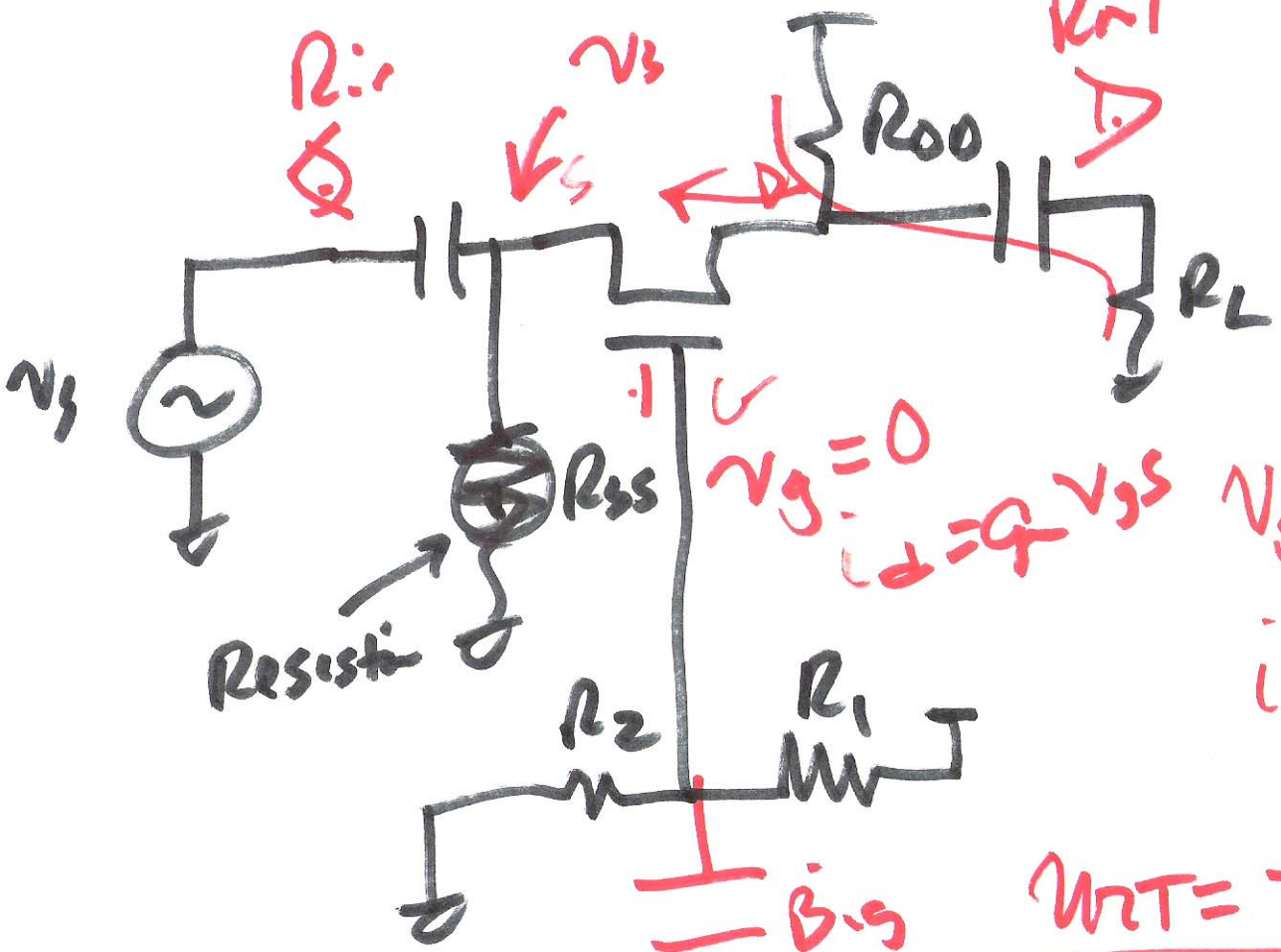
$$A_V = \frac{v_{out}}{v_{in}} = \frac{R_{DD} \| R_L}{1/g_m + R_{SS1} \| R_{SS2}}$$

$$\frac{V_{IN}}{V_S} = \frac{R_1 \| R_2}{R_1 \| R_2 + R_S}$$

I can derive this!

$$R_{out} = R_{DD}$$

C.G



$R_{in} = R_{SS} \parallel \frac{1}{g_m}$

$R_{OUT} = R_{OD}$

$v_g = 0$

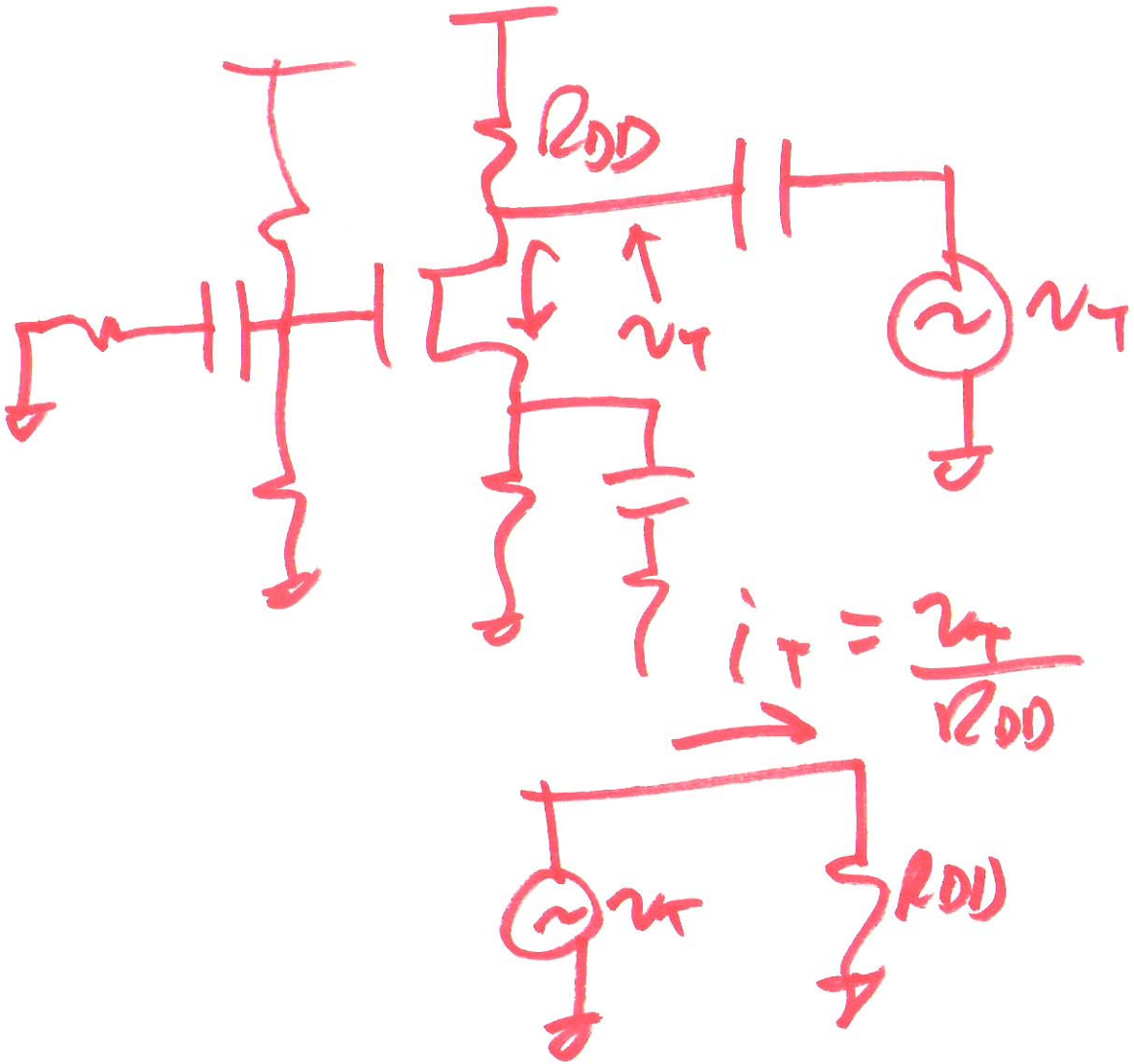
$i_d = g_m v_{gs}$

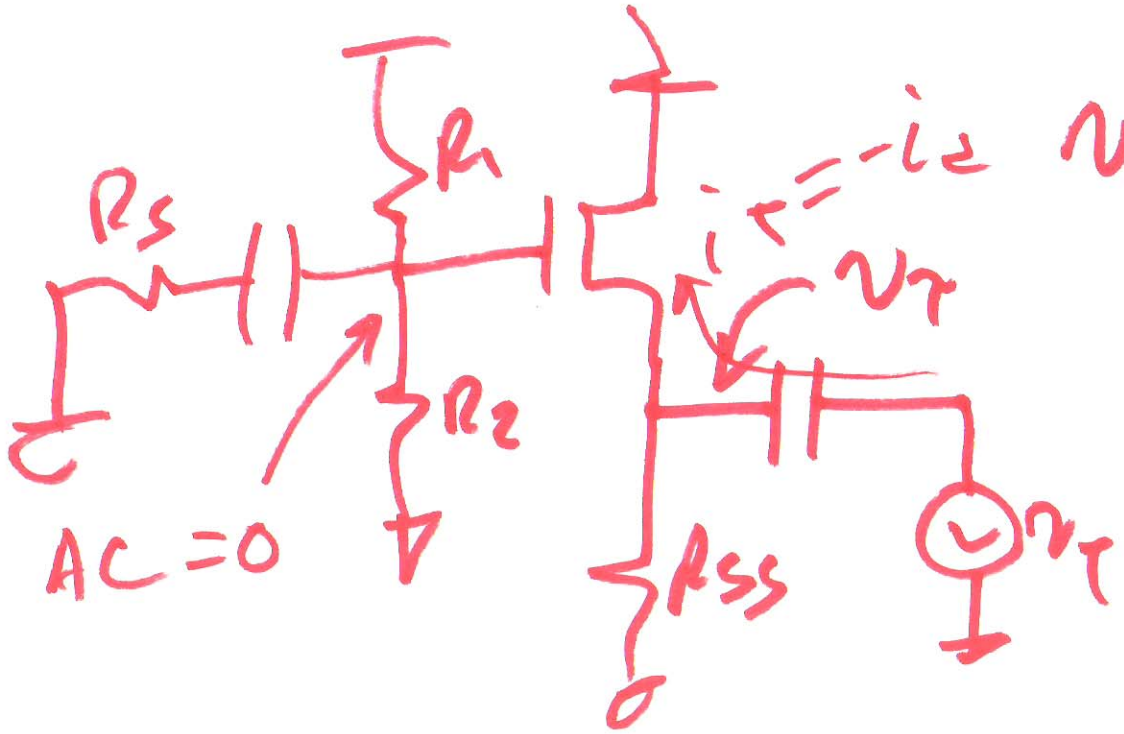
$v_{gs} = -v_s$

$i_d = -g_m v_s$

$v_{OUT} = -i_d \cdot R_{OD} \parallel R_L$

$$\frac{R_{OD} \parallel R_L}{\frac{1}{g_m}} = \frac{v_{OUT}}{v_s} = g_m R_{OD} \parallel R_L$$


R_{DD}
v_T
v_T
$i_T = \frac{v_T}{R_{DD}}$
$\frac{v_T}{i_T} = R_{DD} = R_{OUT}$
v_T
R_{DD}



$v_{gs} = -v_T$

$i_T = -i_d = g v_{gs}$

$= g(-v_T)$

$\frac{v_T}{i_T} = \frac{1}{g_m}$

$R_{NT} = R_{SS} \| 1/g_m$