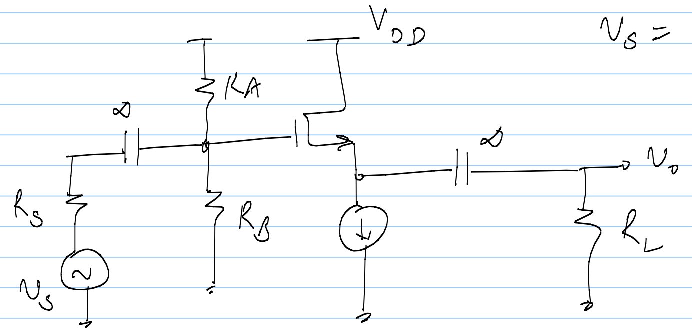
24/9/14

lec 25

Swing limits of CDA



$v_s = V_A \sin \omega t$

Triode limit

$$V_D = V_G - V_T$$

$$\Rightarrow V_{DD} = V_{DD} \cdot \frac{R_B}{R_A + R_B} + V_{A_1} \sin \omega t - V_T$$

$$\boxed{V_{A_1} = \frac{V_{DD} \cdot R_A}{R_A + R_B} + V_T}$$

Cutoff limit

$I_D = 0$

$$I_D = I_Q + i_d$$

$$I_Q = I_{ref}$$

$$i_d = \frac{v_o}{R_L} = \frac{g_m R_L}{1 + g_m R_L} \cdot \frac{V_{A_2} \sin \omega t}{R_L}$$

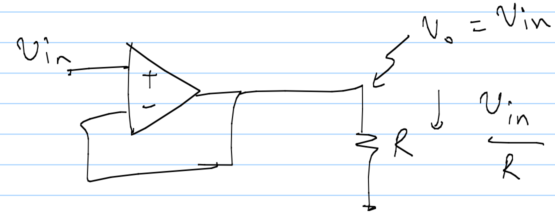
$I_D = 0$

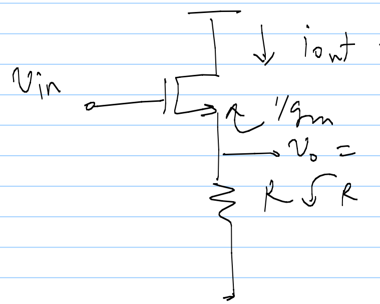
$$\Rightarrow I_{ref} = \frac{g_m R_L}{1 + g_m R_L} \cdot \frac{V_{A_2}}{R_L}$$

$$V_{A_2} = I_{ref} R_L \left[1 + \frac{1}{g_m R_L} \right]$$

Incremental VCCS

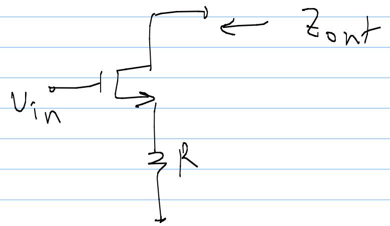
$i_{out} = \frac{v_{in}}{R}$; $Z_{in} = \infty$; $Z_{out} = \infty$

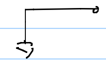


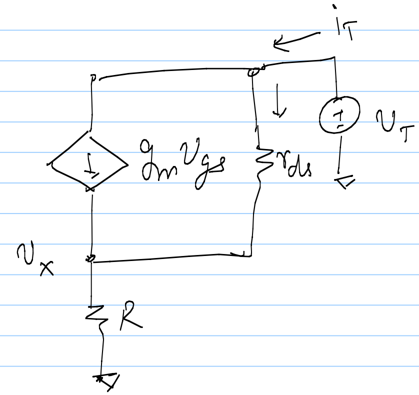


$$i_{out} = \frac{g_m}{1+g_m R} \cdot v_{in}$$

$$v_o = \frac{g_m R}{1+g_m R} \cdot v_{in}$$







$$\frac{(v_T - v_x)}{r_{ds}} - g_m v_x = \frac{v_x}{R}$$

$$v_x = R\, i_T$$

$$(v_T - i_T \cdot R)\, g_{ds} - g_m R\, i_T = i_T$$

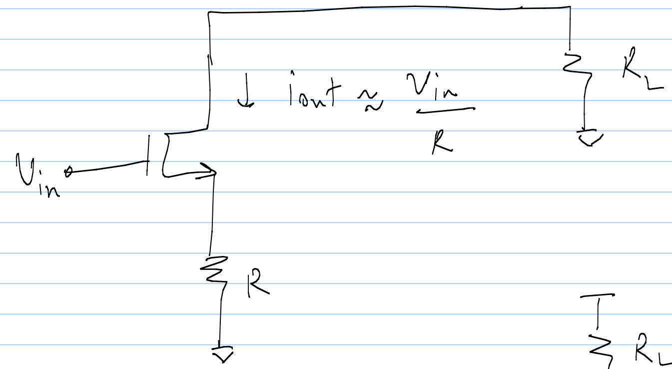
$$v_T \cdot g_{ds} = i_T \left[1 + g_m R + g_{ds} R \right]$$

$$Z_{out} = \frac{v_T}{i_T} = \frac{1 + g_m R + g_{ds} R}{g_{ds}}$$

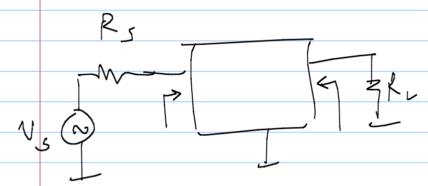
$$= r_{ds} + (g_m r_{ds}) R + R$$

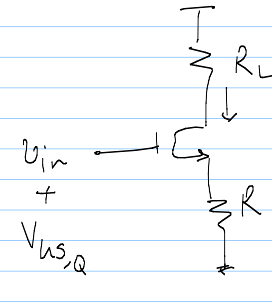
$$\approx (g_m r_{ds})\, R$$

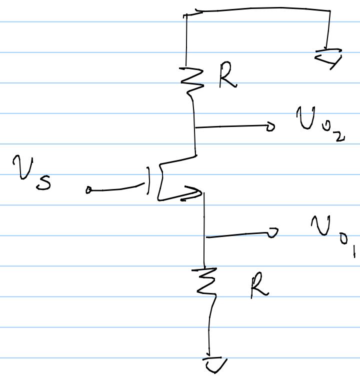
$$= r_{ds} + R(1 + g_m r_{ds})$$



$$i_{out} \approx \frac{v_{in}}{R}$$







$$v_{o_2} = -\frac{g_m R}{1+g_m R} \cdot v_s \approx -v_s$$

$$v_{o_1} = \frac{g_m R}{1+g_m R} \cdot v_s \approx +v_s$$

Phase Splitter Circuit