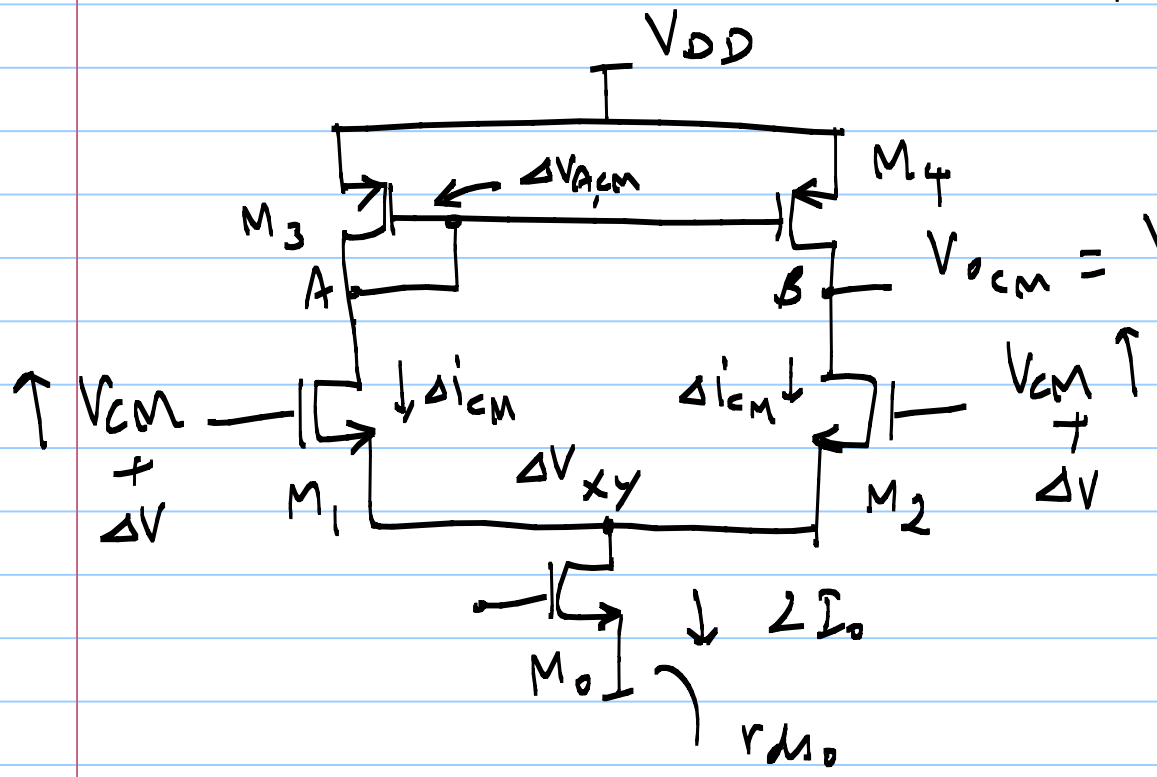
8/10/2020

Lecture 35

"Single stage Opamp"



$V_{OCM} = V_{DD} - V_{SG_3} + \Delta V_{OCM}$

$\frac{\Delta V_{OCM}}{\Delta V} = A_{CM}$ {HW}

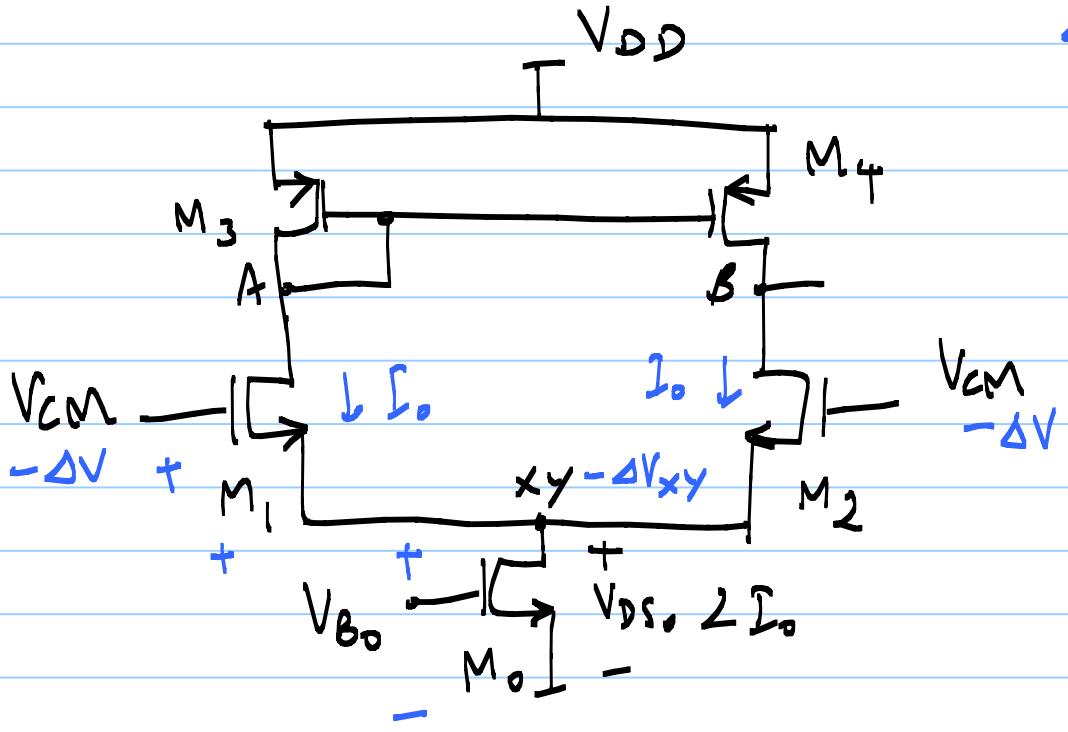
V_{CM} = input CM level → range?

V_{OCM} = Output CM level → range?

ICMR – input CM range

OCMR – output CM range

ICMR: 1) keep ↓ V_{CM}



$\Delta V_{xy} = \Delta V$ if M_0 current does not change

ΔV_{xy} slightly less than ΔV if M_0 has large r_{ds} { V_{DS_0} ↓ }

Eventually M_0 will go into triode region

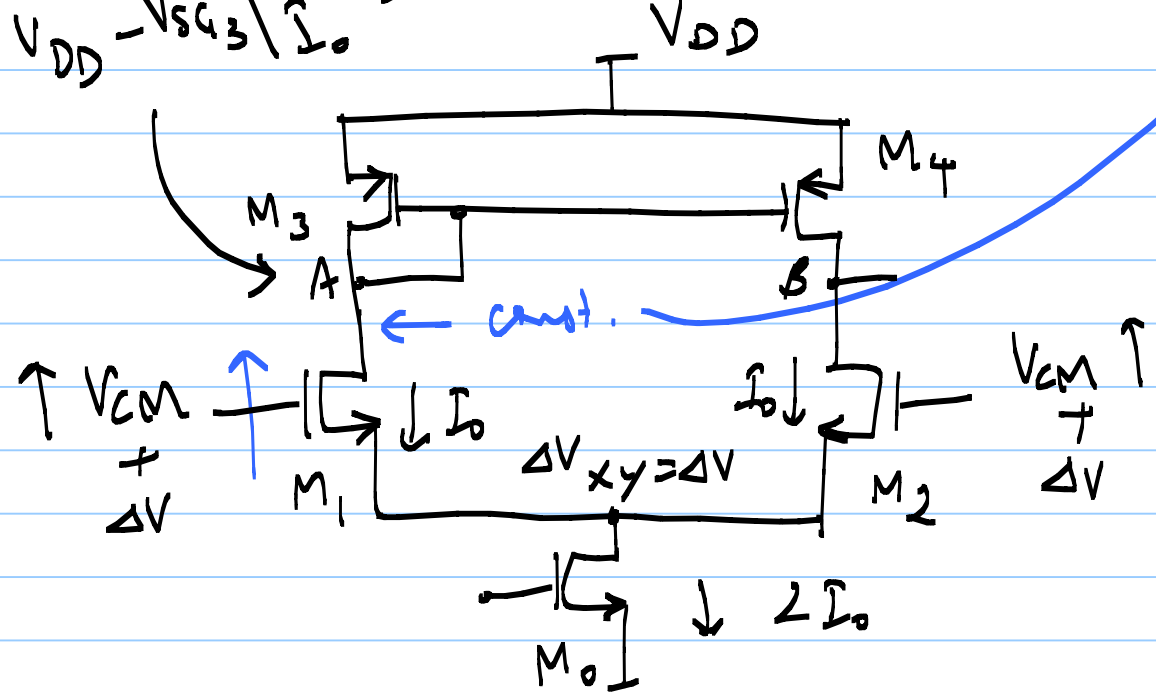
When $V_{DS_0} = V_{B_0} - V_{T_0} = V_{Dsat_0}$

$$V_{CM\,min.} = V_{Dsat_0}\Big|_{2I_0} + V_{GS_1}\Big|_{I_0}$$

2) V_{CM} ↑ → $V_{CM_{max}}$

M_0 moves away from triode boundary

$V_A = V_{DD} - |V_{SG_3}| / I_o = \text{constant}$

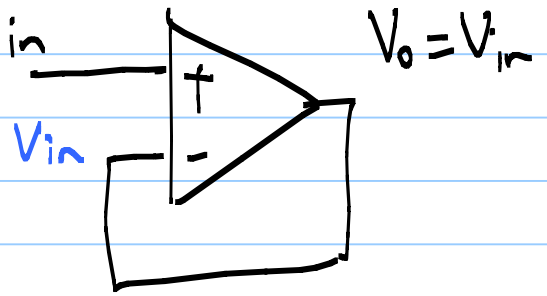


Moving M_1 & M_2 towards triode boundary

M_1 & M_2 will go into triode!

$V_{D_1} = V_{G_1} - V_{T_1}$

(DC)

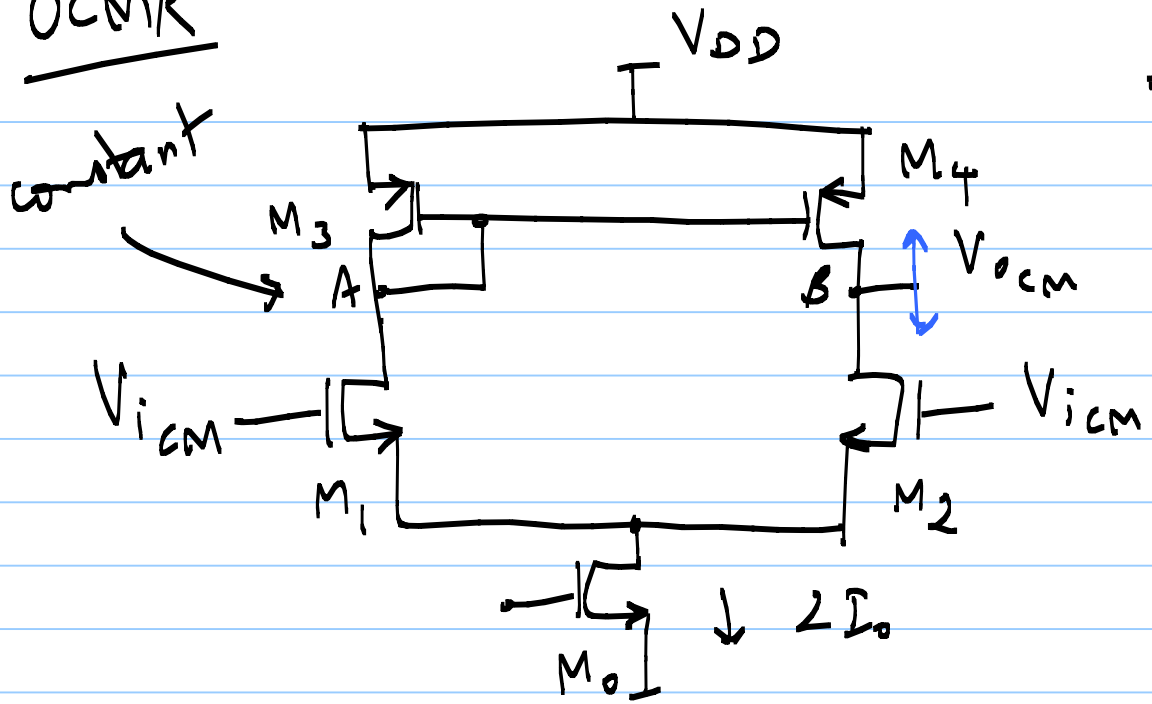


$$V_{DD} - |V_{SG_3}| / I_o = V_{CM_{max}} - V_{T_1}$$

$$V_{CM_{max}} = V_{DD} - |V_{SG_3}| / I_o + V_{T_1}$$

$$ICMR = \{ V_{CM_{min}}, V_{CM_{max}} \}$$

OCMR



* V_{ocm} is set by f.b.

1) $V_{ocm\,max}$ = voltage at which M_4 goes into triode

$$V_{D4} = V_{G4} + V_{T4}$$

$$V_{ocm_{max}} = V_A + V_{T4}$$

$$V_{ocm\,max} = V_{DD} - |V_{SG3}|_{I_o} + V_{T4}$$

$|V_{SG3}|_{I_o} = V_{T3} + V_{SD_{sat_3}}$

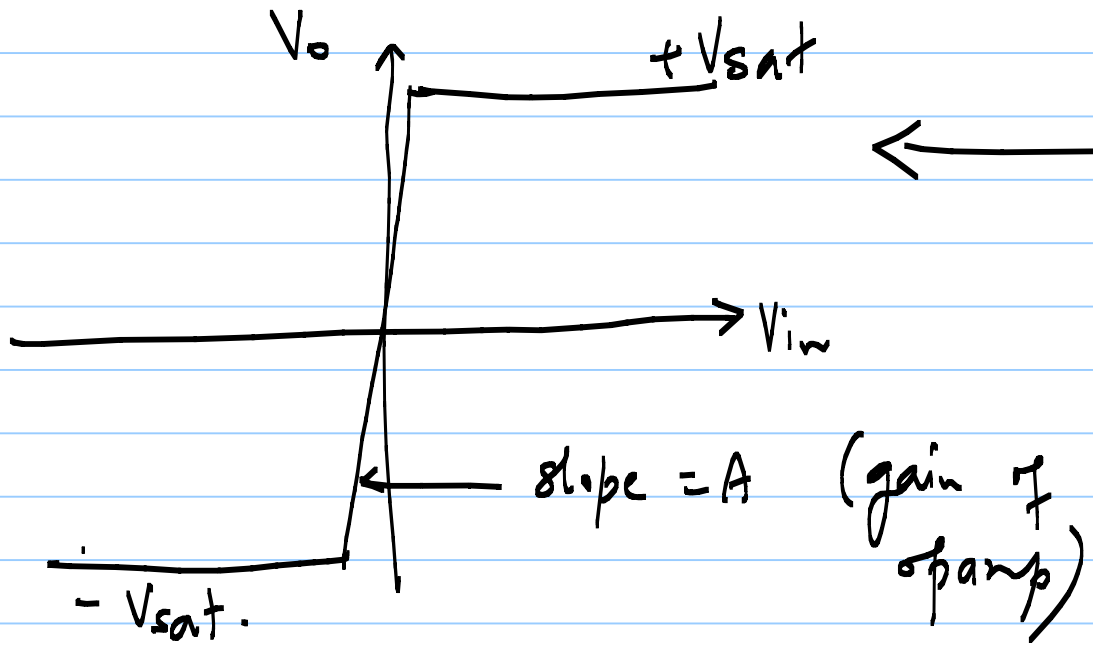
$$V_{ocm\,max} = V_{DD} - V_{SD_{sat_4}}$$

2) ↓ V_{ocm} → $V_{ocm\,min.}$ = voltage at which M_2 goes into triode

$$V_{D_2} = V_{G_2} - V_{T_2}$$

$$V_{OCM\,min.} = \underbrace{V_{ICM}}_{\text{range of values within ICMR}} - V_{T_2}$$

$$OCMR = \{ V_{CM\,min.}, V_{CM\,max} \}$$



Ideal opamp characteristics

One stage opamp :