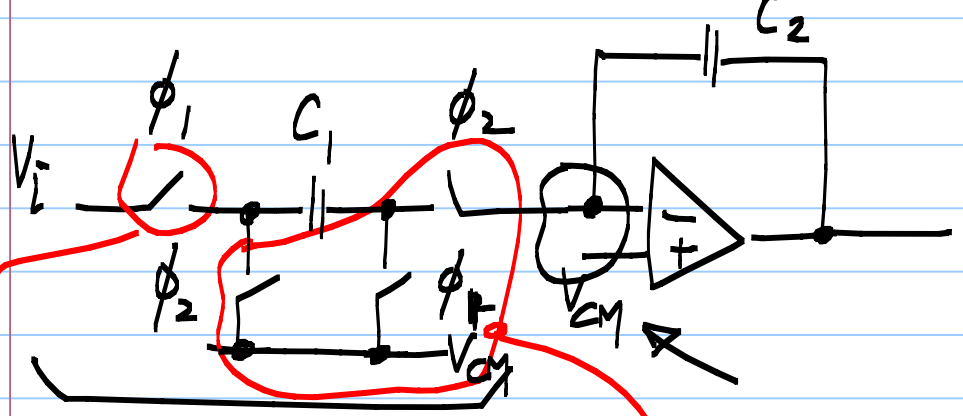
Lecture 60:

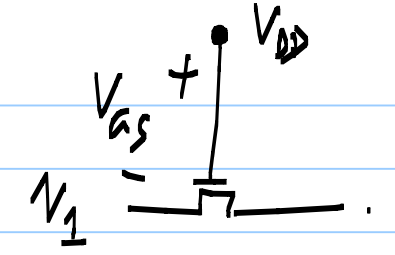
Switched capacitor filters :



MOS transistor switches.

Transmission gate

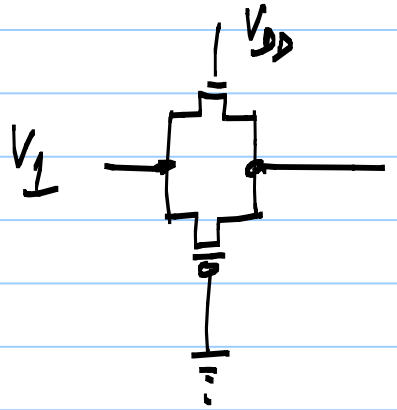
Single channel



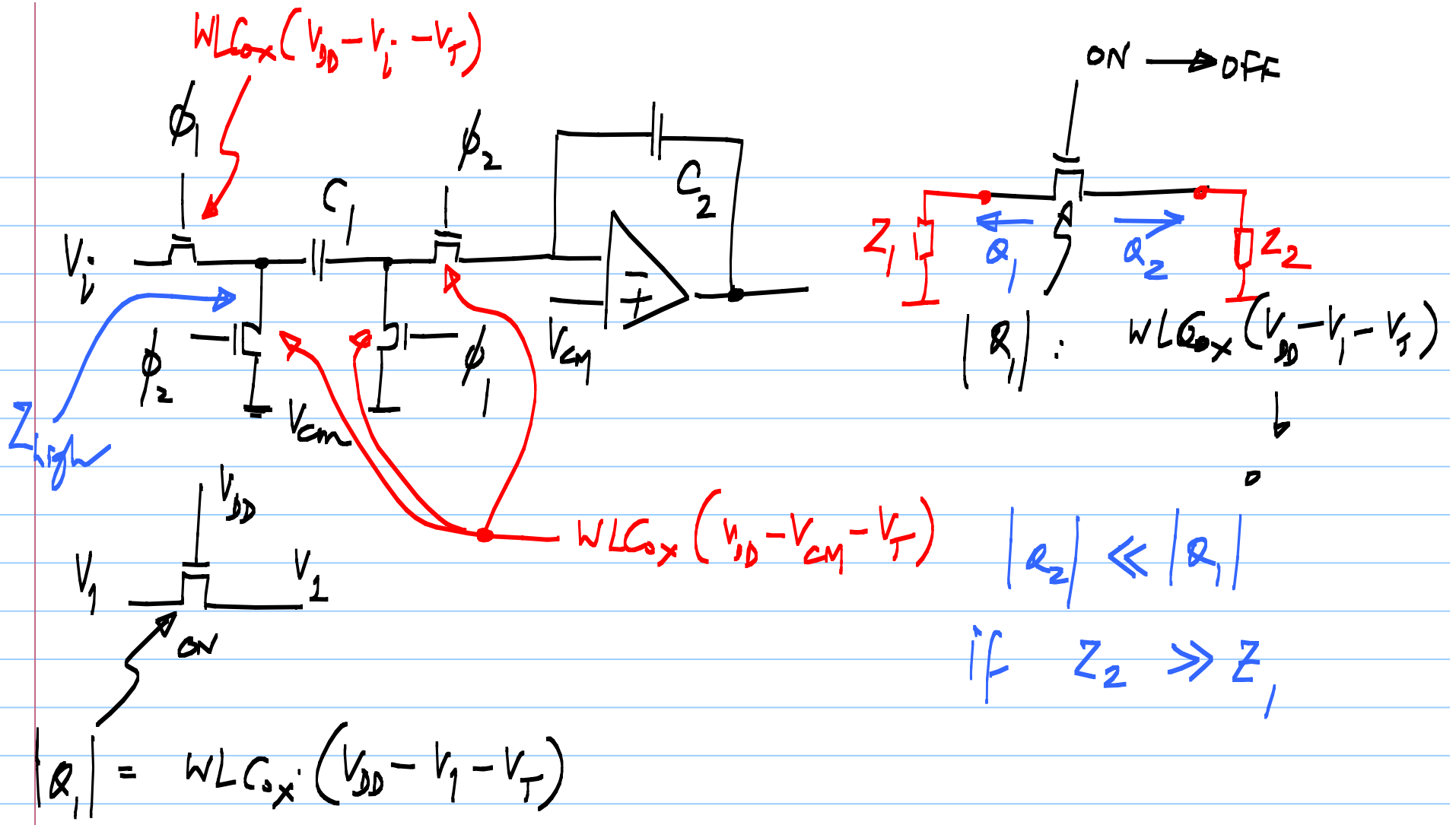
ON if $V_{GS} > V_T$

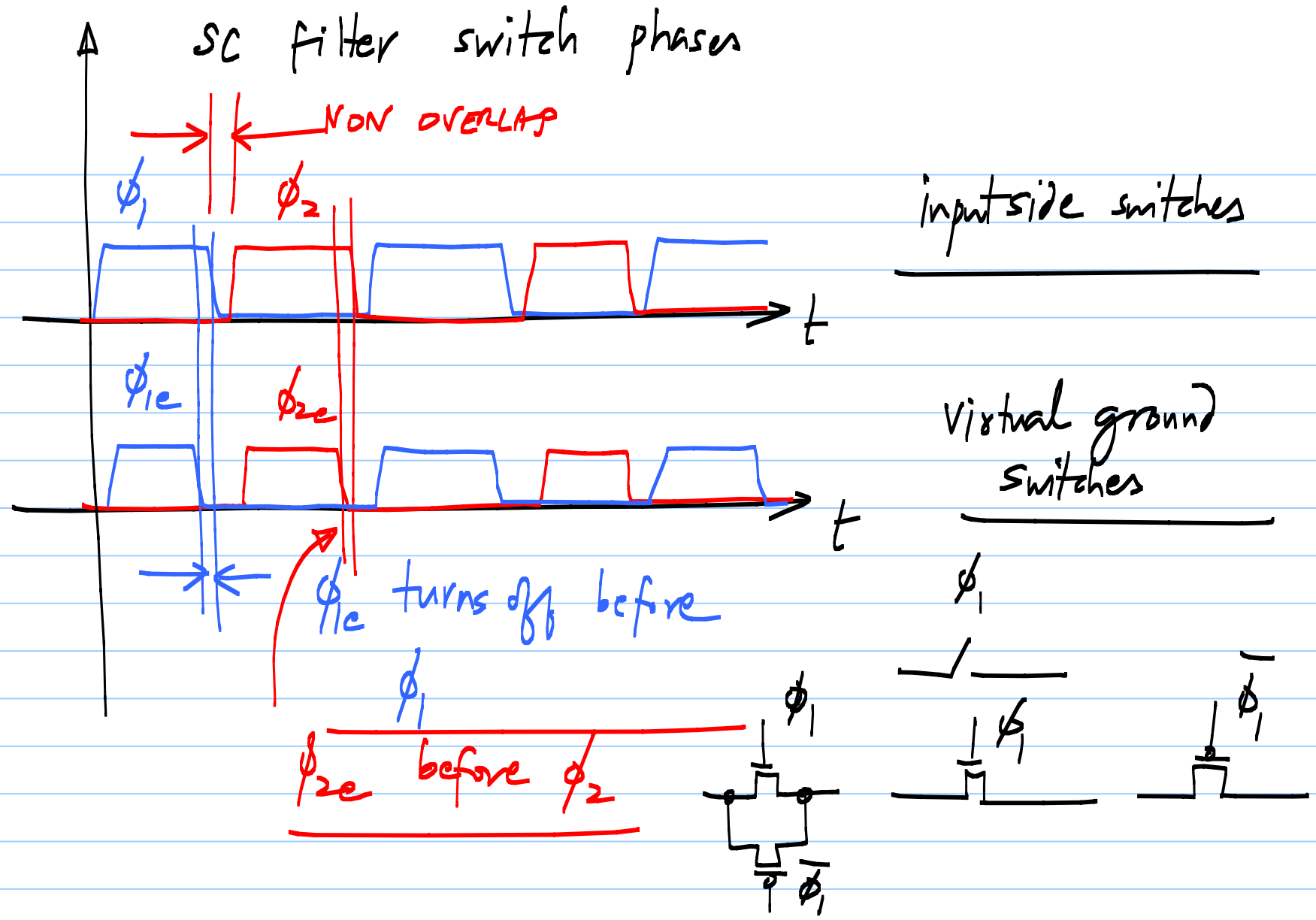
V_1 is close to ground

V_1 is close to V_{DD}



Transmission gate switch


$WLC_{ox}(V_{DD}-V_i-V_T)$
ϕ_1
ϕ_2
C_1
C_2
V_i
V_{CM}
Z_{high}
V_{DD}
V_1
ON
$WLC_{ox}(V_{DD}-V_{CM}-V_T)$
$|Q_1| = WLC_{ox}\cdot(V_{DD}-V_1-V_T)$
ON → OFF
Z_1
Z_2
Q_1
Q_2
$|Q_1|$: $WLC_{ox}(V_{DD}-V_1-V_T)$
$|Q_2| \ll |Q_1|$
if $Z_2 \gg Z_1$


SC filter switch phases
NON OVERLAP
ϕ_1
ϕ_2
t
ϕ_{1e}
ϕ_{2e}
t
ϕ_{1e} turns off before
ϕ_{2e} before ϕ_2
input side switches
Virtual ground switches
ϕ_1
ϕ_1
ϕ_1
ϕ_1
ϕ_1

Choosing transistor sizes:

Square law model: $I_D = \frac{\mu C_{ox}}{2} \frac{W}{L} (V_{GS} - V_T)^2$

not really true @ short L

$I_D \propto W$ $\quad W >> W_{min}$

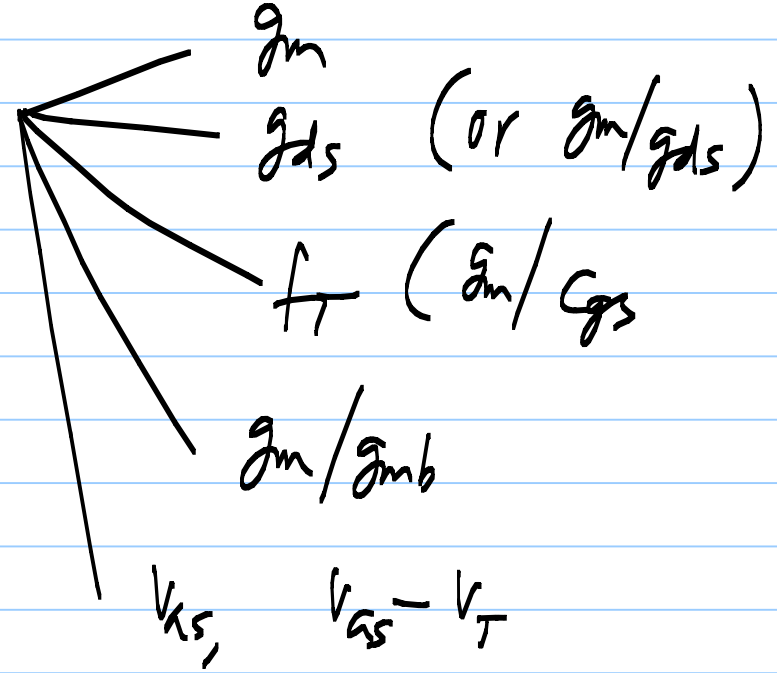
$I_D \propto \frac{1}{L}$ X $\quad I_D$ increases with reducing L

Oversimplified

* Choose a channel length L [e.g. L_{min}]

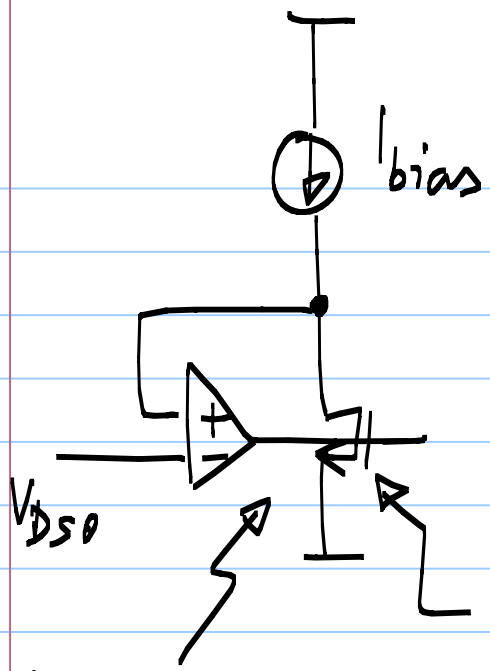
$I_D \propto \left(\frac{W}{L}\right)$ $\{W, L\}$: separate parameters

* Bias at a given I_D



* Vary I_D over some range & plot these parameters

* Repeat for different L.



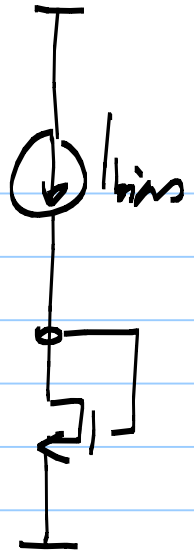
$W \gg W_{min}$

$L = L_{min}$

$I_D = I_{bias}$

$V_{DS} = V_{DS0} = 0.3V$

Plot vs. $\left[I_{bias}/W\right]$



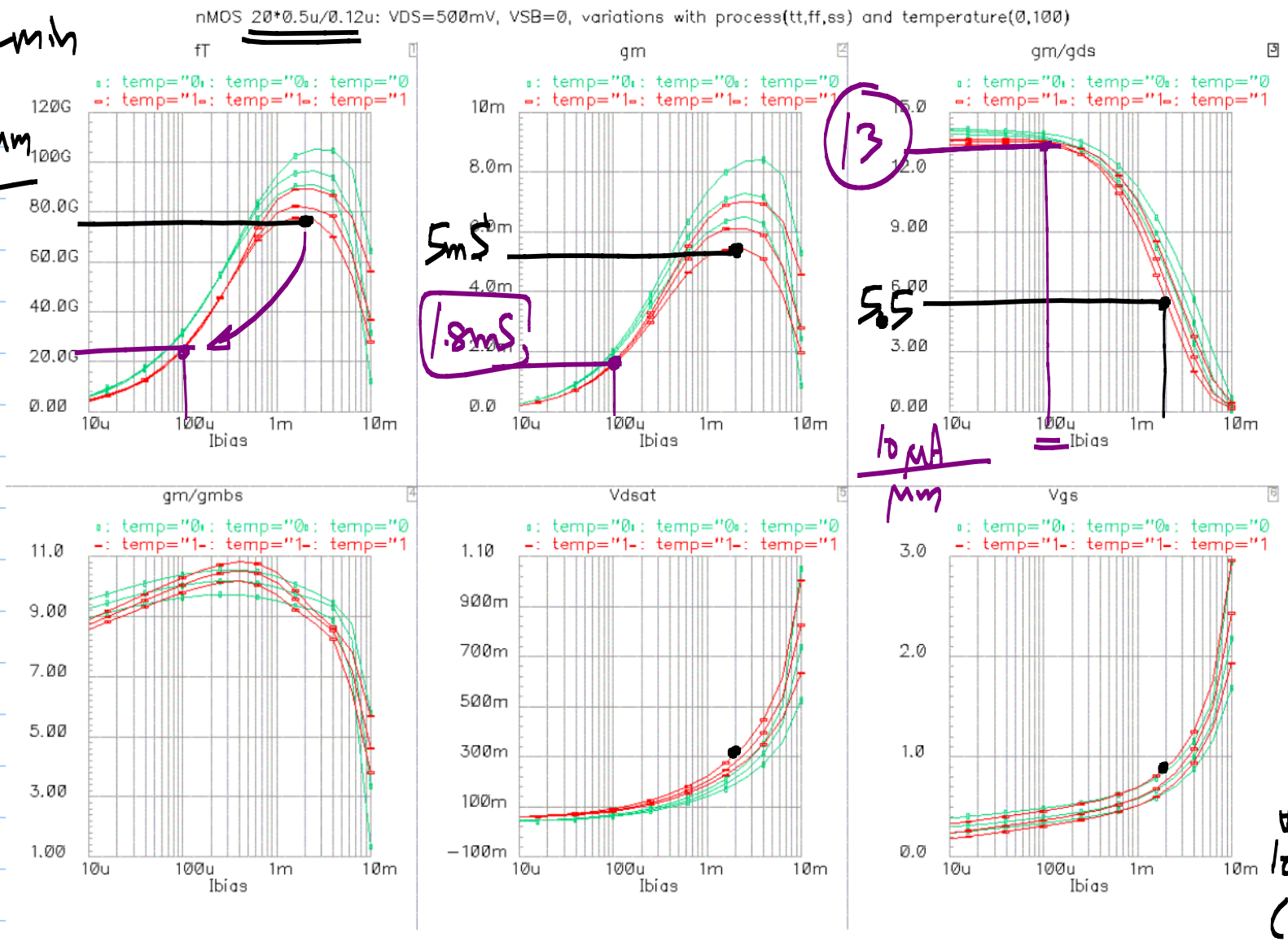
From the operating point info, get g_m, g_{ds} $[g_m/g_{ds}]$

g_m/g_{mb}, $g_m/C_{gs} \sim f_T$

V_{GS}, $V_{GS} - V_T$

L = Lmin

= 0.12μm



$\frac{I_{bias}}{I_{DN}}$

$\frac{2mA}{(10\mu)}$

$\left[\frac{200\mu A}{micron}\right]$

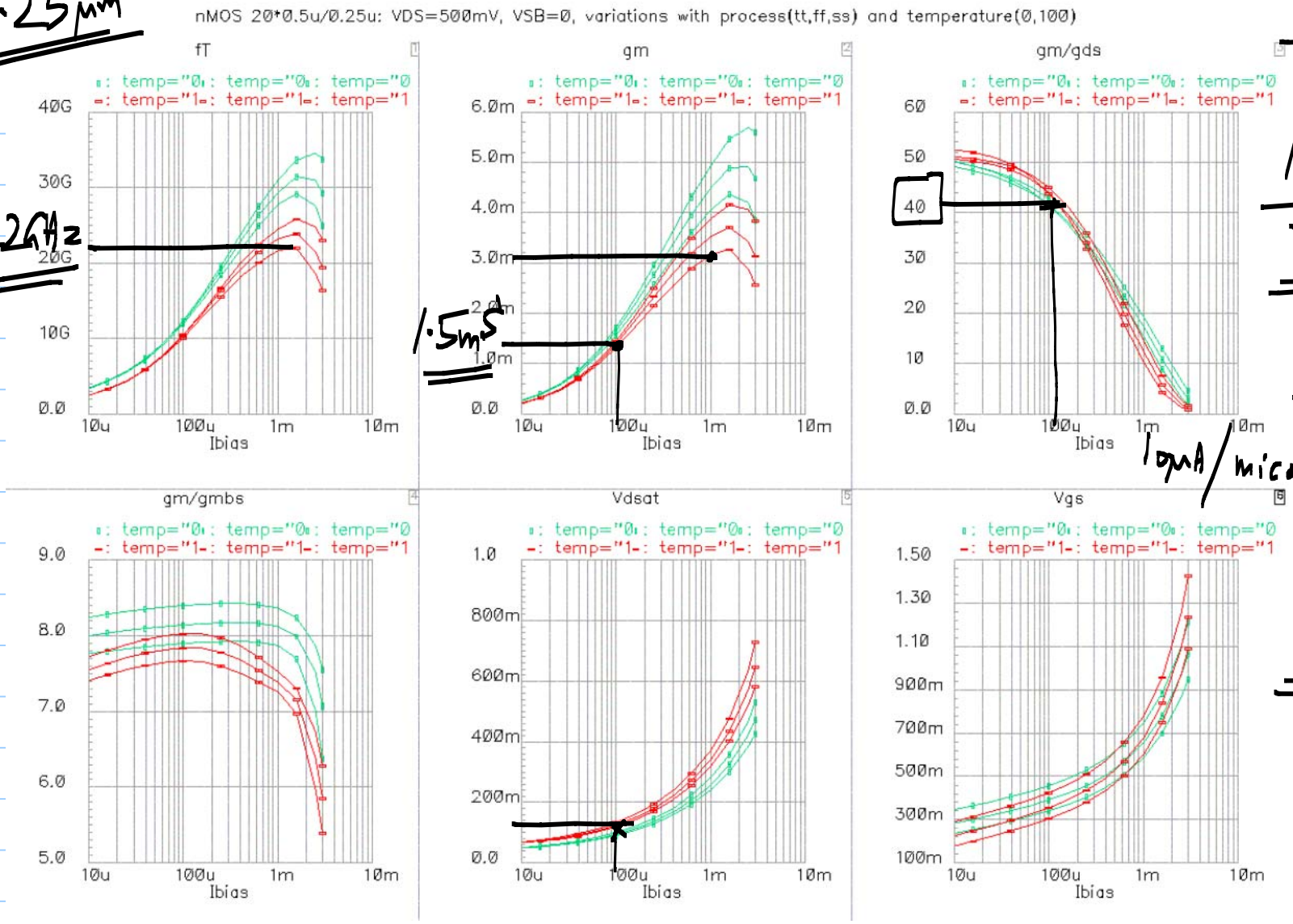
$\frac{500\mu S}{micron}$

58mS

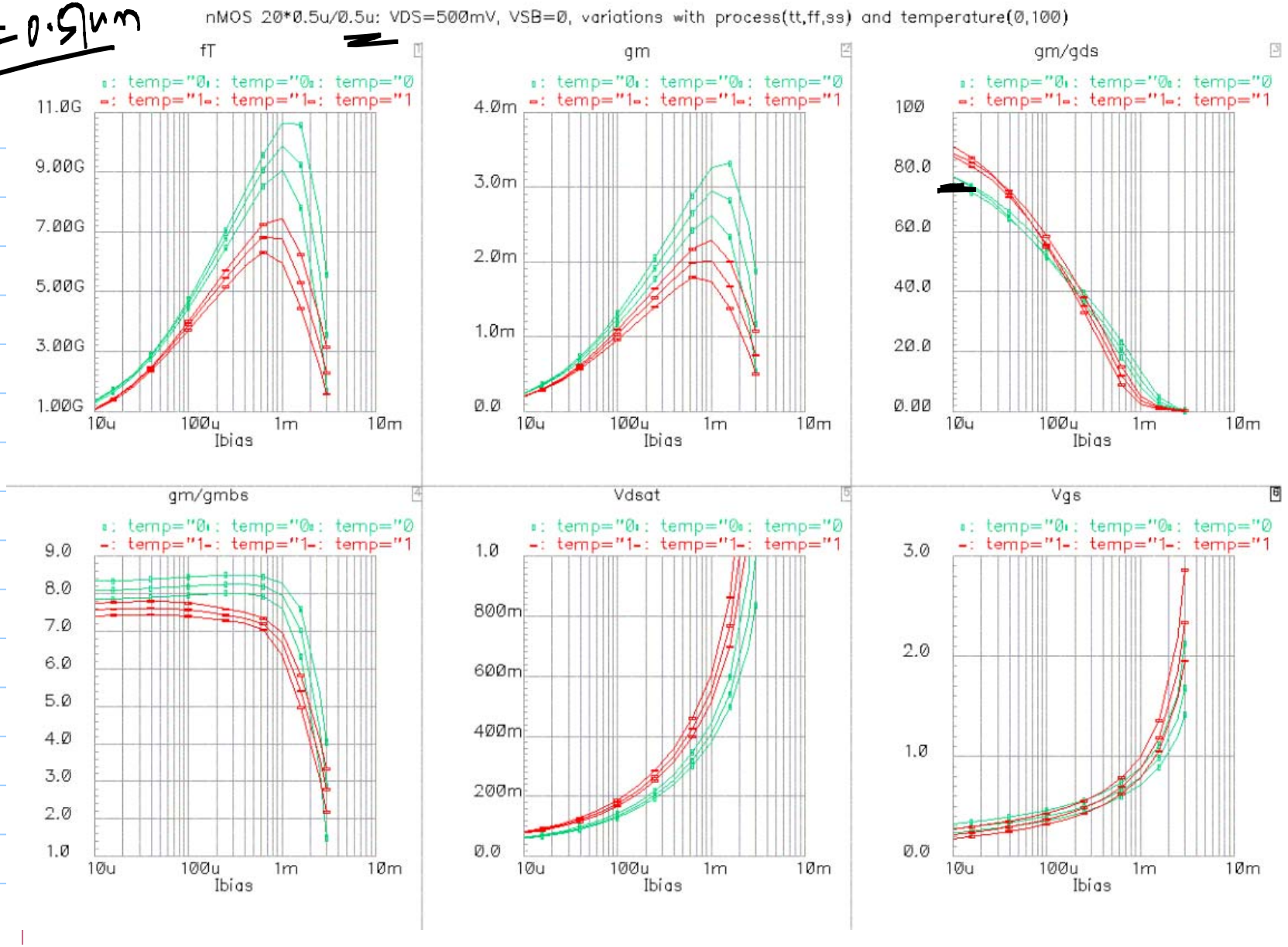
100μ ; 2mA

(W)

L = 0.25 μm


nMOS 20*0.5u/0.25u: VDS=500mV, VSB=0, variations with process(tt,ff,ss) and temperature(0,100)
fT
gm
gm/gds
gm/gmbs
Vdsat
Vgs
Ibias
22GHz
1.5mS
40
1.5mS / 10μ (W)
150mS / micron
15mS
10mA / micron
100x
100 μm
1mA, Io

L = 0.5μm


nMOS 20*0.5u/0.5u: VDS=500mV, VSB=0, variations with process(tt,ff,ss) and temperature(0,100)
fT
gm
gm/gds
gm/gmbs
Vdsat
Vgs
Ibias
10u
100u
1m
10m