AEC lec 41 — 25/10/23

3 transistor current mirror:

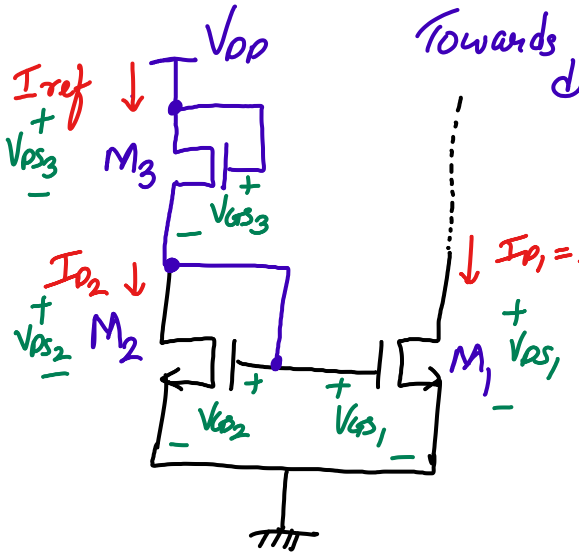
$I_{D_1} = I_{out}$

$I_{ref} = I_{D3} = I_{D_2}$

$V_{GS_1} = V_{GS_2}$

M_1 & M_2 are identical

$\downarrow$ $V_{TN_1} = V_{TN_2}$ $\quad$ $\downarrow$ $\lambda_1 = \lambda_2$



$$\underline{V_{GS_3} = V_{DD} - V_{GS_2}}$$

$$V_{DS_3} = V_{GS_3}$$

$$\underline{V_{DS_2} = V_{GS_2} = V_{GS_1}}$$

$$I_{out} = I_{D_1} = k_{n_1}(V_{GS_1} - V_{TN_1})^2(1 + \lambda_1 V_{DS_1}) \quad -(1)$$

$$I_{D_2} = k_{n_2}(V_{GS_2} - V_{TN_2})^2(1 + \lambda_2 V_{DS_2}) \quad -(2)$$

$V_{GS_3} = V_{DD} - V_{GS_2}$

$$I_{D_3} = I_{ref} = k_{n3}(V_{GS_3} - V_{TN_3})^2(1 + \lambda V_{DS_3}) \quad -(3)$$

$V_{DS_3} \to V_{GS3}$

$$I_{D3} = I_{ref} = k_{n_3}(V_{DD} - V_{GS_2} - V_{TN_3})^2(1 + \lambda(V_{DD} - V_{GS_2})) \quad -(4)$$

$$\frac{I_{out}}{I_{ref}} = \frac{k_{n_1}(V_{GS_1} - V_{TN_1})^2(1 + \lambda_1 V_{DS_1})}{k_{n3}(V_{DD} - V_{GS_2} - V_{TN3})^2(1 + \lambda(V_{DD} - V_{GS_2}))} = 1 \quad -(5)$$

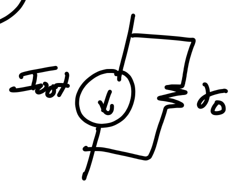
If M_1 & M_2 are identical, the o/p current I_{out} exactly mirror's the drain current through M_2 & M_3

$$I_{out} \approx I_{D_1} \approx I_{D_2}$$

$$I_{out} = k_{n_1}(V_{GS_1} - V_{TN_1})^2 \qquad (\lambda = 0)$$

$$\boxed{I_{out} = \frac{\mu_n C_{ox}}{2}\left(\frac{W}{L}\right)_1 (V_{GS_1} - V_{TN_1})^2}$$

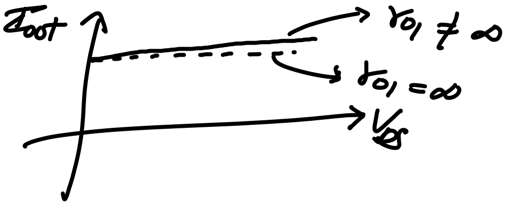
$$k_n = \frac{\mu_n C_{ox}}{2}\frac{W}{L}$$



Output resistance (R_{out}):-

↳ Refer 2 transistor current mirror's o/p resistance

$$\boxed{R_{out} = r_{o1} = \frac{1}{\lambda_1 I_{D1}}}$$



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