Elektronik I

MOSFET small signal – küçük işaret modeli ve yükselteç yapıları

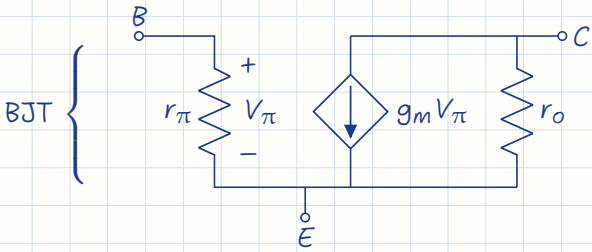
Orijinal not: 0706-Elektronik-1-Mosfet-small-signal.pdf

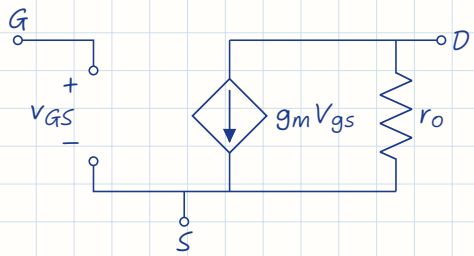
UYARI Bu belge, el yazısı ders notlarından Claude (Anthropic) yardımıyla dijitale aktarılmıştır. Yardımcı kaynak olarak hazırlanmıştır; hata veya eksik içerebilir. Lütfen orijinal notları ve ders kaynaklarını esas alın.

NOTICE *This document was transcribed from handwritten lecture notes with the help of Claude (Anthropic). It is meant as a supplementary resource and may contain errors or omissions. Always check against the original notes and official course material.*

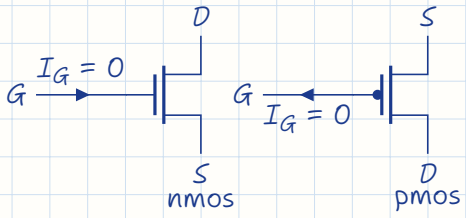
Mosfet small signal

orj. s. 1





$$g_m = \frac{2I_D}{V_{ov}}, \qquad r_o = \frac{V_A}{I_D}$$

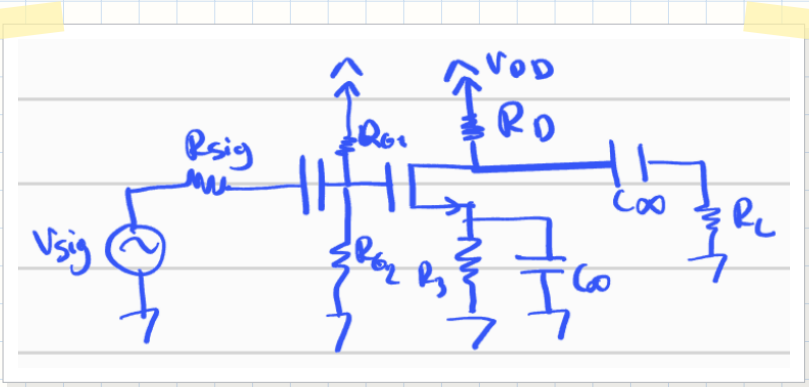


- Common emitter (Source)
- Common emitter with R_E (Source ” R_S)
- Common Collector (Source Follow) (Drain)
- Common Base (Gate)

Base → Gate
Emitter → Source
Collector → Drain

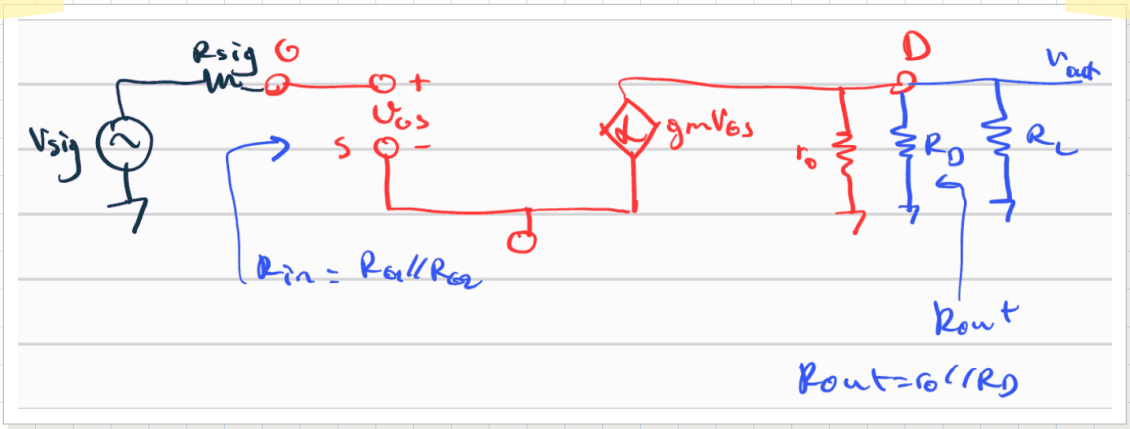
Common source Amplifier

- Voltage Amp (High)
- $R_{in} = \infty$ } Inf
- $R_{out} = r_o \parallel R_D \parallel R_L$ } High
  R_{out} (intrinsic) = r_o



orijinal çizim, s. 1

⇒



orijinal çizim, s. 1

$$R_{in} = R_{G1} \parallel R_{G2} \qquad R_{out} = r_o \parallel R_D$$

orj. s. 2

$$A_v = \frac{v_{out}}{v_{sig}} = \frac{(r_o \parallel R_D \parallel R_L) \times -g_m V_{gs}}{V_{sig}}$$

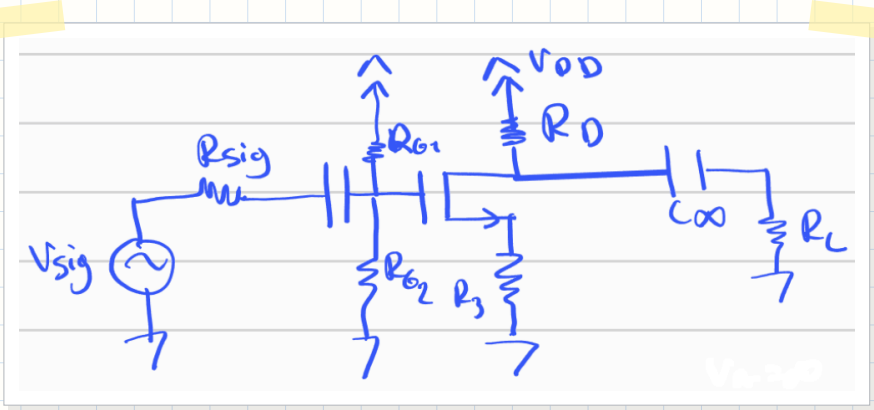
$$V_{gs} = \frac{(R_{G1} \parallel R_{G2})}{(R_{sig} + R_{G1} \parallel R_{G2})} \quad 1$$

$$\hookrightarrow = -(r_o \parallel R_D \parallel R_L)\, g_m \cdot \left(\frac{R_{G1} \parallel R_{G2}}{R_{sig} + R_{G1} \parallel R_{G2}} \right)$$

$$R_{sig} \approx 0 \qquad A_v = -g_m (R_D \parallel R_L \parallel r_o)$$

[1] Claude notu: muhtemelen sağ tarafta bir $\cdot V_{sig}$ çarpanı olmalı.

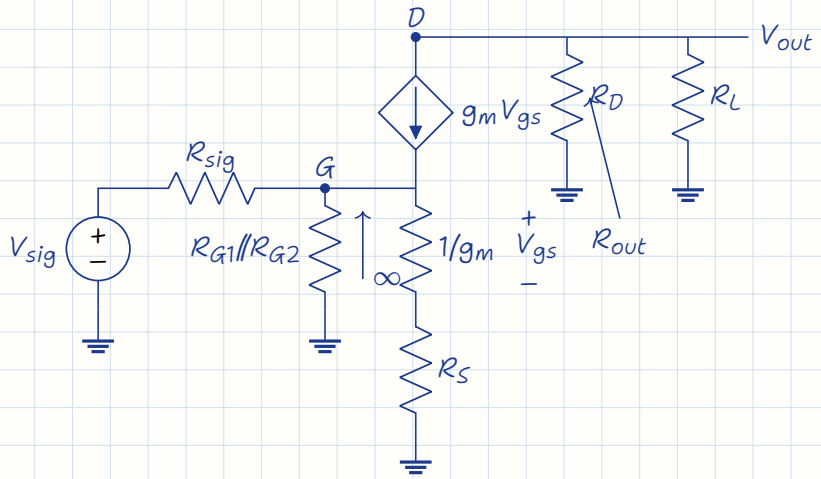
Common Source with R_S



orijinal çizim, s. 2

$V_A = \infty$ Channel length modulation ignore

T model



$$R_{in} = R_{G1} /\!/ R_{G2} /\!/ \infty = R_{G1} /\!/ R_{G2} \qquad A_v = \frac{-(R_o /\!/ R_L)\, g_m V_{gs}}{V_{sig}}$$

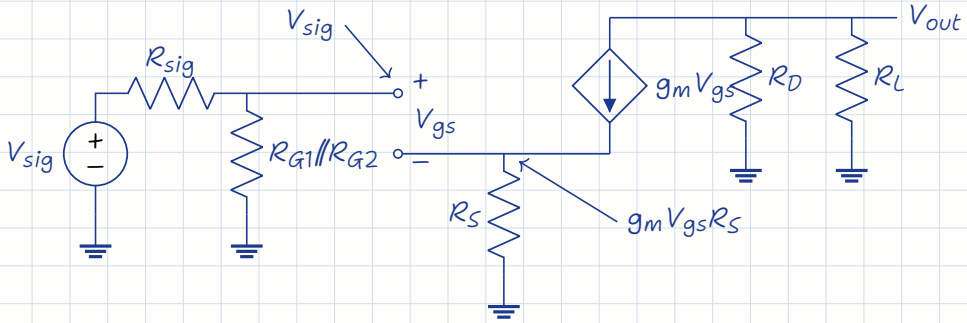
$R_{sig} \approx 0$ ↷

$$V_{sig} = V_{gs} + V_{gs}\, g_m \cdot R_s \qquad \Rightarrow A_v = \frac{-(R_o /\!/ R_L)\, g_m V_{gs}}{V_{sig}}$$

$$V_{sig} = V_{gs}(1 + g_m R_s) \qquad = \frac{-(R_o /\!/ R_L)\, g_m V_{gs}}{V_{gs}(1 + g_m R_s)} \approx A_v = -\frac{(R_o /\!/ R_L)}{R_s}$$

orj. s. 3

π model

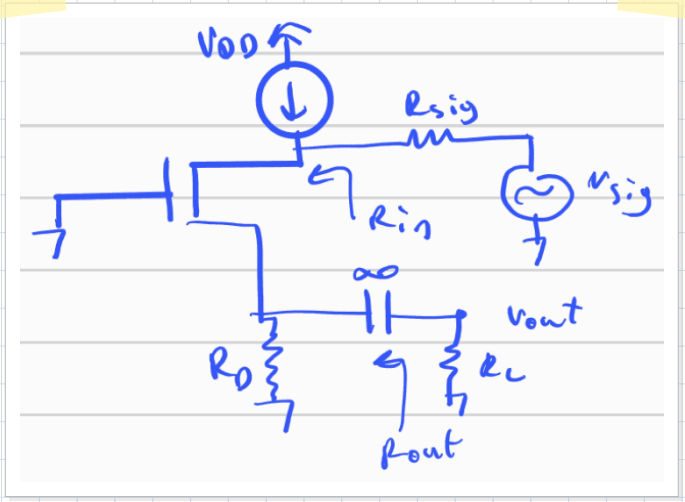


$$V_{sig} = -g_m V_{gs} R_S \quad [2] \qquad A_v = \frac{V_{out}}{V_{sig}} = \frac{-g_m (R_D \parallel R_L) V_{gs}}{(1 + g_m R_S) \cdot V_{gs}}$$

$$V_{sig} = (1 + g_m R_S) V_{gs} \qquad A_v \cong -\frac{R_D \parallel R_L}{R_S} \quad (g_m R_S \gg 1)$$

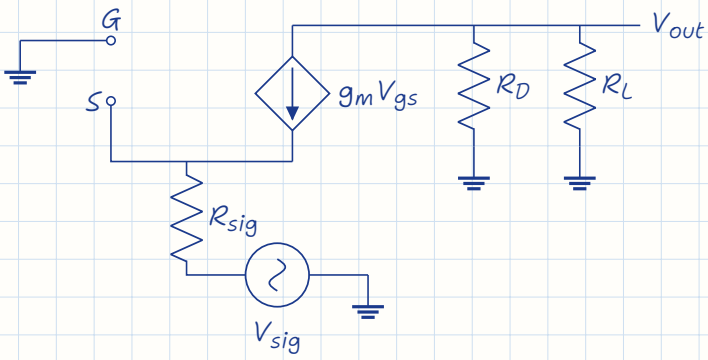
Common-Gate

$V_A = \infty$
$r_o = \infty$



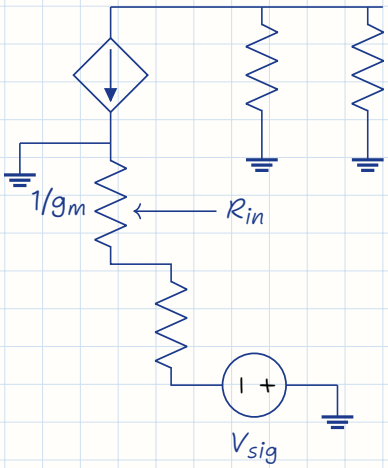
orijinal çizim, s. 3

T model önerilir



T model

[2] Claude notu: muhtemelen $V_{sig} = V_{gs} + g_m V_{gs} R_S$ olmalı (alt satırla tutarlı olan budur).



$R_{in} \cong 1/g_m$ very small $\quad R_{sig} = 0 \Rightarrow V_{sig} = -V_{gs}$

$R_{out} = R_D$ moderate high $\quad V_{out} = -g_m(R_D \parallel R_L)V_{gs}$ } $A_v = g_m(R_D \parallel R_L)$

$A_v \Rightarrow$ high

orj. s. 4

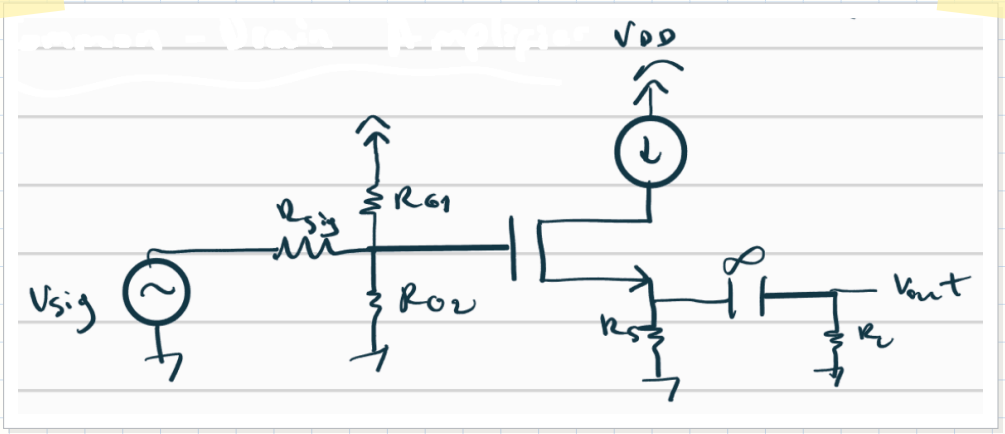
$R_{sig} \neq 0$

$V_{sig} = -g_m V_{gs} R_{sig} - V_{gs}$

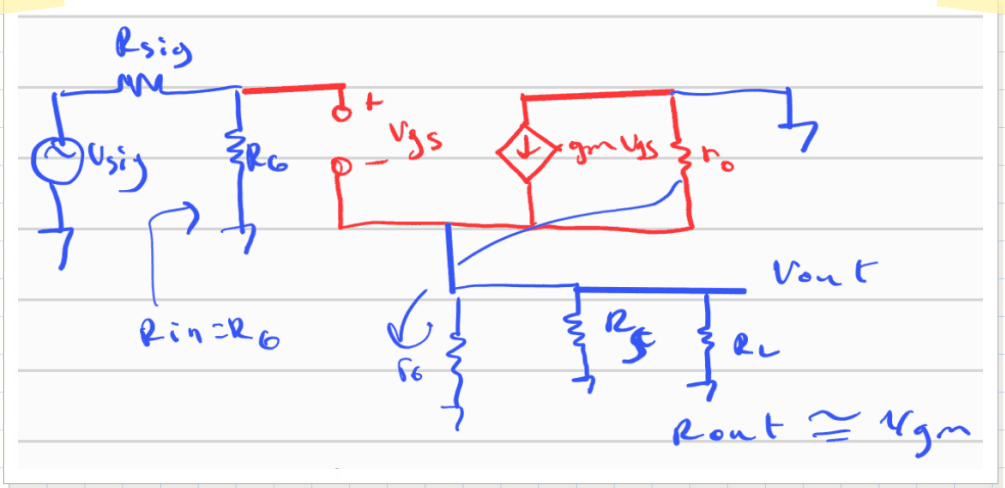
$V_{out} = -g_m (R_D \parallel R_L) \cdot V_{gs}$

$$A_v = \frac{V_{out}}{V_{sig}} =$$

Common-Drain Amplifier (Source follower)



orijinal çizim, s. 4



orijinal çizim, s. 4

$$R_{in} = R_G \qquad R_{out} \cong 1/g_m$$

$$V_{out} = g_m V_{gs} (R_S \parallel R_L \parallel r_o)$$
$$R_{sig} = 0$$
$$V_{gs} = V_{sig} - g_m V_{gs} (r_o \parallel R_L \parallel R_S)$$
$$V_{sig} = V_{gs} (1 + g_m (r_o \parallel R_L \parallel R_S))$$

$$\Rightarrow A_v = \frac{g_m V_{gs} (R'_L)}{1 + g_m V_{gs} (R'_L)} < 1$$ [3]

[3] Claude notu: V_{gs}'ler sadeleşince muhtemelen $A_v = \frac{g_m R'_L}{1 + g_m R'_L}$ olmalı.