# EE 420 / ECG 620

Lecture 7 MARCH 5, 2014

Review for midterm

study H.W. & Quizzes

Ch. 9 → IV plots

IV curves for MOSFETS

$I_{D,SAT}$, $I_{ON}$ ($I_{drive}$)

$V_{DS,SAT} = V_{GS} - V_{THN}$

$V_{GS} > V_{THN}$

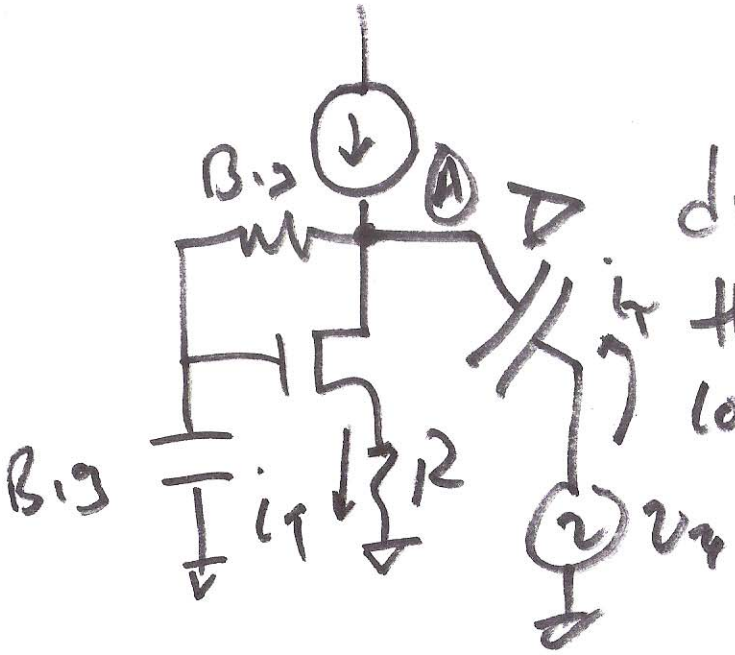
Qualitative MOSFET operation (inject/steal)

Ex. 9.3!

# Ex. 9.5

Body effect & Body transconductance

output resistance




discuss how to find the small-signal resistance looking into A.

$f_T$, $g_m r_o$, GFT

How to select

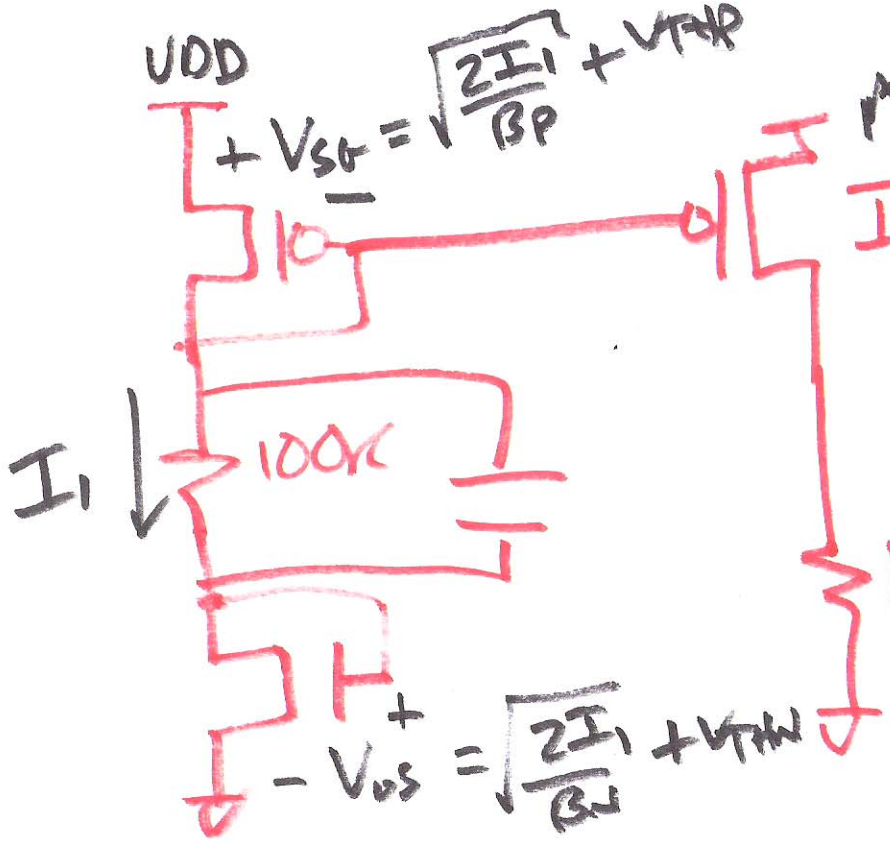
→ W, L, overdrive

Long channel $V_{DS,SAT} = V_{GS} - V_{THN}$

$= V_{OVN}$

# Ch. 20

## Basic calculations




What is MAX value of $R_2$ for M2 to Remain in SAT.

$$V_{DD} - V_{SG} - I_1 \cdot 100K - V_{DS} = 0$$

ON TEST :)

# Current mirrors

## Mismatch issues

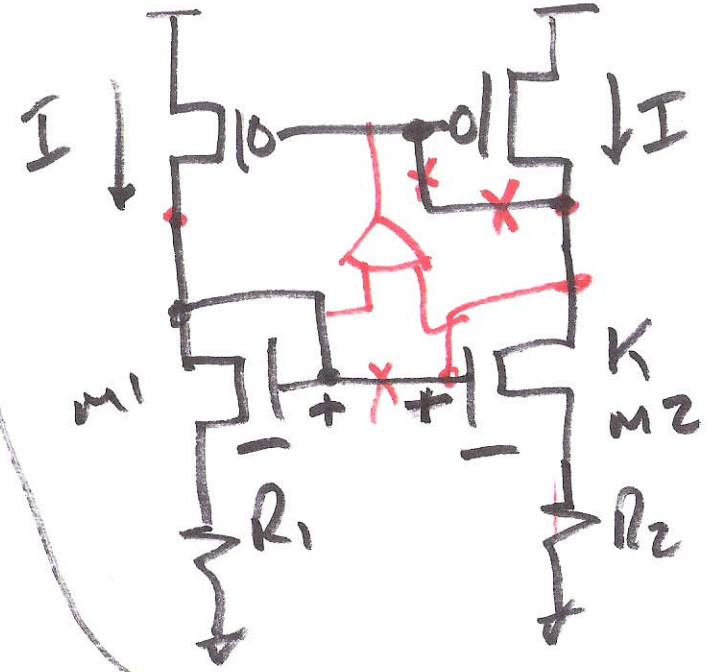
$V_{DS}$

BMR ← Quizzes, H.W.

$V_{GS1} = V_{GS2} + I(R_2 - R_1)$

$R_2 > R_1$

let $R = R_2 - R_1$




find I

How must $I_1$ & $R_2$ be related? why

$V_{GS1} > V_{GS2}$

$V_{GS1} + IR_1 = V_{GS2} + IR_2$

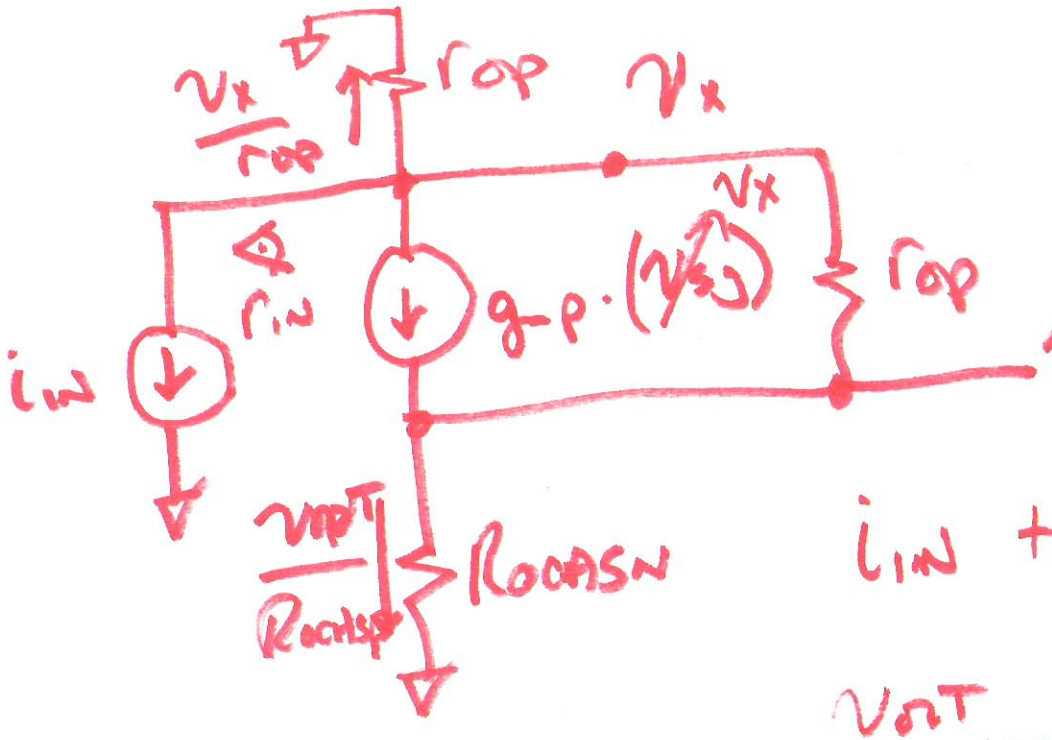
Ch. 21

Know how to calculate gains.

$r_{IN} = \frac{v_x}{-i_{IN}}$ *

CASCODES, C.S., C.D., (S.F.),

C.G. $r_{IN} = ? = \frac{v_x}{i_{IN}}$




$\frac{v_{OUT}}{i_{IN}} = ?$

$i_{IN} + \frac{v_x}{r_{op}} + \frac{v_x - v_{OUT}}{r_{op}} + g_m v_x = 0$

$g_{mp}\cdot r_{op}\cdot v_x$

$\frac{v_{OUT}}{R_{CASN}} = \frac{v_x - v_{OUT}}{r_{op}} + g_{mp}\cdot v_x$

$$V_{OUT} = \frac{R_{OCMSN}}{r_{op}}\left(V_X - V_{OUT}\right) + \left(g_{mp} \cdot V_X\right) \cdot R_{OCMSN}$$

$$V_{OUT}\left(1 + \frac{R_{OCMSN}}{r_{op}}\right) = V_X\left(\frac{R_{OCMSN}}{r_{op}} + g_{mp} R_{OCMSN}\right)$$

$$V_{OUT} = V_X \cdot \frac{\frac{R_{OCMSN}}{r_{op}} + g_{mp} R_{OCMSN}}{1 + \frac{R_{OCMSN}}{r_{op}}}$$

$$= V_X \cdot \frac{1 + g_{mp} \cdot r_{op}}{1 + \frac{r_{op}}{R_{OCMSN}}} \approx g_{mp} r_{op} \cdot V_X$$

$$i_{in} + \frac{v_x}{r_{op}} + \frac{v_x - g_m r_{op} v_x}{r_{op}} + g_m v_x = 0$$

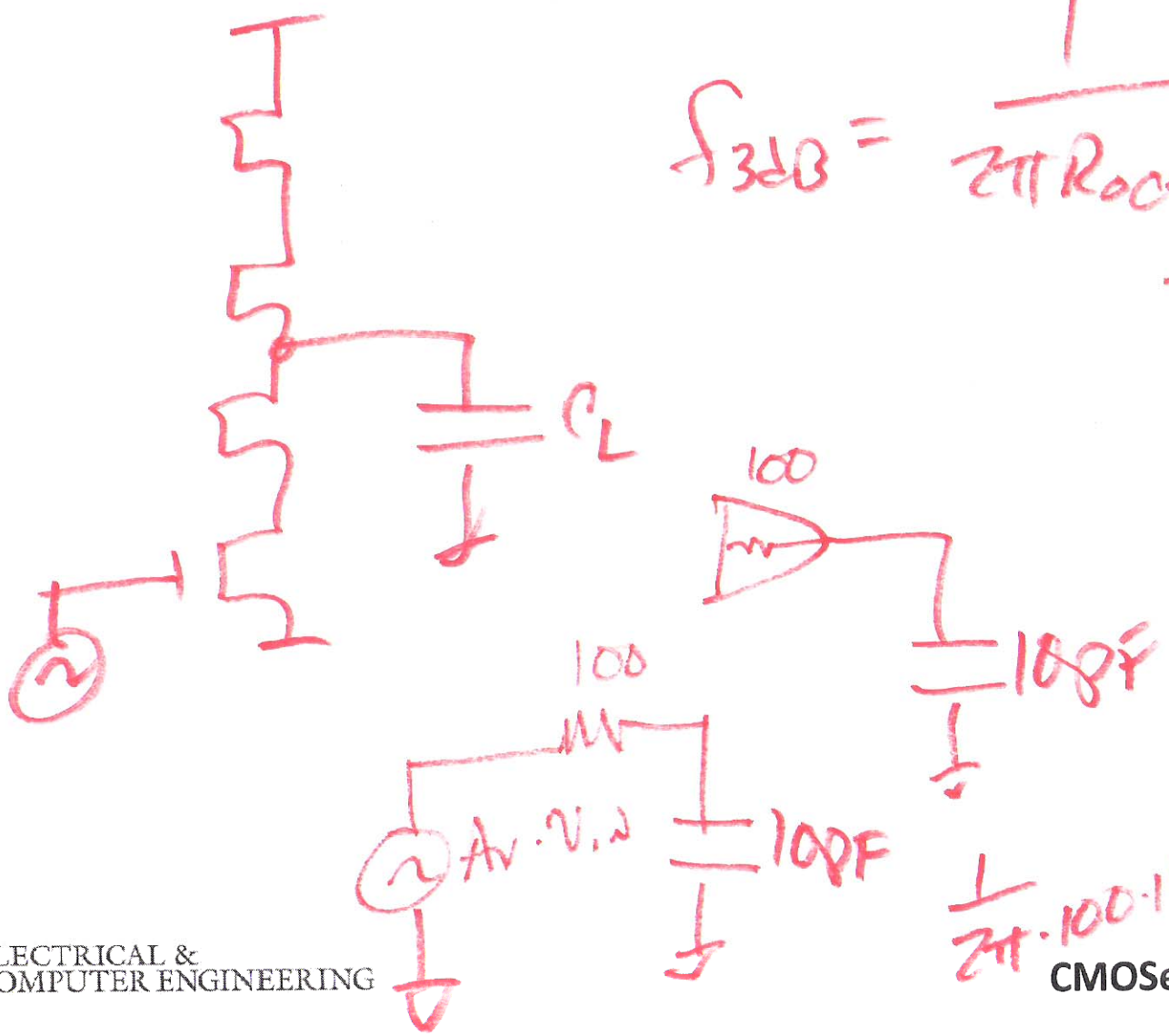
$$i_{in} + \frac{v_x}{r_{op}} + \frac{v_x}{r_{op}} - g_m v_x + g_m v_x = 0$$

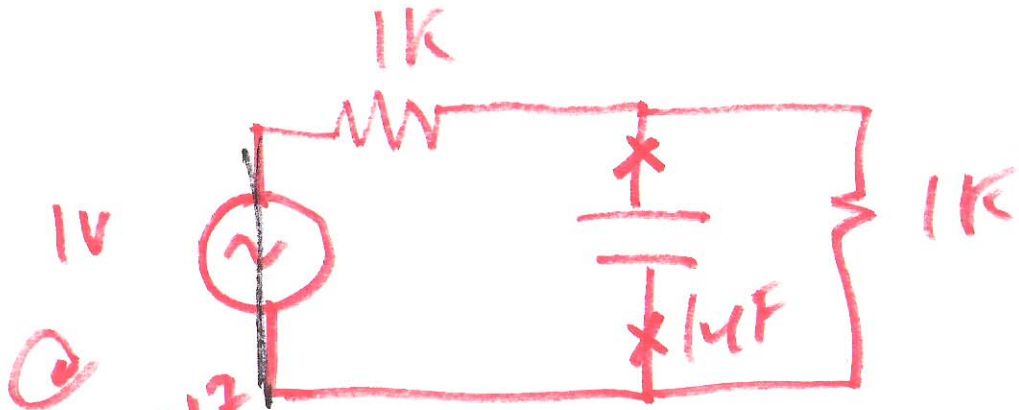
$$v_x \left( \frac{1}{r_{op}} + \frac{1}{r_{op}} \right) = -i_{in}$$

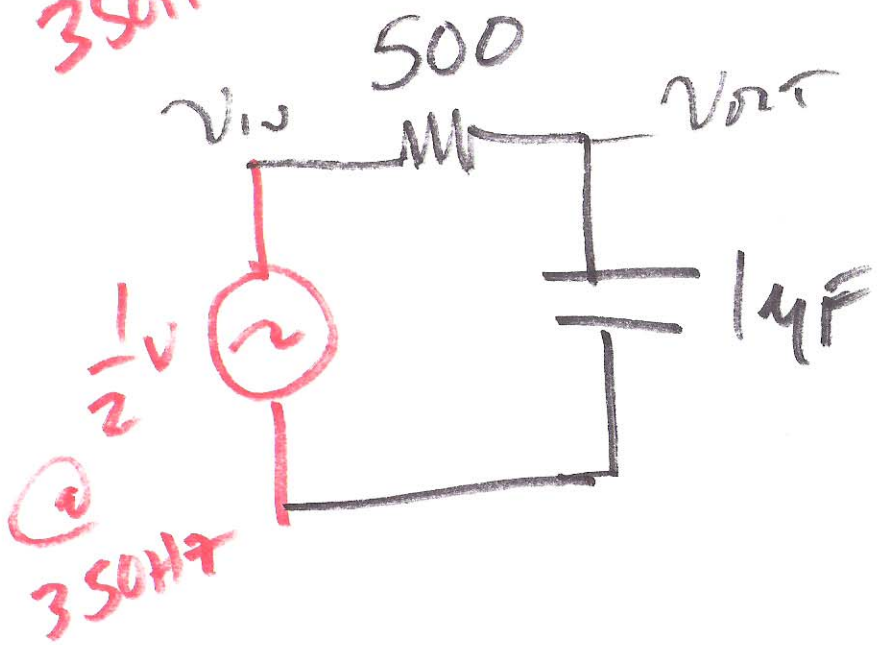
$$\boxed{\frac{v_x}{-i_{in}} = \frac{r_{op}}{2}}$$

Derive Miller's theorem freq. response problem

$$f_{3dB} = \frac{1}{2\pi R_{out,sw} \| R_{out,p} \cdot C_L}$$






$$V_{out} = \frac{\frac{1}{j\omega C}}{j\omega C + R} \cdot V_{in}$$

$$\frac{V_{out}}{V_{in}} = \frac{1}{1 + j\omega RC}$$

$R = 500$

$@ = 1\text{mF}$

a)