Chapter 4. 基本場效電晶體(FET)放大器(Basic FET Amplifiers)

4.3 共汲極放大器-源極隨耦器(Source Follower)

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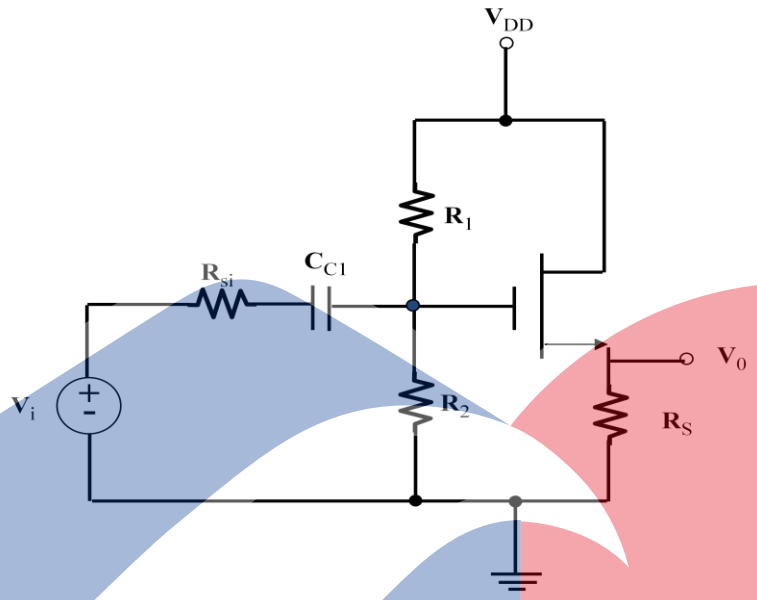
1. 步驟(一)DC 分析



A. 假設 M 工作於 SAT

B. 計算

$$V_G = \frac{R_2}{R_1 + R_2} V_{DD}$$

$$i_D = k_n(V_{GS} - V_{TN})^2 - - - ②$$

$$V_S = I_D R_S$$

$$V_{GS} = V_G - V_S = V_G - I_D R_S - - - ①$$

①代入②解二次方程式後可得I_D'

將I_D'代入①中做驗證，$V_{GS} > V_{TN}$求得I_D、V_{GS}

C. 驗證

$V_{GS} > V_{TN}$

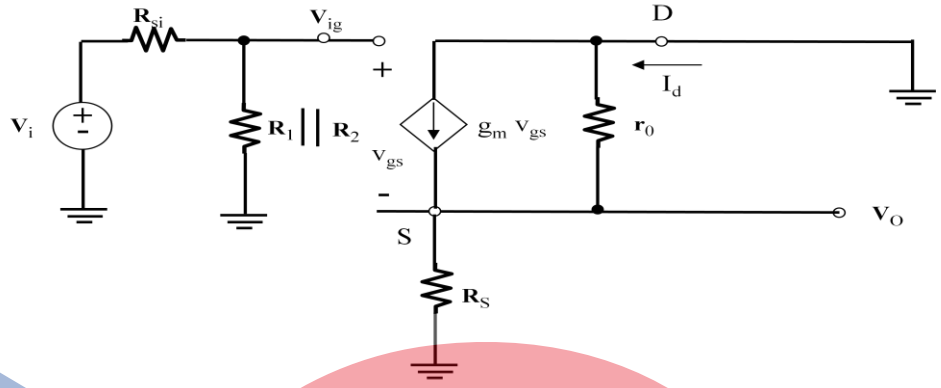
$V_{DS} > V_{DS(SAT)} = V_{GS} - V_{TN}$

2. 步驟(二)AC 分析

A. 畫等效電路圖

求戴維寧等效電路

$R_{TH} = R_1 \parallel R_2$



B. 計算參數

$g_m = 2\sqrt{k_n I_D}$

$r_o = (\lambda I_D)^{-1}$

C. 求A_V、R_{in}、R_{out}

$v_O = g_m v_{gs}(r_o \parallel R_S) - - - ①$

$v_{ig} = \frac{R_{TH}}{R_{TH} + R_{si}} v_i$

$v_{ig} - v_{gs} = v_o$

$v_{gs} = \frac{R_{TH}}{R_{TH} + R_{si}} v_i - v_o - - - ②$

由②代入① $v_O = g_m \left[\frac{R_{TH}}{R_{TH}+R_{si}} v_i - v_o\right](r_o \parallel R_S)$

$v_O = g_m \frac{R_{TH}}{R_{TH} + R_{si}} v_i (r_o \parallel R_S) - g_m v_o (r_o \parallel R_S)$

$[1 + g_m(r_o \parallel R_S)]\, v_o = g_m \frac{R_{TH}}{R_{TH}+R_{si}} v_i (r_o \parallel R_S)$

可得$A_V = \frac{v_O}{v_i} = \frac{-g_m \frac{R_{TH}}{R_{TH}+R_{si}}}{1+g_m(r_o \parallel R_S)} (r_o \parallel R_S)$

$R_{in} = R_{TH} = R_1 \parallel R_2$

$R_{out} = \frac{r_o \parallel R_S}{1 + g_m(r_o \parallel R_S)}$