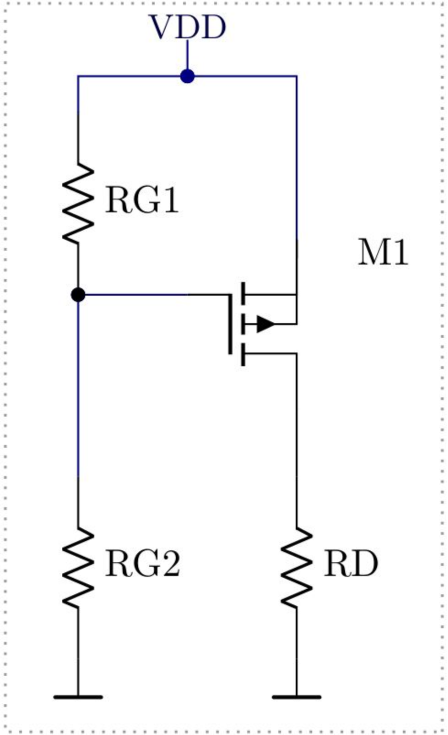
[86.03/66.25] Dispositivos Semiconductores
1er Cuatrimestre 2020

Transistor MOS

1. Polarización
2. Modelo de Pequeña Señal

Enunciado



Para el circuito de la figura y los siguientes datos:

- $|V_T| = 0.8$ V, $\mu_P C'_{ox} = 80\ \mu A/V^2$
- W = 32 µm, L = 4 µm, $\lambda = 0.02\ V^{-1}$, $\gamma^2 = 0.5$ V
- $R_{G1} = 130$ kΩ, $R_{G2} = 370$ kΩ $R_D = 18$kΩ, $V_{DD} = 5$ V

hallar

1. El punto de polarización
2. El modelo de pequeña señal
3. La variación de corriente de Drain al variar 1 mV la v_{gs}

Enunciado

Datos

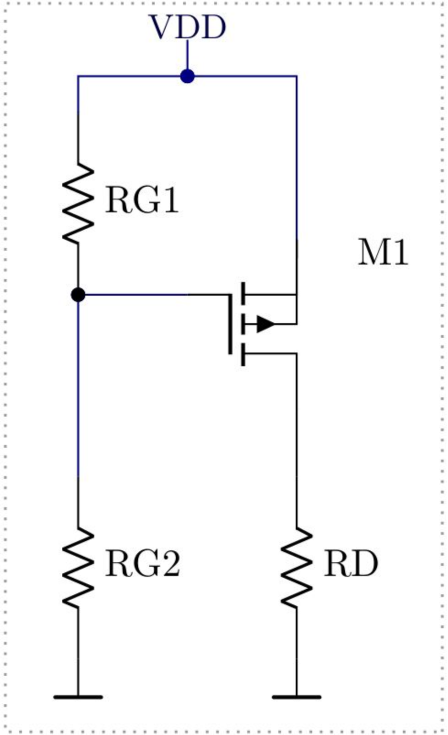
$|V_T| = 0.8$ V, $\mu_P C'_{ox} = 80$ μA/V^2

W = 32 μm, L = 4 μm

$\lambda = 0.02$ V^{-1}, $\gamma^2 = 0.5$ V

$R_{G1} = 130$ kΩ, $R_{G2} = 370$ kΩ

$R_D = 18$kΩ, $V_{DD} = 5$ V



Para el circuito de la figura y los siguientes datos:

- $|V_T| = 0.8$ V, $\mu_P C'_{ox} = 80$ μA/V^2
- W = 32 μm, L = 4 μm, $\lambda = 0.02$ V^{-1}, $\gamma^2 = 0.5$ V
- $R_{G1} = 130$ kΩ, $R_{G2} = 370$ kΩ $R_D = 18$kΩ, $V_{DD} = 5$ V

hallar

1. El punto de polarización
2. El modelo de pequeña señal
3. La variación de corriente de Drain al variar 1 mV la v_{gs}

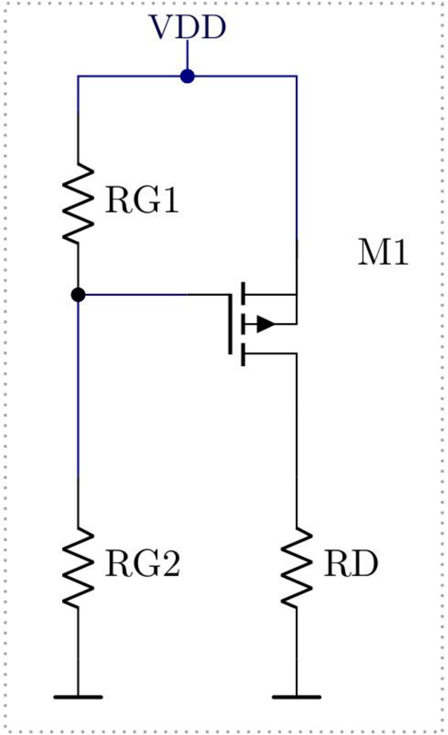
La polarización la la calculamos

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

Enunciado



Para el circuito de la figura y los siguientes datos:

- $|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
- W = 32 μm, L = 4 μm, λ = 0.02 V^{-1}, γ^2 = 0.5 V
- R_{G1} = 130 kΩ, R_{G2} = 370 kΩ R_D = 18kΩ, V_{DD} = 5 V

hallar

1. **El punto de polarización**
2. El modelo de pequeña señal
3. La variación de corriente de Drain al variar 1 mV la v_{gs}

V_{GS} = -1.3 V

I_D = -85.5 μA

V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2

I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos

$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2

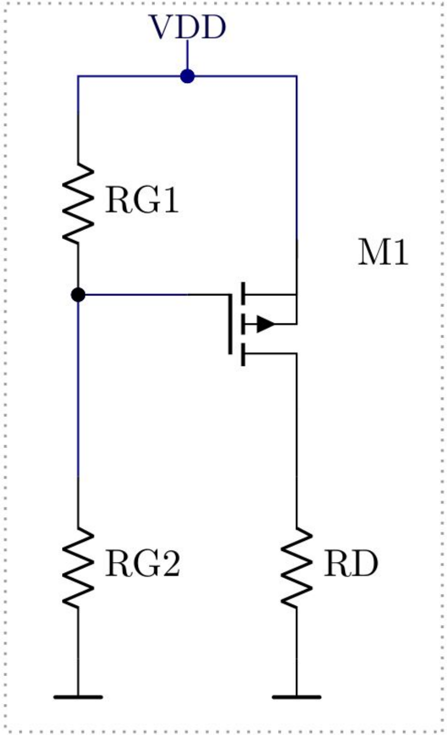
W = 32 μm, L = 4 μm

λ = 0.02 V^{-1}, γ^2 = 0.5 V

R_{G1} = 130 kΩ, R_{G2} = 370 kΩ

R_D = 18kΩ, V_{DD} = 5 V

Enunciado



Para el circuito de la figura y los siguientes datos:

- $|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
- W = 32 μm, L = 4 μm, λ = 0.02 V^{-1}, γ^2 = 0.5 V
- R_{G1} = 130 kΩ, R_{G2} = 370 kΩ R_D = 18kΩ, V_{DD} = 5 V

hallar

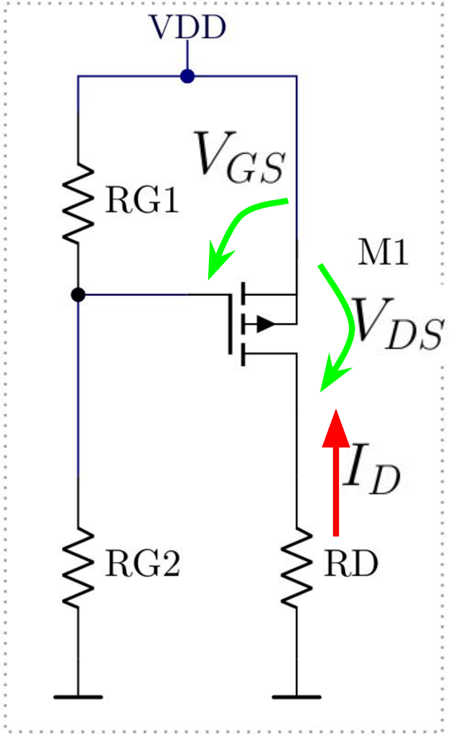
1. El punto de polarización
2. **El modelo de pequeña señal**
3. La variación de corriente de Drain al variar 1 mV la v_{gs}

2. Mod. de Pequeña Señal

V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



<u>Utilizamos 2 modelos de pequeña señal:</u>

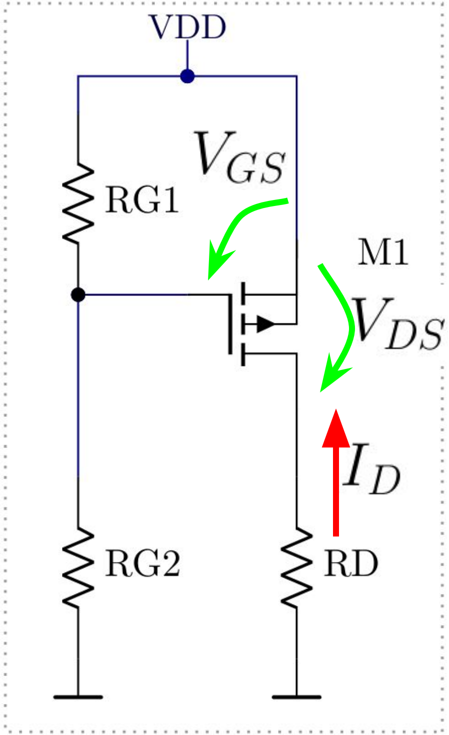
- Uno para **frecuencias bajas o medias**
- Otro para **frecuencias altas**: Se agregan las capacidades.

2. Mod. de Pequeña Señal

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



<u>Utilizamos 2 modelos de pequeña señal:</u>

- Uno para **frecuencias bajas o medias**
- Otro para **frecuencias altas**: Se agregan las capacidades.

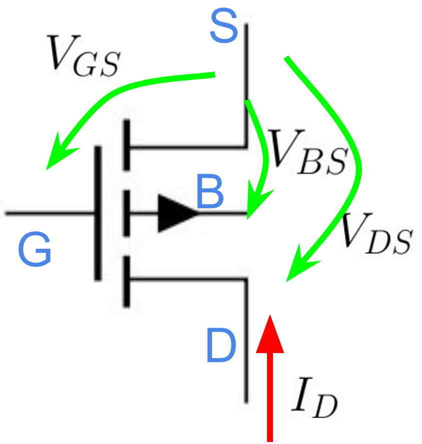
Una vez tenemos que tenemos el punto de trabajo, el MPS es independiente del circuito externo.

2. Mod. de Pequeña Señal

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



<u>Utilizamos 2 modelos de pequeña señal:</u>

- Uno para **frecuencias bajas o medias**
- Otro para **frecuencias altas**: Se agregan las capacidades.

Una vez tenemos que tenemos el punto de trabajo, el MPS es independiente del circuito externo.

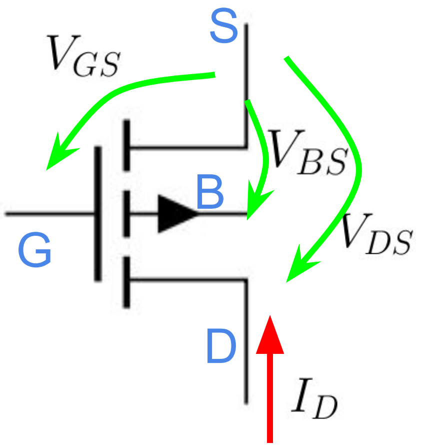
2. Mod. de Pequeña Señal

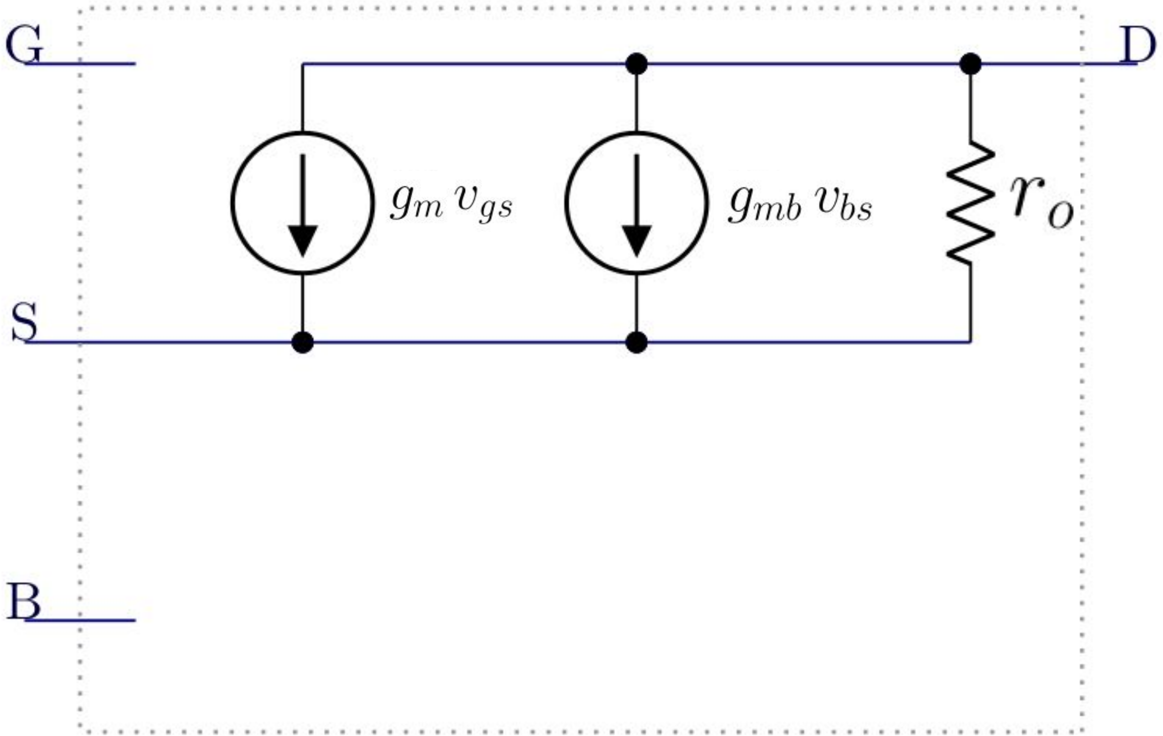
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

Para frecuencias bajas/medias





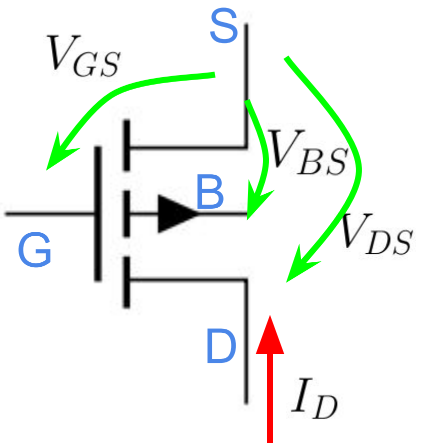
2. Mod. de Pequeña Señal

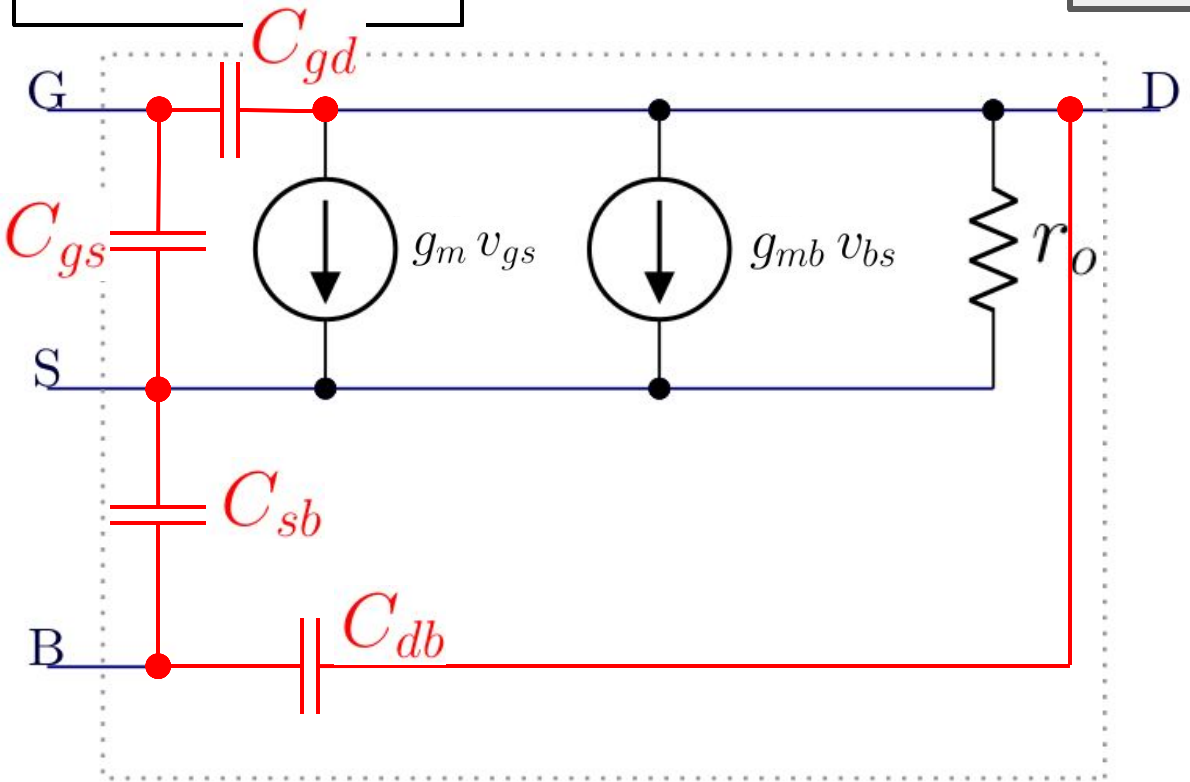
V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

Para frecuencias altas



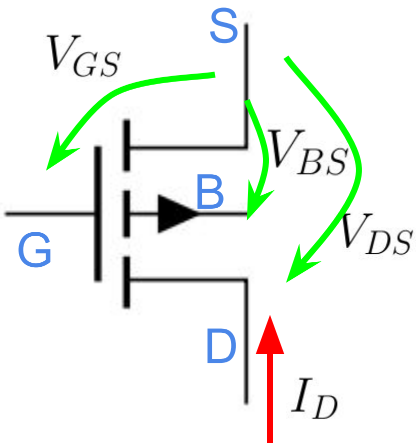


2. Mod. de Pequeña Señal

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Para frecuencias bajas/medias

g_m

g_{mb}

g_o

Para frecuencias altas

C_{gd}

C_{gs}

C_{sb}

C_{db}

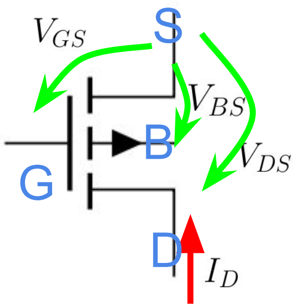
2. Mod. de Pequeña Señal

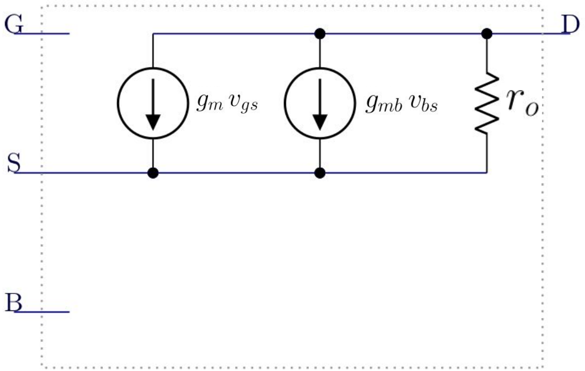
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





2. Mod. de Pequeña Señal

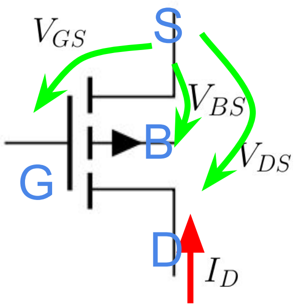
Para frecuencias bajas/medias

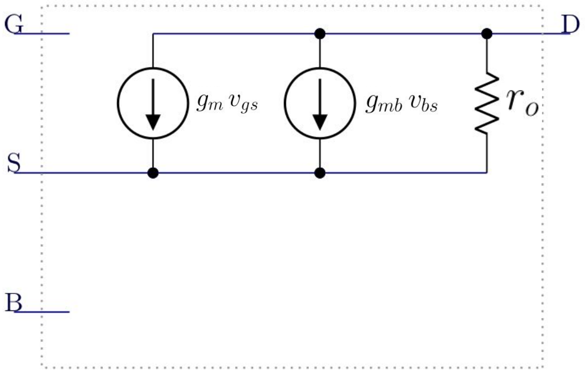
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-sat}}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$





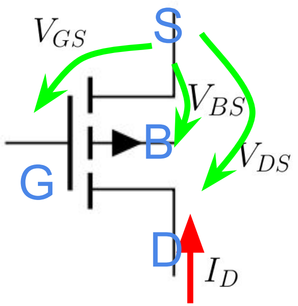
2. Mod. de Pequeña Señal

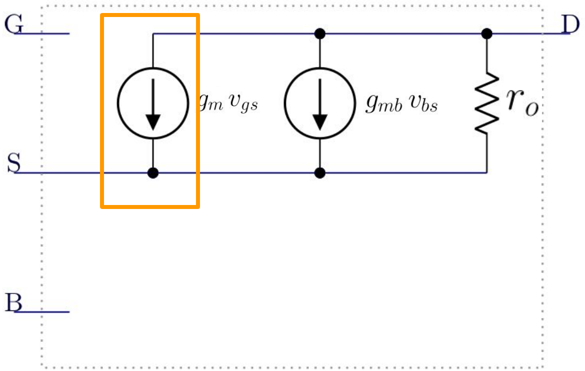
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$

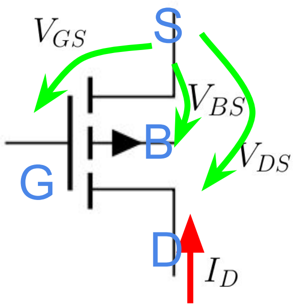
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

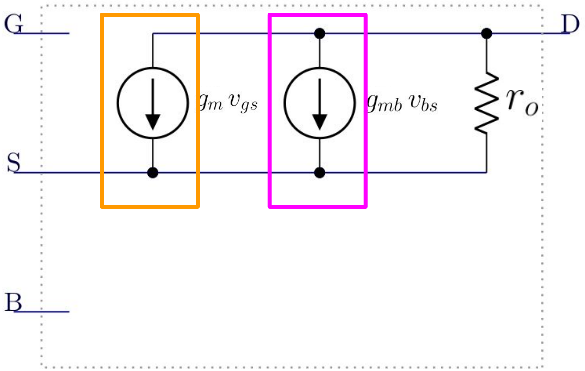
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$



$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$

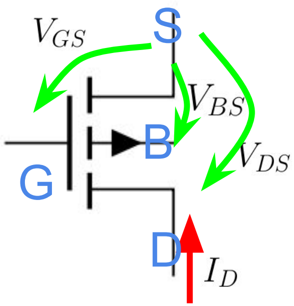
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

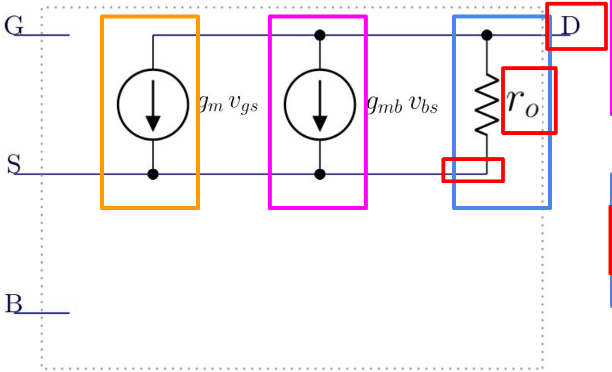


$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$



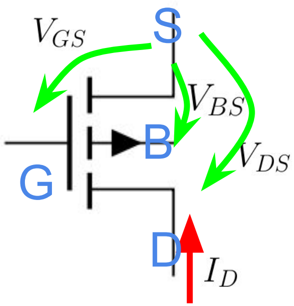
2. Mod. de Pequeña Señal

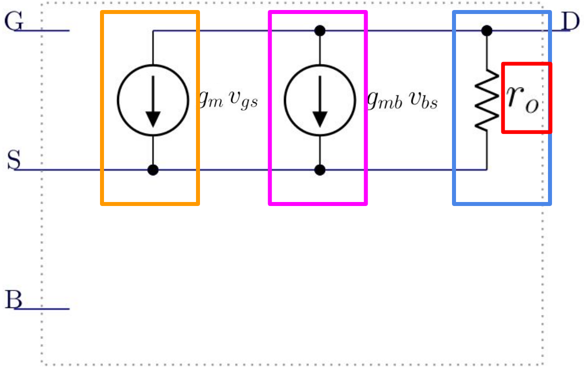
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$

$$r_0 = \frac{1}{g_0}$$

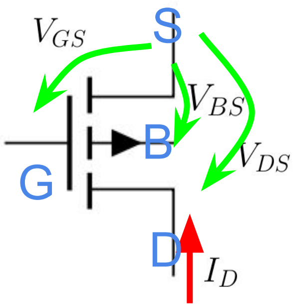
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

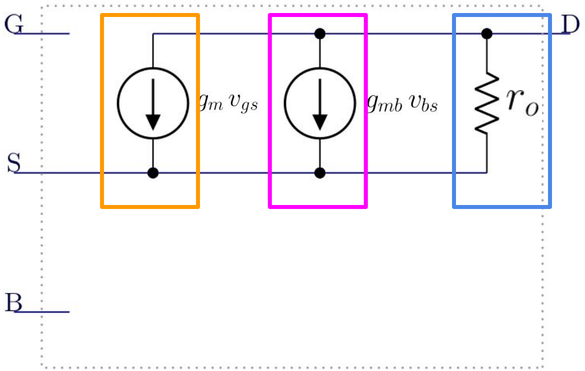
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-sat}}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$



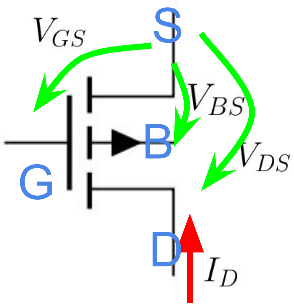
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

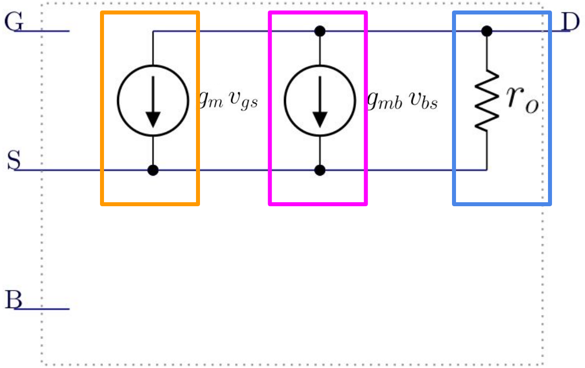
<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$

$$g_m = -2\,k\,(V_{GS} - V_T)\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$



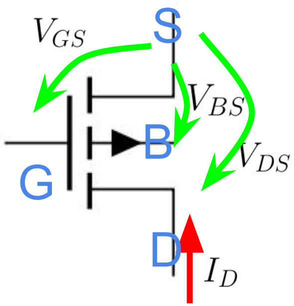
2. Mod. de Pequeña Señal

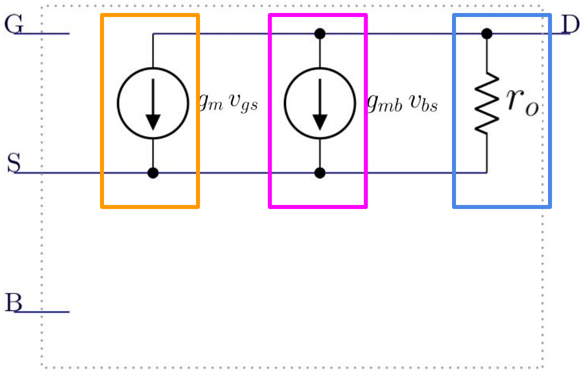
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$

$$g_m = -2\,k\,\underbrace{(V_{GS} - V_T)}_{-\sqrt{\frac{-I_{D\text{-sat}}}{k}}}\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

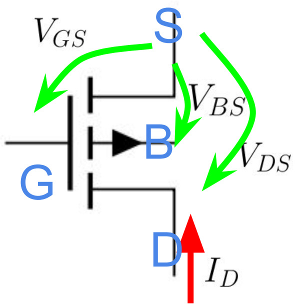
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

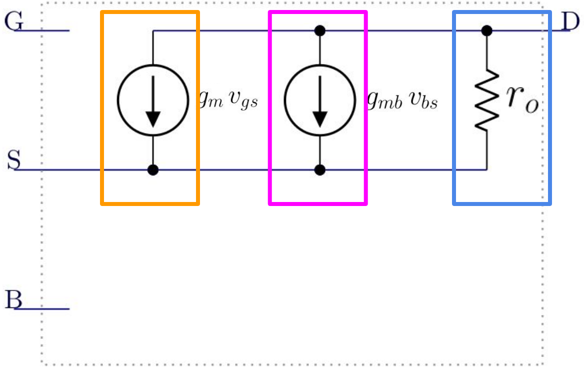
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$



$$g_m = -2\,k\,\underbrace{(V_{GS} - V_T)}_{-\sqrt{\frac{-I_{D\text{-sat}}}{k}}}\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = 2\sqrt{-k\,I_{D\text{-sat}}}\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

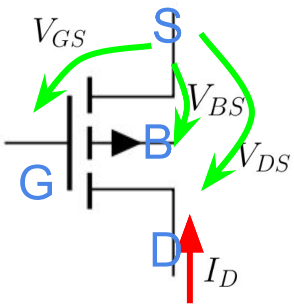
2. Mod. de Pequeña Señal

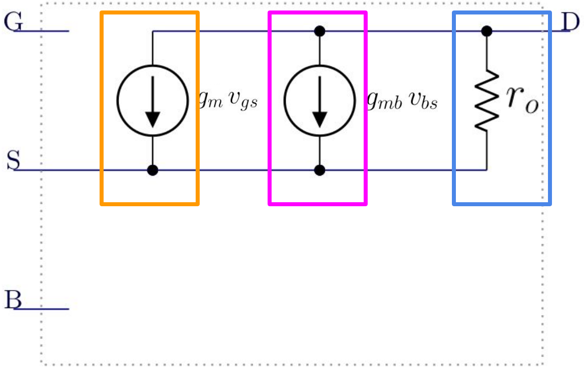
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$

$$g_m = -2\,k\,\underbrace{(V_{GS} - V_T)}_{-\sqrt{\frac{-I_{D\text{-sat}}}{k}}}\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = 2\sqrt{-k\,I_{D\text{-sat}}}\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m \approx 2\sqrt{-k\,I_{D\text{-sat}}}$$

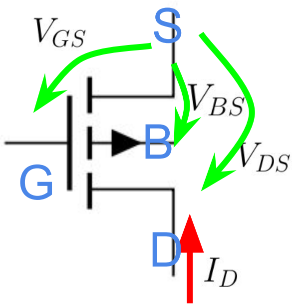
2. Mod. de Pequeña Señal

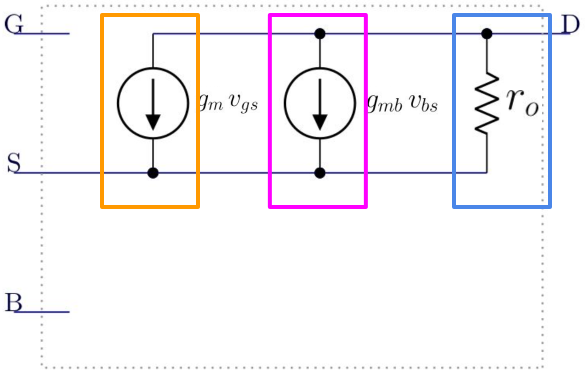
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q$$

$$g_m = -2\,k\,\underbrace{(V_{GS} - V_T)}_{-\sqrt{\frac{-I_{D\text{-sat}}}{k}}}\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m = 2\sqrt{-k\,I_{D\text{-sat}}}\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_m \approx 2\sqrt{-k\,I_{D\text{-sat}}}$$

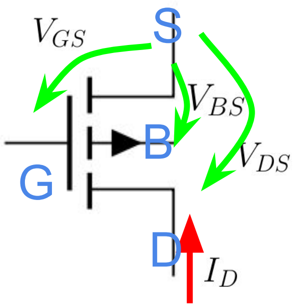
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

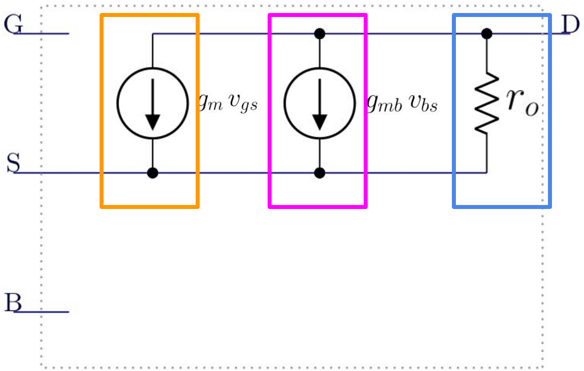
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$



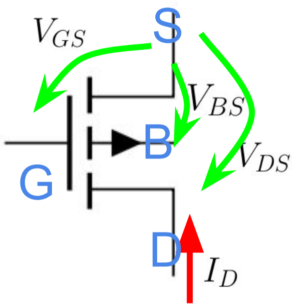
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

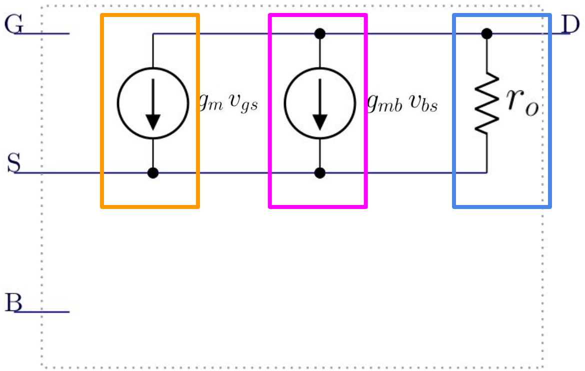
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$



$$g_{mb} = \underbrace{-2\,k\,(V_{GS} - V_T)\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]}_{g_m}\left.\left(-\frac{\partial V_T}{\partial V_{BS}}\right)\right|_Q$$

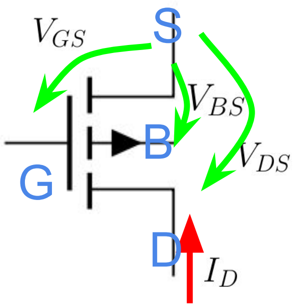
2. Mod. de Pequeña Señal

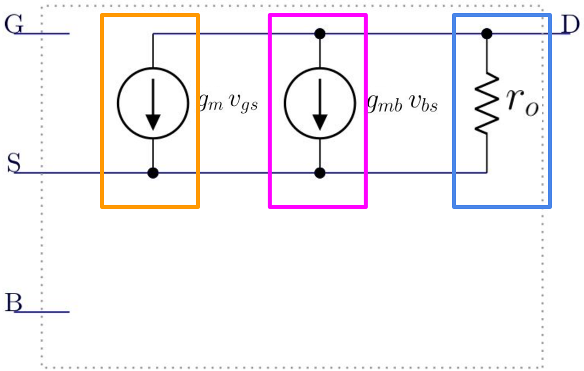
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$

$$g_{mb} = \underbrace{-2\,k\,(V_{GS} - V_T)\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]}_{g_m}\left.\left(-\frac{\partial V_T}{\partial V_{BS}}\right)\right|_Q$$

$$V_T = V_{T0} - \gamma(\sqrt{2\,\phi_n + V_{BS}} - \sqrt{2\,\phi_N})$$

$$\frac{\partial V_T}{\partial V_{BS}} = -\frac{\gamma}{2}\frac{1}{\sqrt{2\phi_n + V_{BS}}}$$

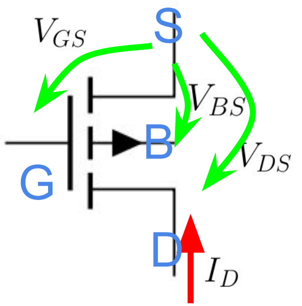
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

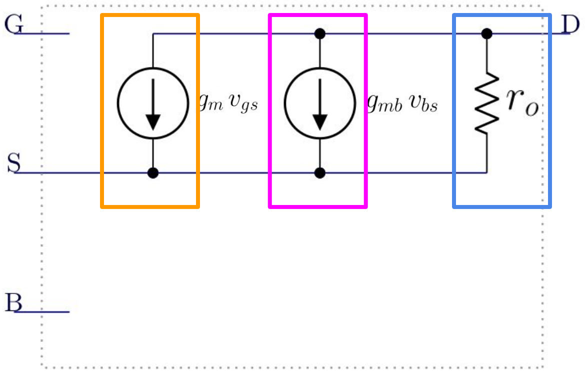
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
|V_T| = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$



$$g_{mb} = \underbrace{-2\,k\,(V_{GS} - V_T)\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]}_{g_m}\left.\left(-\frac{\partial V_T}{\partial V_{BS}}\right)\right|_Q$$

$$V_T = V_{T0} - \gamma(\sqrt{2\,\phi_n + V_{BS}} - \sqrt{2\,\phi_N})$$

$$\frac{\partial V_T}{\partial V_{BS}} = -\frac{\gamma}{2}\frac{1}{\sqrt{2\phi_n + V_{BS}}}$$

$$g_{mb} = g_m\,\frac{\gamma}{\sqrt{2\phi_n + V_{BS}}}$$

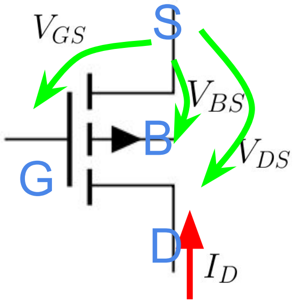
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

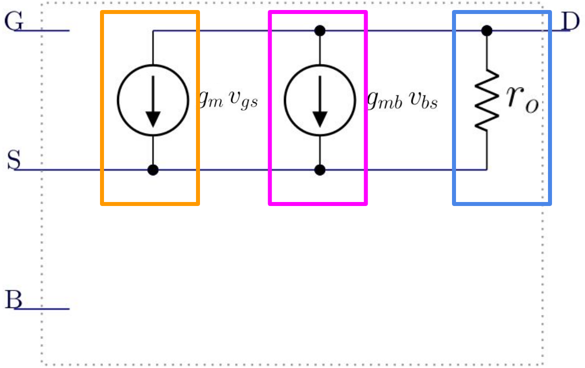
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q$$



$$g_{mb} = \underbrace{-2\,k\,(V_{GS} - V_T)\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]}_{g_m}\left.\left(-\frac{\partial V_T}{\partial V_{BS}}\right)\right|_Q$$

$$V_T = V_{T0} - \gamma\left(\sqrt{2\,\phi_n + V_{BS}} - \sqrt{2\,\phi_N}\right)$$

$$\frac{\partial V_T}{\partial V_{BS}} = -\frac{\gamma}{2}\frac{1}{\sqrt{2\phi_n + V_{BS}}}$$

$$g_{mb} = g_m\,\frac{\gamma}{\sqrt{2\phi_n + V_{BS}}}$$

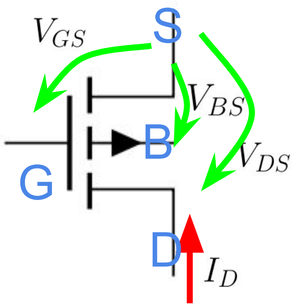
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

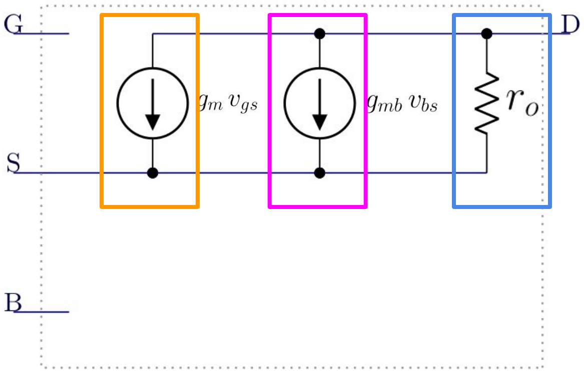
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\left(V_{GS} - V_T\right)^2\left[1 - \lambda(V_{DS} - V_{DS\text{-sat}})\right]$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$



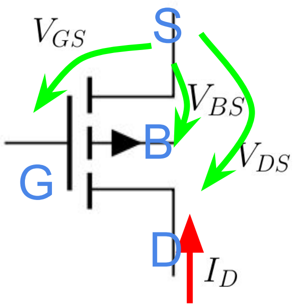
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

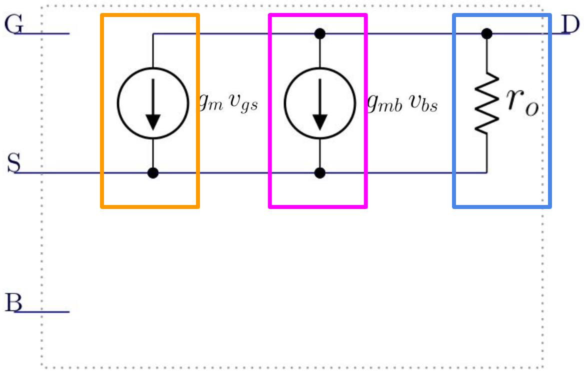
<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$

$$g_0 = -k\,(V_{GS} - V_T)^2\,(-\lambda)$$



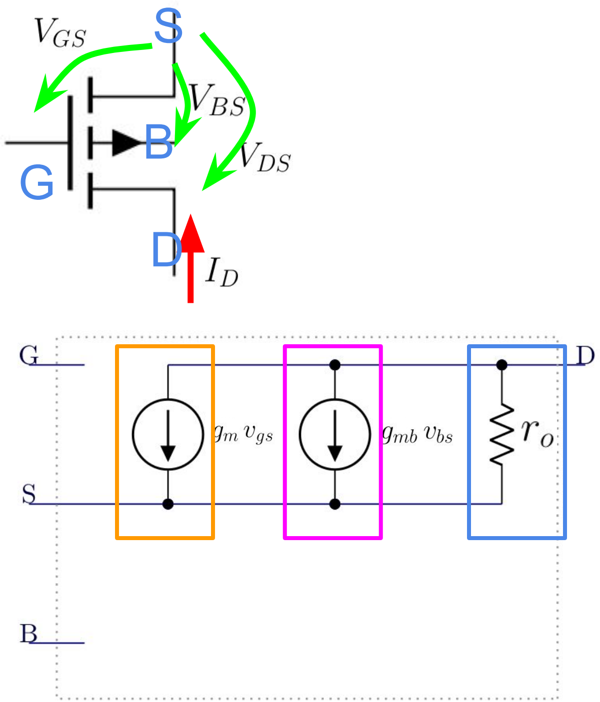
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$

$$g_0 = -k\,(V_{GS} - V_T)^2(-\lambda)$$

$$g_0 = -\lambda\, I_{D\text{-sat}}$$

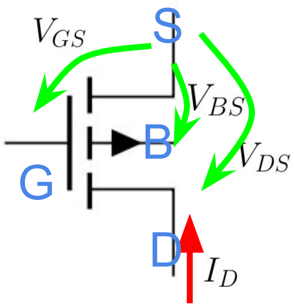
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

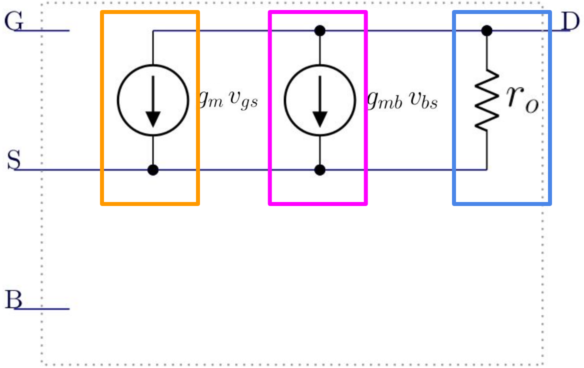
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-sat}}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$



$$g_0 = -k\,(V_{GS} - V_T)^2\,(-\lambda)$$

$$g_0 = -\lambda\,I_{D\text{-sat}}$$

$$r_0 = \frac{1}{g_0}$$

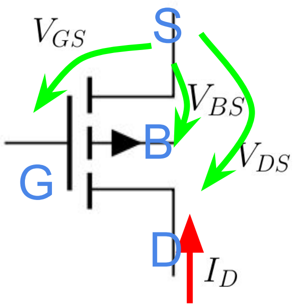
2. Mod. de Pequeña Señal

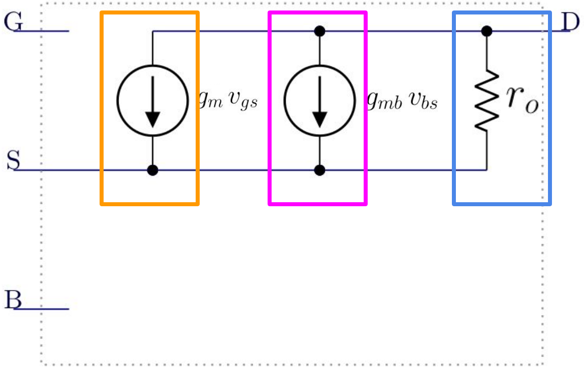
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-sat}}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$I_D = -k\,(V_{GS} - V_T)^2\,[1 - \lambda(V_{DS} - V_{DS\text{-sat}})]$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q$$

$$g_0 = -k\,(V_{GS} - V_T)^2\,(-\lambda)$$

$$g_0 = -\lambda\, I_{D\text{-sat}}$$

$$r_0 = \frac{1}{g_0}$$

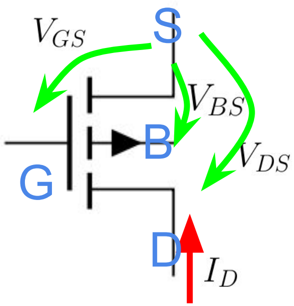
2. Mod. de Pequeña Señal

Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

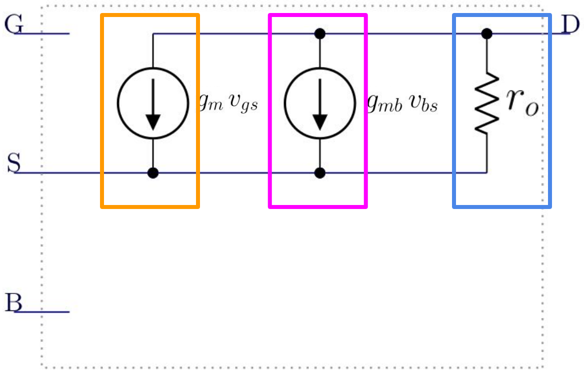
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q = 2\sqrt{-k\,I_{D\text{-sat}}}\,[1 - \lambda(V_{DS} - V_{DS-sat})$$

$$\approx 2\sqrt{-k\,I_{D\text{-sat}}}$$



$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q = g_m \frac{\gamma}{\sqrt{2\phi_n + V_{BS}}}$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q = -\lambda\,I_{D\text{-sat}}$$

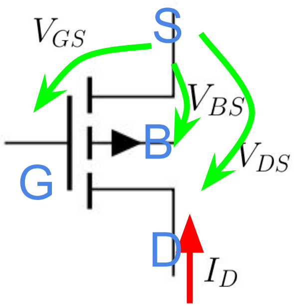
2. Mod. de Pequeña Señal

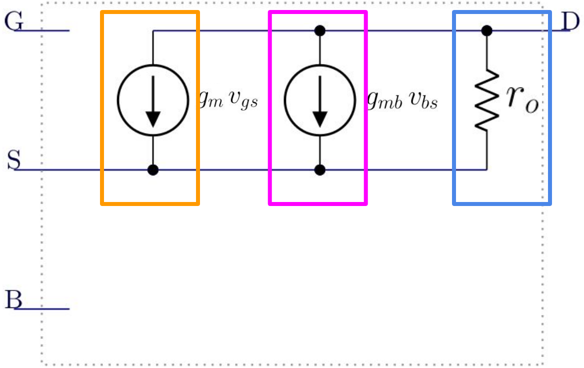
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q = 2\sqrt{-k\, I_{D\text{-sat}}}\,[1 - \lambda(V_{DS} - V_{DS-sat})$$

$$= 339\,\mu\text{A/V}$$

$$\approx 2\sqrt{-k\, I_{D\text{-sat}}} = 320\,\mu\text{A/V}$$

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q = g_m \frac{\gamma}{\sqrt{2\phi_n + V_{BS}}} = 293\,\mu\text{A/V}$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q = -\lambda\, I_{D\text{-sat}} = 1.6\,\mu\text{A/V} \rightarrow r_o = 625\,\text{k}\Omega$$

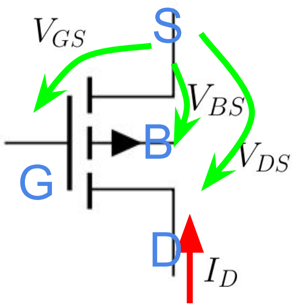
2. Mod. de Pequeña Señal

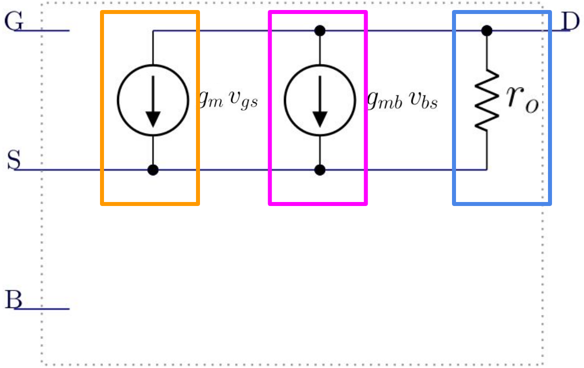
Para frecuencias bajas/medias

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_Q = 2\sqrt{-k\, I_{D\text{-sat}}}\,[1 - \lambda(V_{DS} - V_{DS-sat})$$

$$= 339\,\mu\text{A/V}$$

$$\approx 2\sqrt{-k\, I_{D\text{-sat}}} = 320\,\mu\text{A/V}$$

No tengo lo datos, así que tomo $N_D = 10^{15}\text{cm}^{-3}$ Tal que ϕ_n = 279.9 mV

$$g_{mb} = \left.\frac{\partial I_D}{\partial V_{BS}}\right|_Q = g_m \frac{\gamma}{\sqrt{2\phi_n + V_{BS}}} = 293\,\mu\text{A/V}$$

$$g_o = \left.\frac{\partial I_D}{\partial V_{DS}}\right|_Q = -\lambda\, I_{D\text{-sat}} = 1.6\,\mu\text{A/V} \rightarrow r_o = 625\,\text{k}\Omega$$

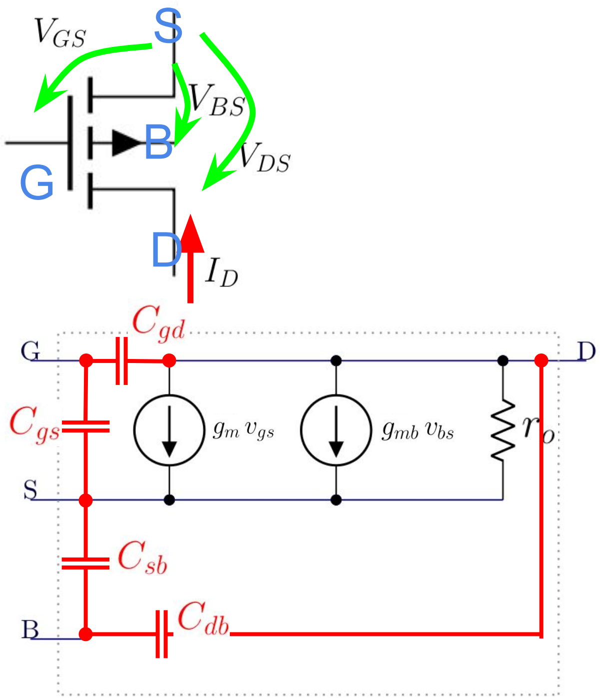
2. Mod. de Pequeña Señal

Para frecuencias altas

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



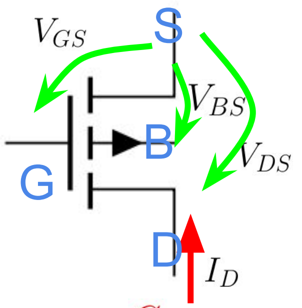
2. Mod. de Pequeña Señal

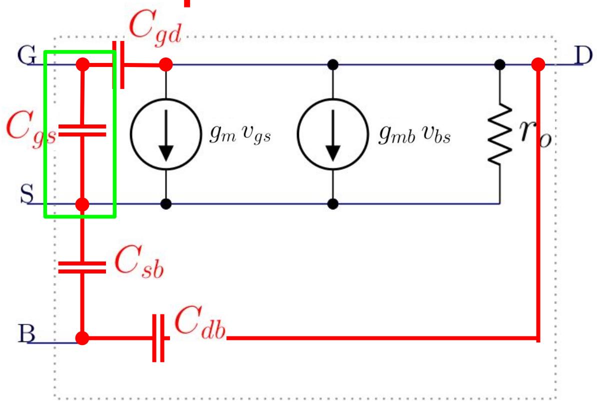
Para frecuencias altas

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q$$

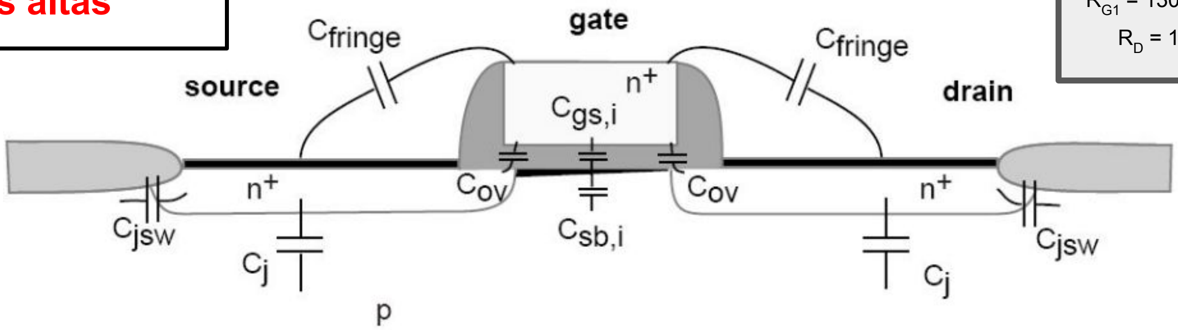
2. Mod. de Pequeña Señal

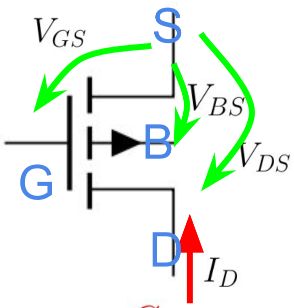
Para frecuencias altas

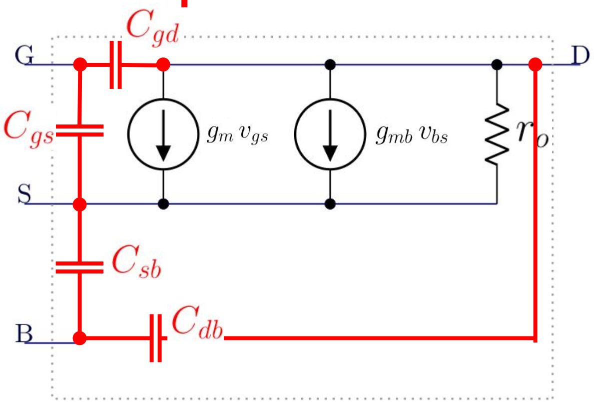
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-sat}}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V







$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q$$

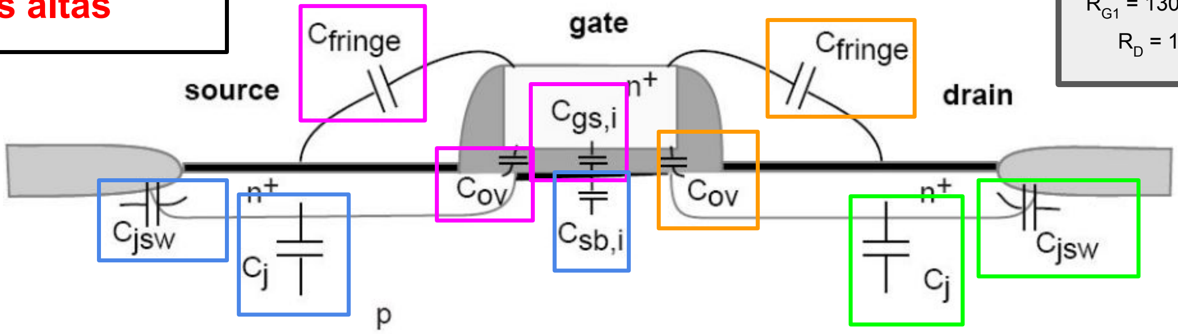
2. Mod. de Pequeña Señal

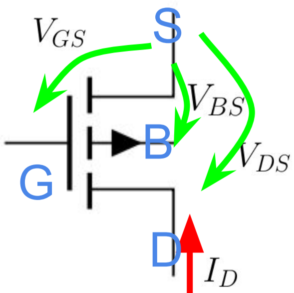
Para frecuencias altas

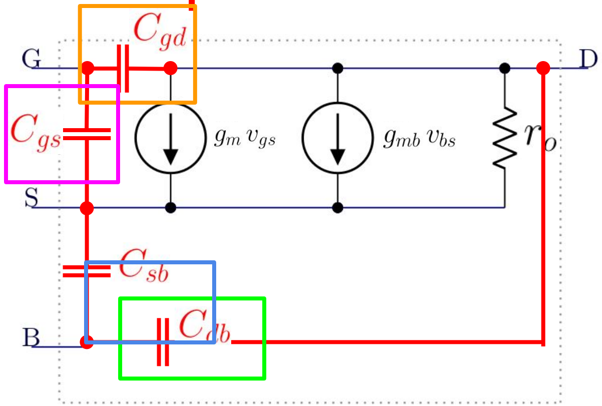
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V







$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q$$

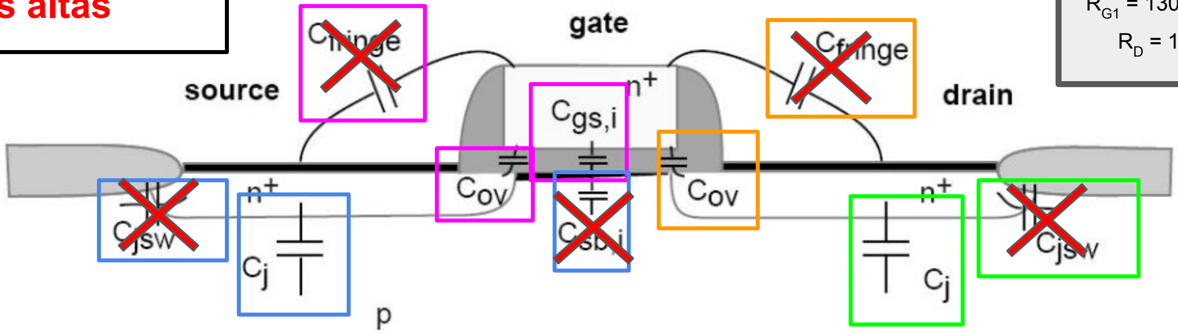
2. Mod. de Pequeña Señal

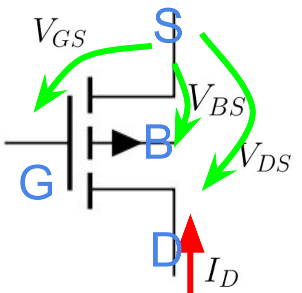
Para frecuencias altas

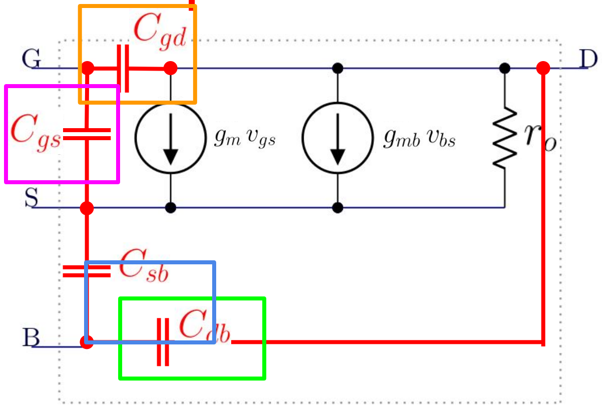
V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 µA/V²
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 µA/V²
W = 32 µm, L = 4 µm
λ = 0.02 V⁻¹, γ² = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V







$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q$$

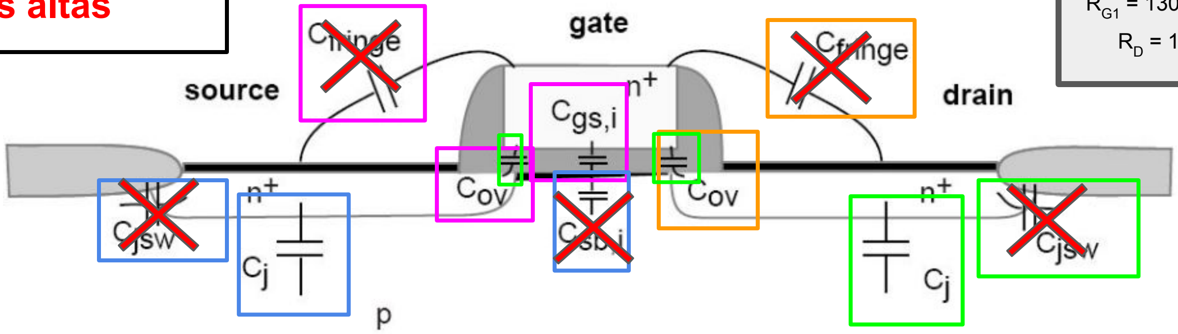
2. Mod. de Pequeña Señal

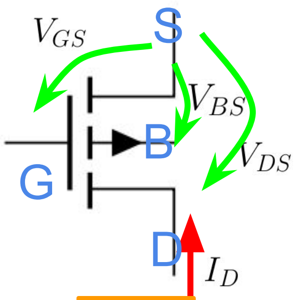
Para frecuencias altas

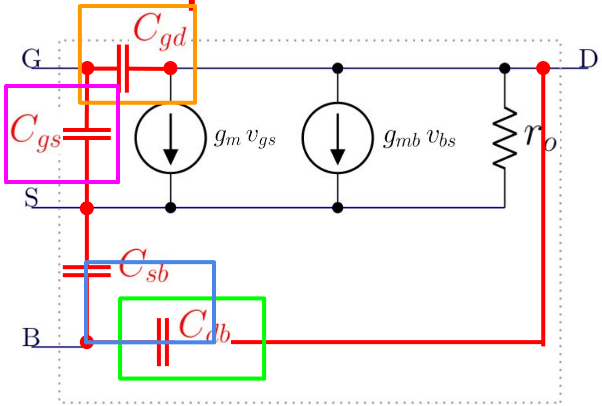
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V







$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q = \frac{2}{3} W\, L\, C'_{ox} + W\, C_{ov}$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q = W\, C_{ov}$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q = C'_j\, A_S$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q = C'_j\, A_D$$

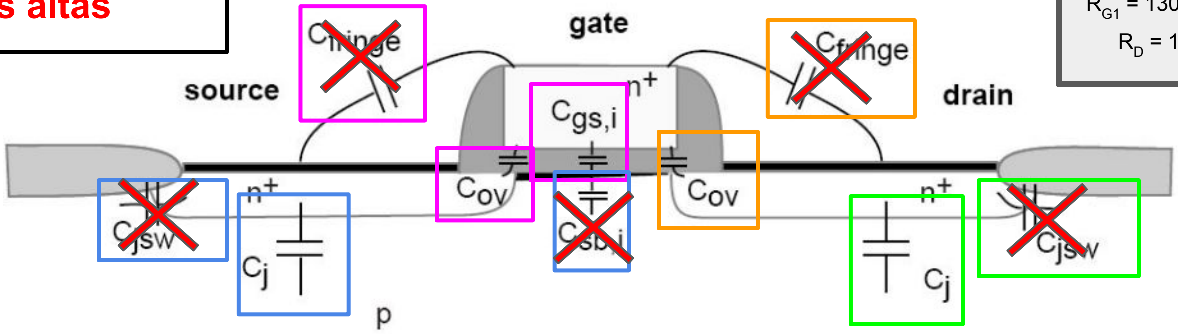
2. Mod. de Pequeña Señal

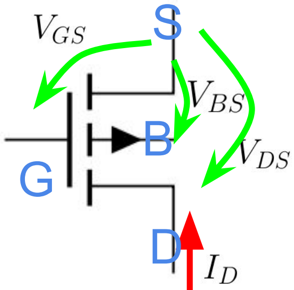
Para frecuencias altas

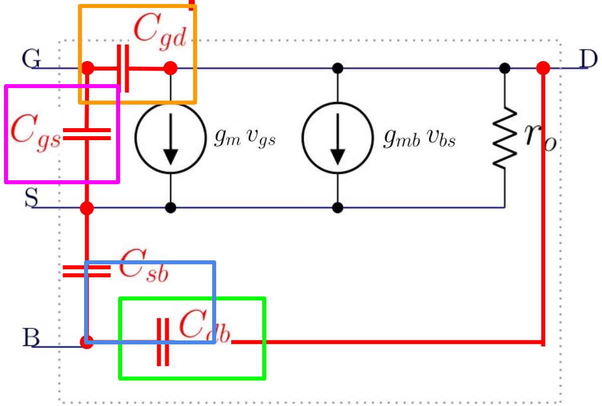
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V







$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q = \frac{2}{3} W\,L\,C'_{ox} + W\,C_{ov}$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q = W\,C_{ov}$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q = C'_j\,A_S$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q = C'_j\,A_D$$

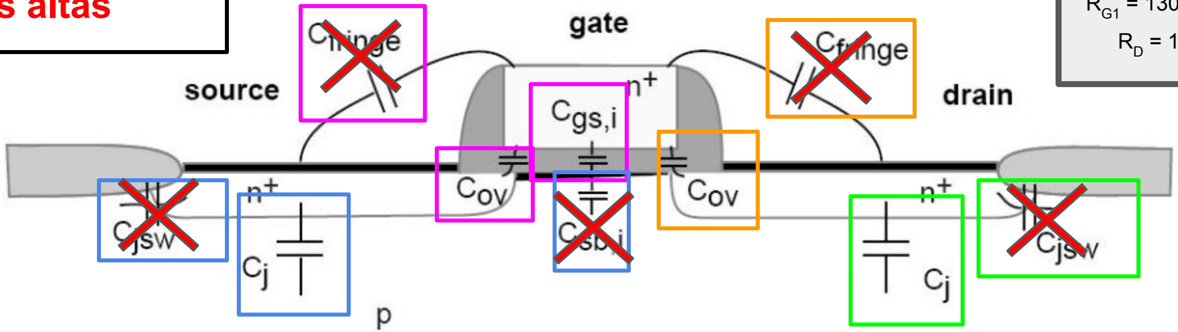
2. Mod. de Pequeña Señal

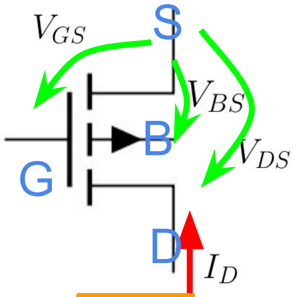
Para frecuencias altas

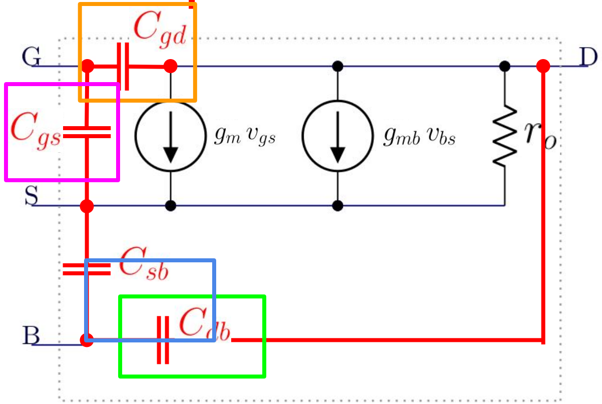
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V







$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q = \frac{2}{3} W L C'_{ox} + W C_{ov}$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q = W C_{ov}$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q = C'_j A_D$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q = C'_j A_S$$

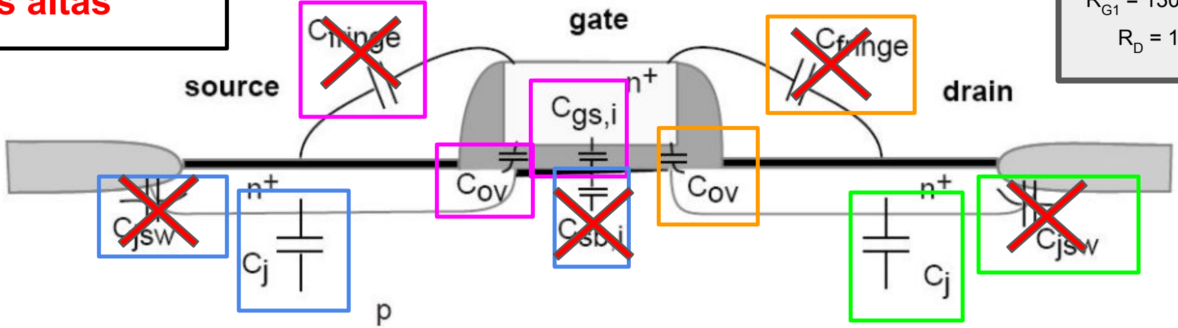
2. Mod. de Pequeña Señal

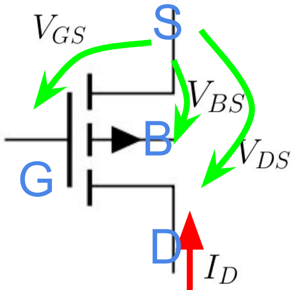
Para frecuencias altas

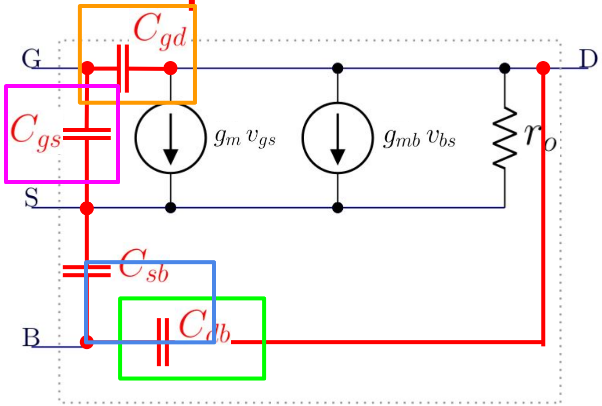
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V







$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q = \tfrac{2}{3} W L C'_{ox} + W C_{ov}$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q = W C_{ov}$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q = C'_j A_D$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q = C'_j A_S$$

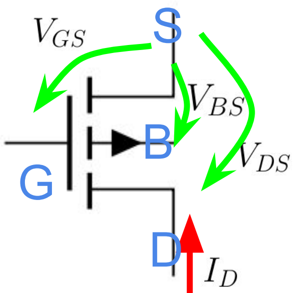
2. Mod. de Pequeña Señal

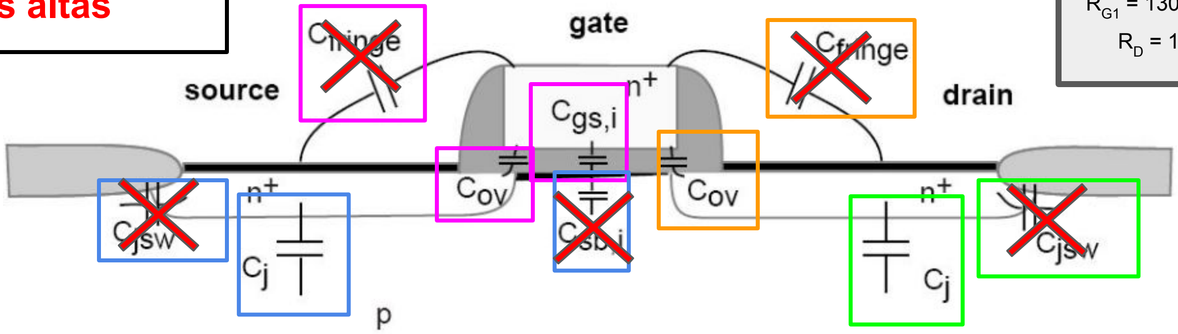
V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

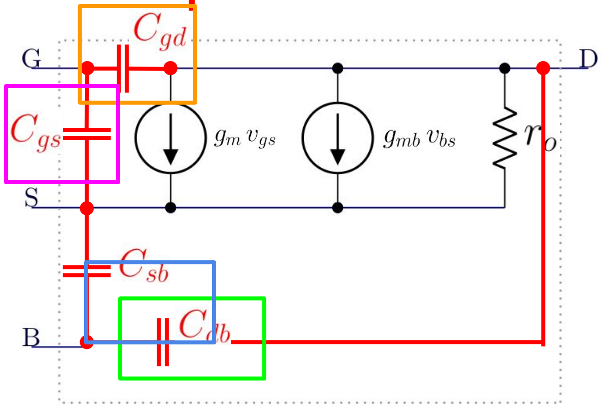
V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, V_{DS-sat} = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

Para frecuencias altas





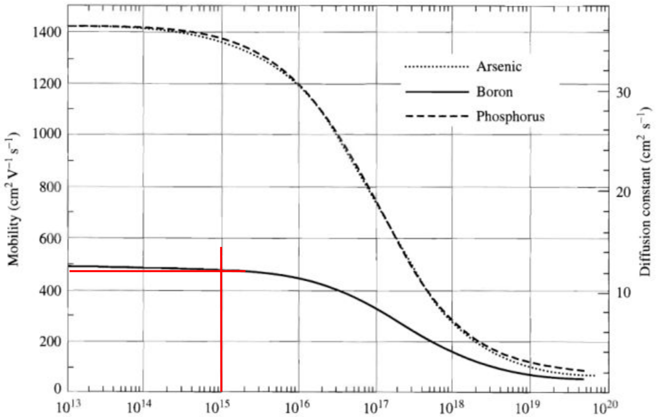


$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q = \frac{2}{3} W L C'_{ox} + W C_{ov}$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q = W C_{ov}$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q = C'_j A_d$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q = C'_j A_s$$



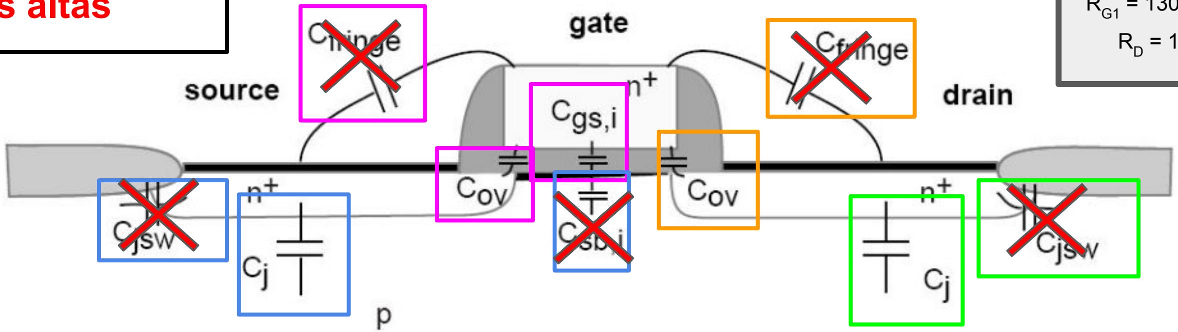
2. Mod. de Pequeña Señal

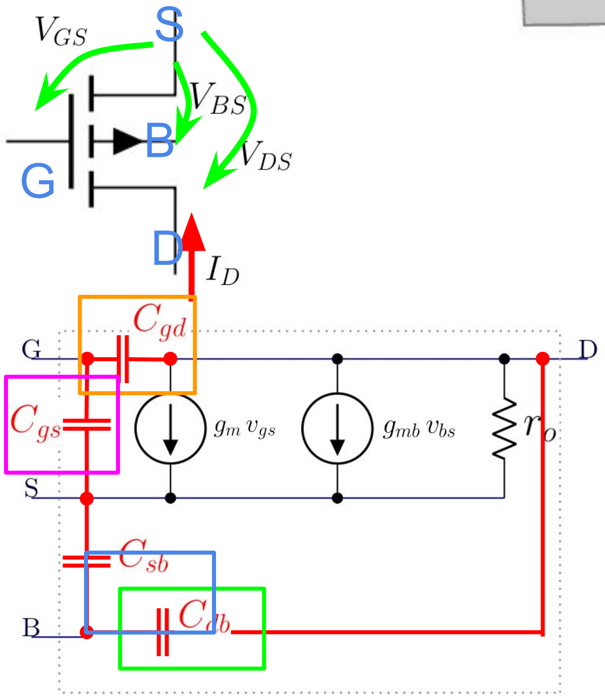
Para frecuencias altas

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





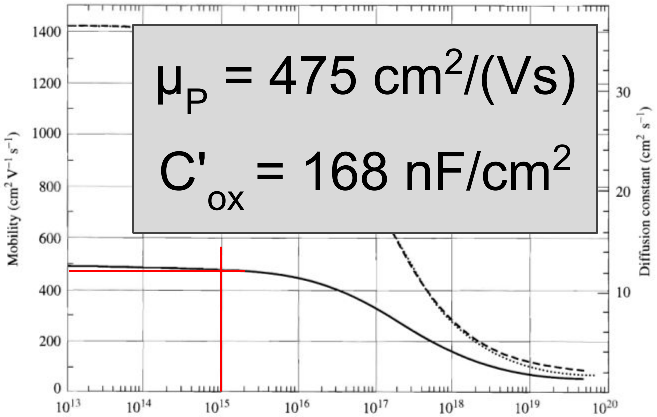
$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q = \frac{2}{3} W\, L\, C'_{ox} + W\, C_{ov}$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q = W\, C_{ov}$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q = C_j' A_D$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q = C_j' A_S$$

μ_P = 475 cm^2/(Vs)
C'_{ox} = 168 nF/cm^2



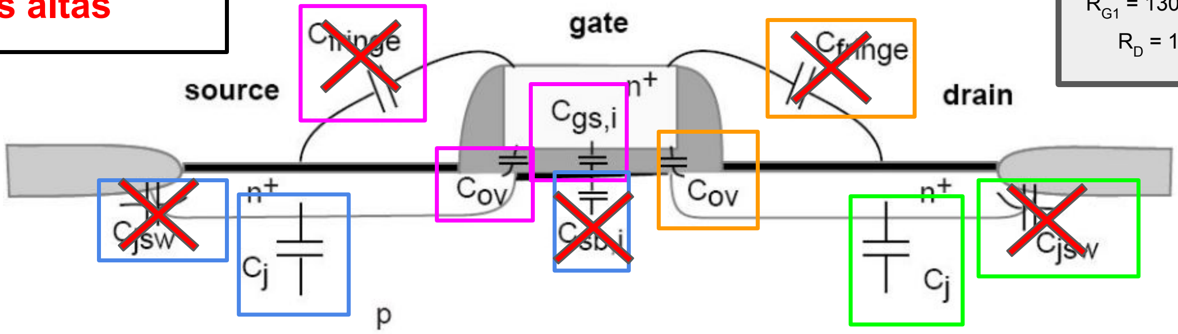
2. Mod. de Pequeña Señal

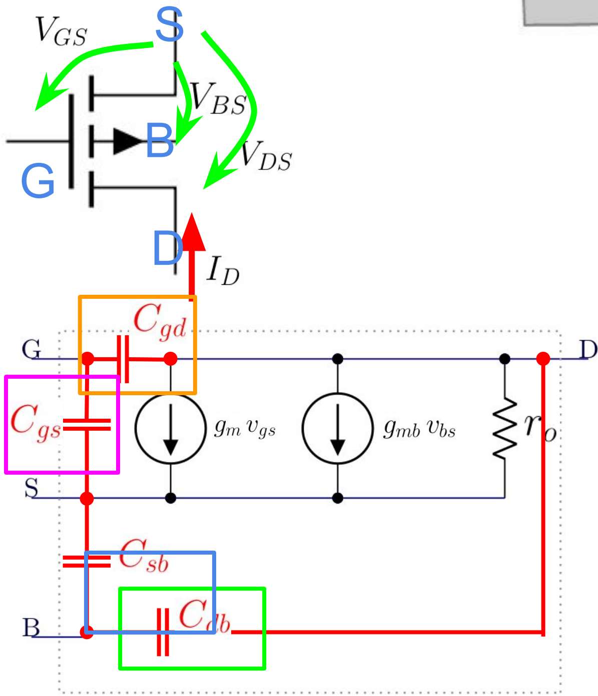
Para frecuencias altas

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



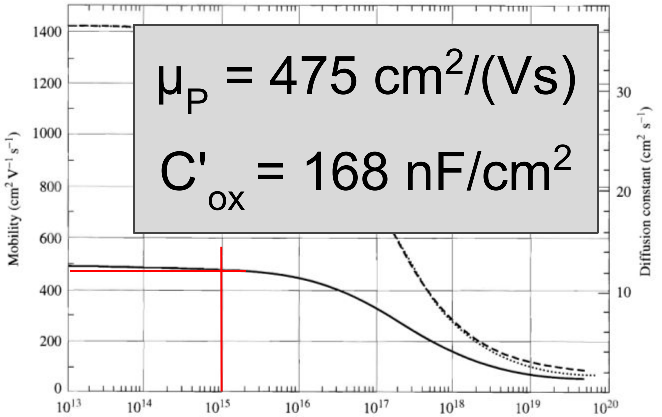


$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q = \frac{2}{3} W L C'_{ox} + W C_{ov} = 1.4372 \times 10^{-17}\text{F}$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q = W C_{ov}$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q = C_j A_D$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q = C_j A_S$$



2. Mod. de Pequeña Señal

Para frecuencias altas

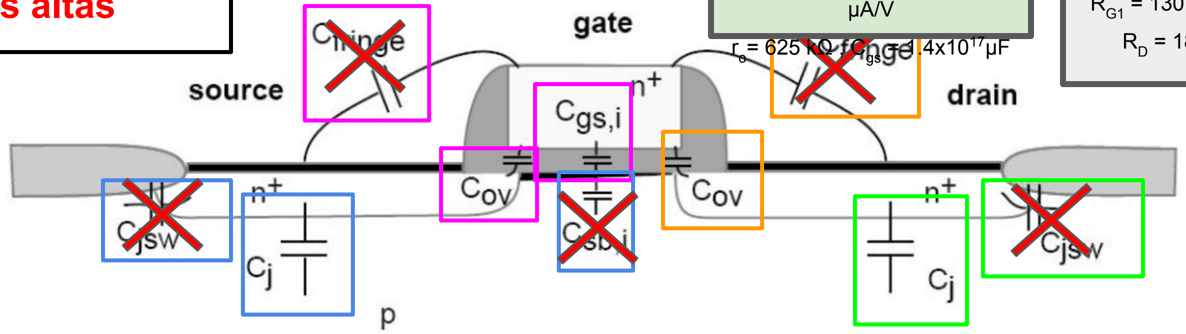
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

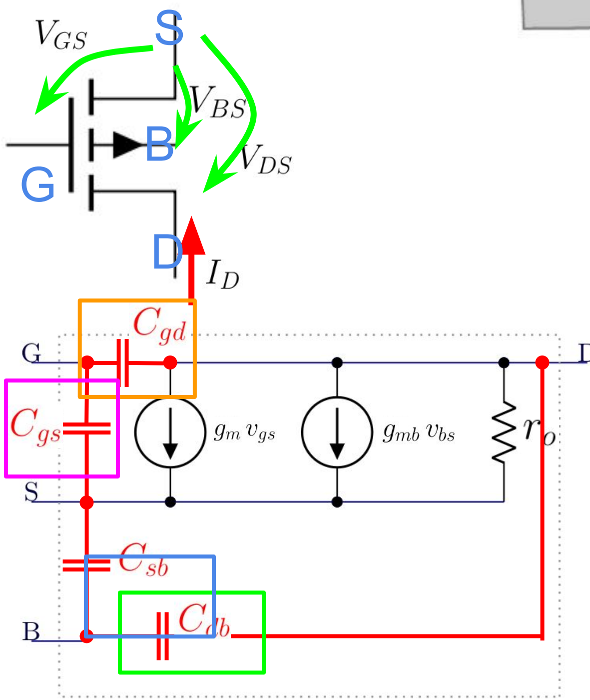
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o = 625 kΩ, C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



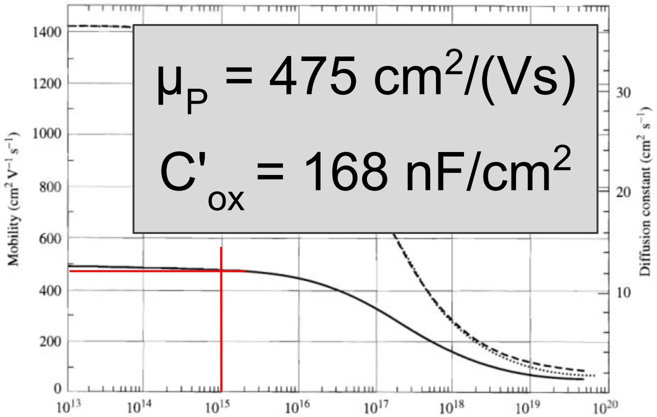


$$C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_Q = \tfrac{2}{3} W\, L\, C'_{ox} + W\, C_{ov} = 1.4372 \times 10^{-17}\text{F}$$

$$C_{gd} = \left.\frac{\partial Q}{\partial V_{GD}}\right|_Q = W\, C_{ov}$$

$$C_{db} = \left.\frac{\partial Q}{\partial V_{DB}}\right|_Q = C_j\, A_D$$

$$C_{sb} = \left.\frac{\partial Q}{\partial V_{SB}}\right|_Q = C_j\, A_S$$



2. Mod. de Pequeña Señal

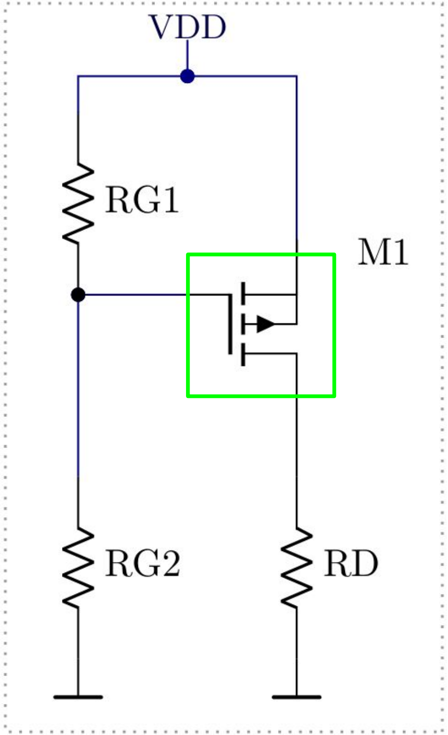
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



¿Para qué se utiliza el Modelo e Pequeña Señal?

El MPS *modela* mediante elementos lineales el comportamiento del transistor alrededor del punto de trabajo. Si trabajamos en su rango de validez, nos liberamos de las ecuaciones no lineales de I_D y V_{GS} y es más fácil resolver el circuito.

2. Mod. de Pequeña Señal

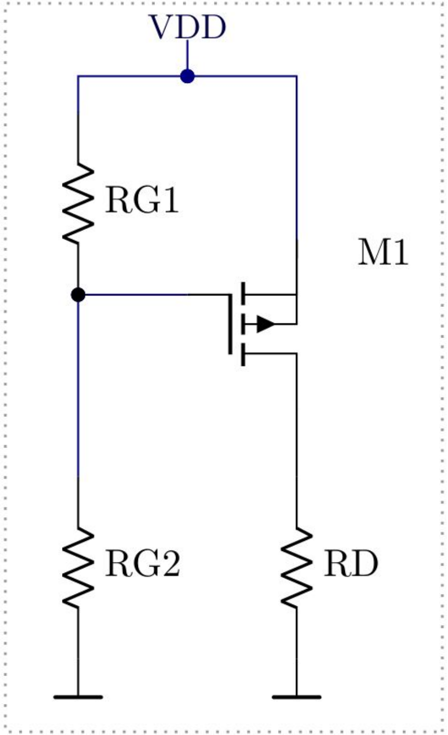
V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 µA/V, g_{mb} = 293 µA/V

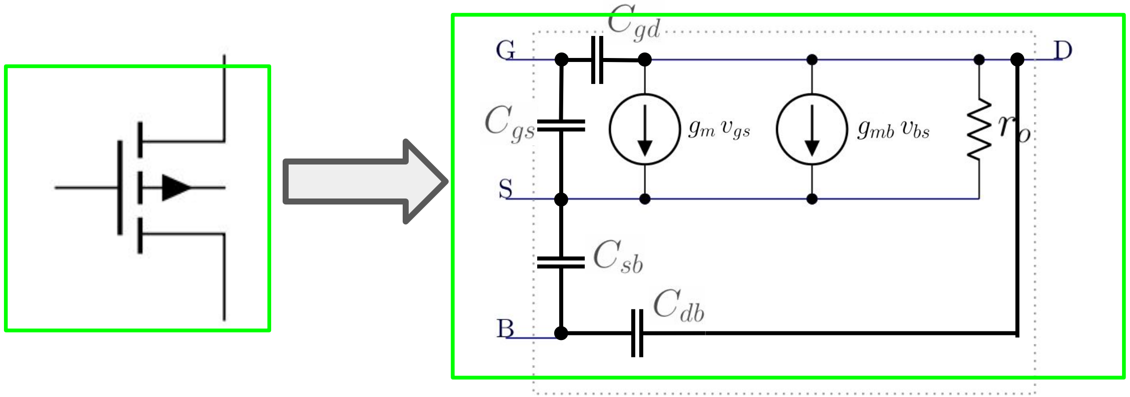
r_o= 625 kΩ , C_{gs} = 1.4x10^{17}µF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



¿Para qué se utiliza el Modelo e Pequeña Señal?

El MPS *modela* mediante elementos lineales el comportamiento del transistor alrededor del punto de trabajo. Si trabajamos en su rango de validez, nos liberamos de las ecuaciones no lineales de I_D y V_{GS} y es más fácil resolver el circuito.



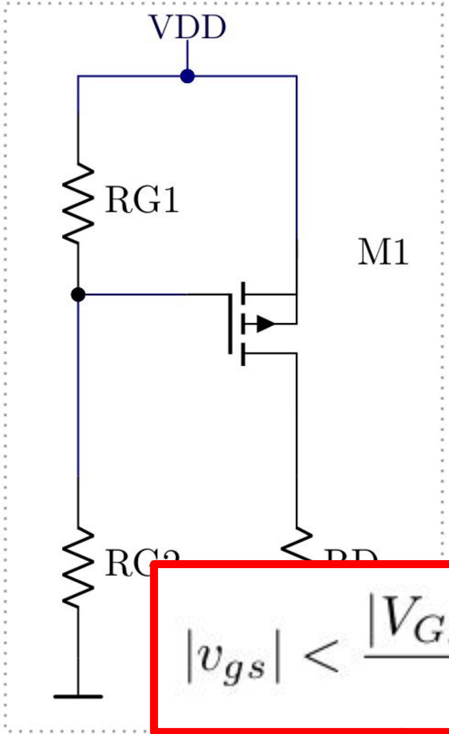
2. Mod. de Pequeña Señal

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V
r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

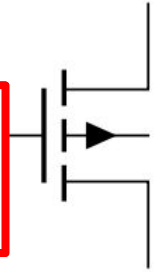
Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

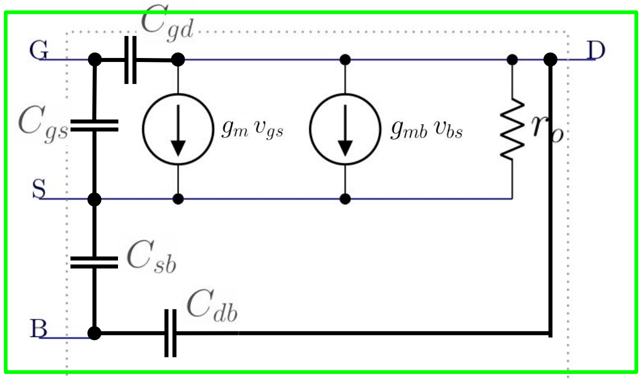


¿Para qué se utiliza el Modelo e Pequeña Señal?

El MPS *modela* mediante elementos lineales el comportamiento del transistor alrededor del punto de trabajo. Si trabajamos en su **rango de validez**, nos liberamos de las ecuaciones no lineales de I_D y V_{GS} y es más fácil resolver el circuito.

$$|v_{gs}| < \frac{|V_{GS} - V_T|}{5}$$





V_{GS} **= -1.3 V**

I_D **= -85.5 μA**

V_{DS} **= -3.46V**

$V_T = -0.8$ V, $k = 320$ μA/V^2

$I_{Dsat} = -80$ μA, $V_{DS\text{-}sat} = -0.5$V

$g_m = 320$ μA/V, $g_{mb} = 293$ μA/V

$r_o = 625$ kΩ , $C_{gs} = 1.4\text{x}10^{17}$μF

Datos

$|V_T| = 0.8$ V, $\mu_P C'_{ox} = 80$ μA/V^2

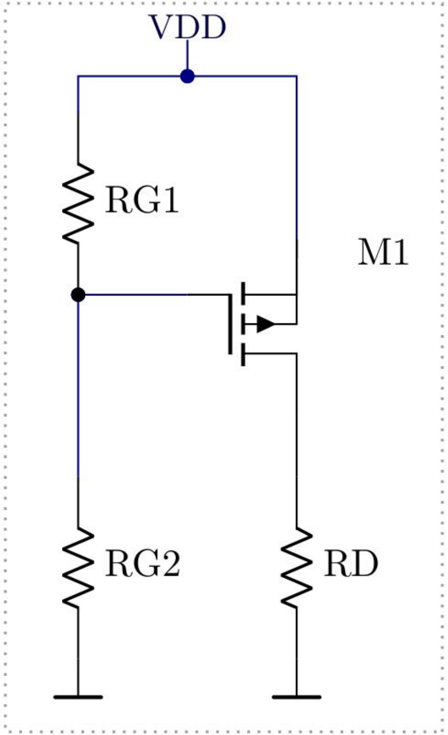
W = 32 μm, L = 4 μm

$\lambda = 0.02$ V^{-1}, $\gamma^2 = 0.5$ V

$R_{G1} = 130$ kΩ, $R_{G2} = 370$ kΩ

$R_D = 18$kΩ, $V_{DD} = 5$ V

Enunciado



Para el circuito de la figura y los siguientes datos:

- $|V_T| = 0.8$ V, $\mu_P C'_{ox} = 80$ μA/V^2
- W = 32 μm, L = 4 μm, $\lambda = 0.02$ V^{-1}, $\gamma^2 = 0.5$ V
- $R_{G1} = 130$ kΩ, $R_{G2} = 370$ kΩ $R_D = 18$kΩ, $V_{DD} = 5$ V

hallar

1. El punto de polarización
2. El modelo de pequeña señal
3. **La variación de corriente de Drain al variar 1 mV la v_{gs}**

3. Circuito de Peq. Señal

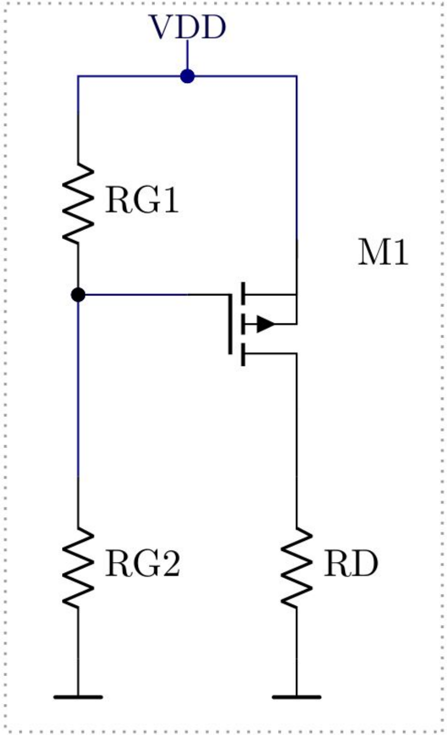
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

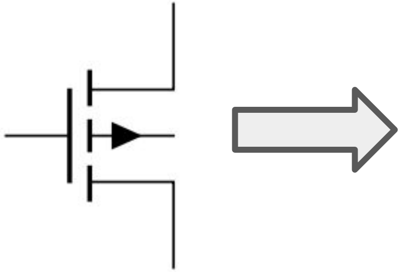
g_m= 320 μA/V, g_{mb} = 293 μA/V

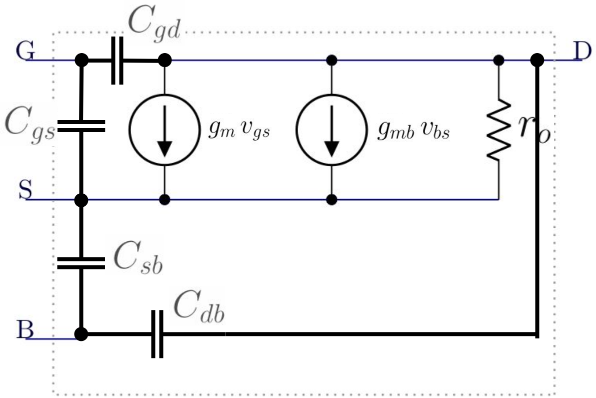
r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Simplificamos el modelo de pequeña señal





3. Circuito de Peq. Señal

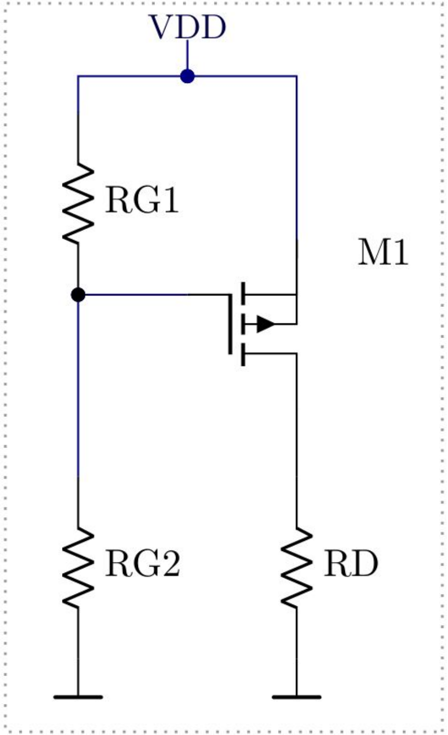
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

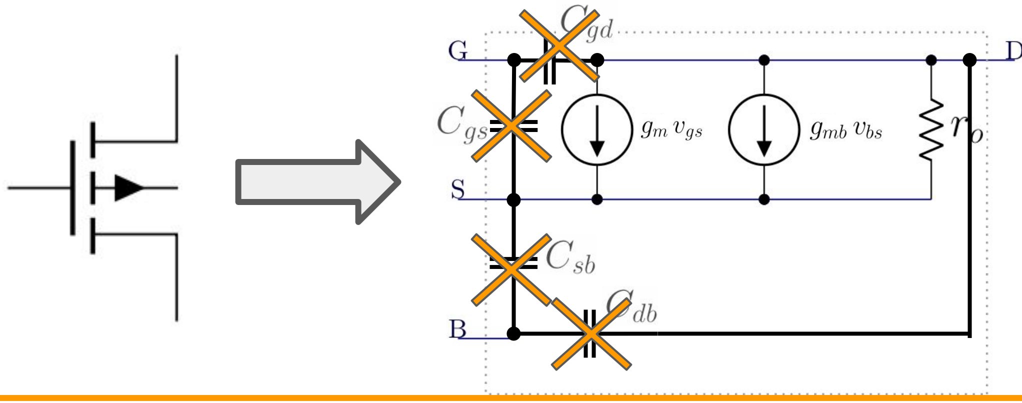
g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Simplificamos el modelo de pequeña señal



Se puede considerar frecuencias bajas o medias.

<u>Enunciado:</u>

3. La variación de corriente de Drain al variar 1 mV la v_{gs}

3. Circuito de Peq. Señal

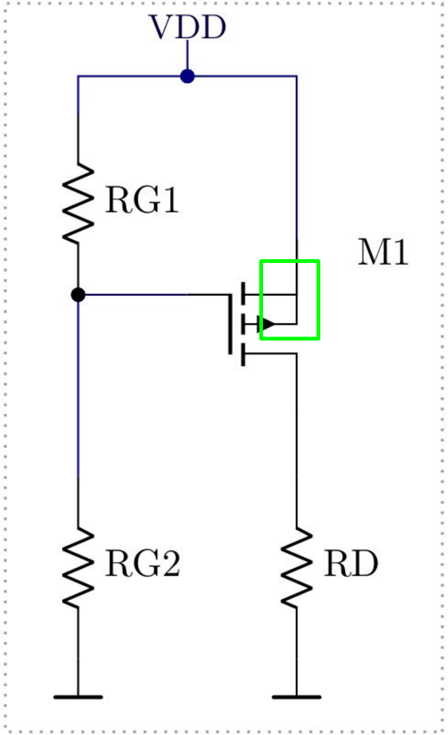
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

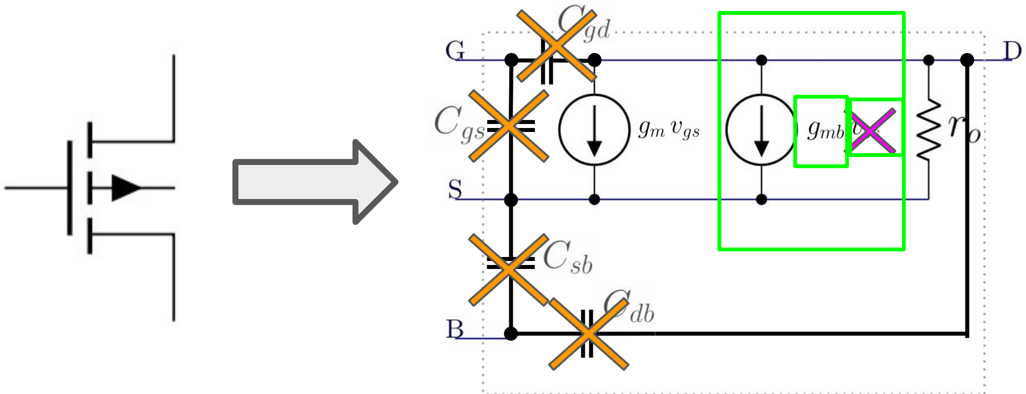
g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Simplificamos el modelo de pequeña señal



Se puede considerar frecuencias bajas o medias.

B y S cortocircuitados

3. Circuito de Peq. Señal

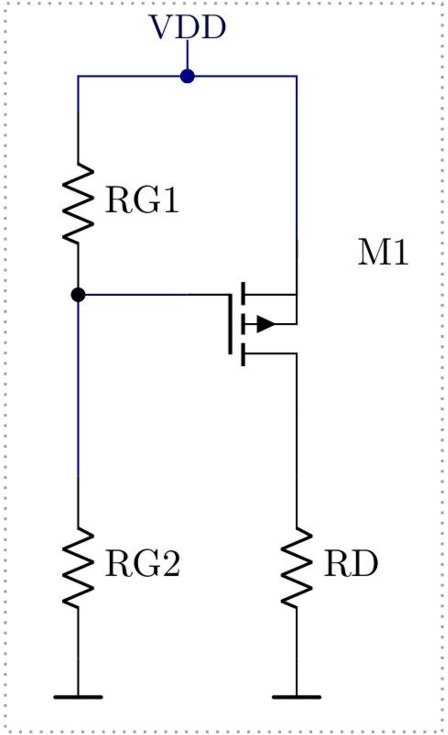
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

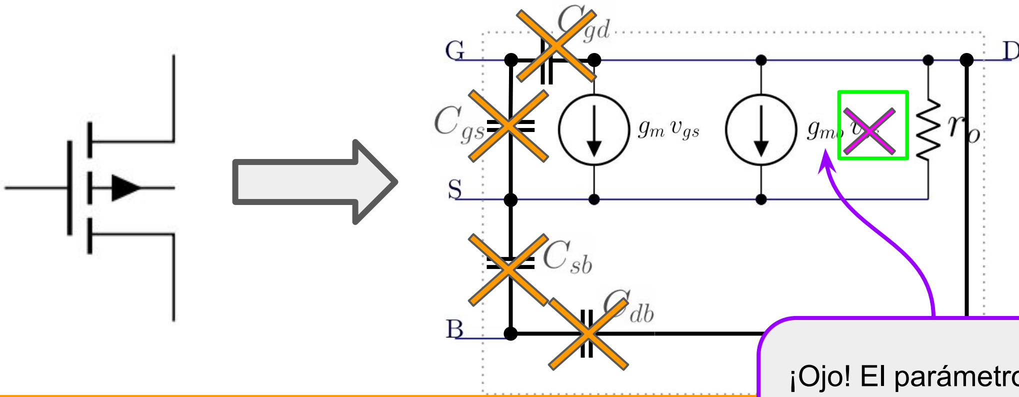
g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Simplificamos el modelo de pequeña señal



¡Ojo! El parámetro g_{mb} y la fuente controlada siguen estando, aunque V_{BS}=0

Se puede considerar frecuencias ba

B y S cortocircuitados

3. Circuito de Peq. Señal

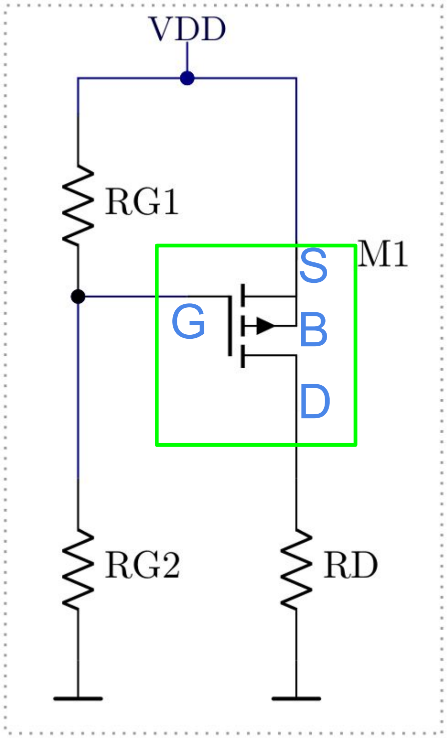
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

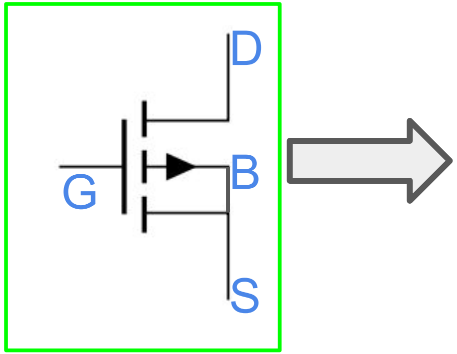
g_m= 320 μA/V, g_{mb} = 293 μA/V

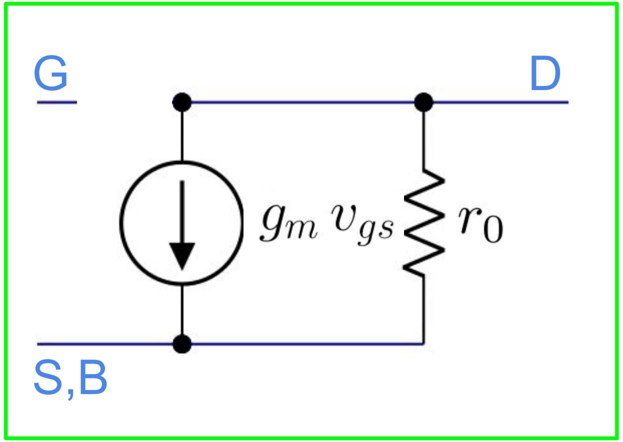
r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Simplificamos el modelo de pequeña señal





3. Circuito de Peq. Señal

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

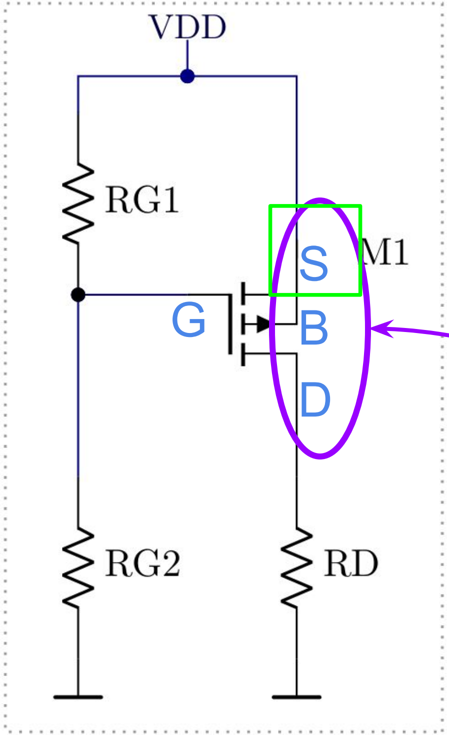
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

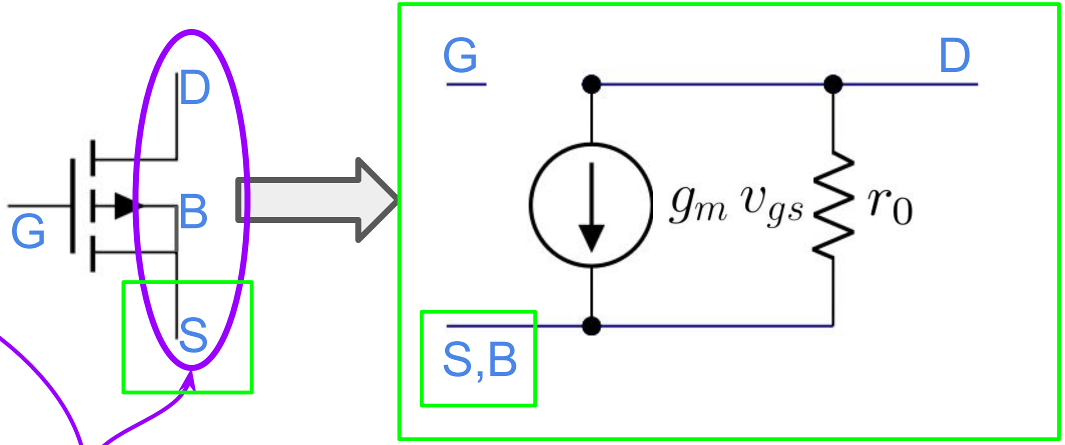
g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

Simplificamos el modelo de pequeña señal





¡Ojo! Están al revés

3. Circuito de Peq. Señal

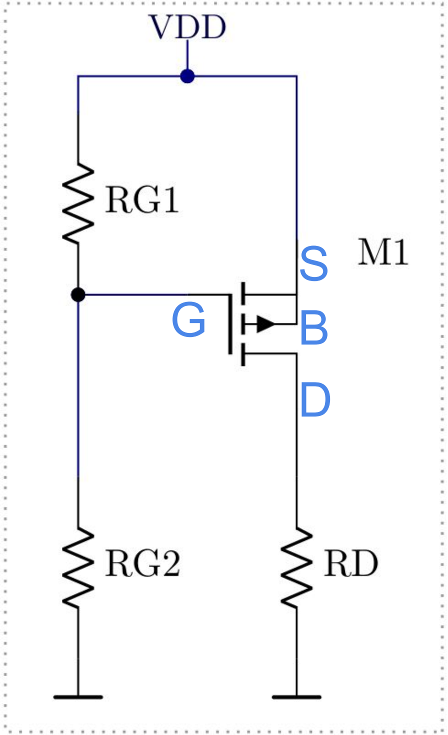
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Ahora sí pasamos al circuito de pequeña señal:

3. Circuito de Peq. Señal

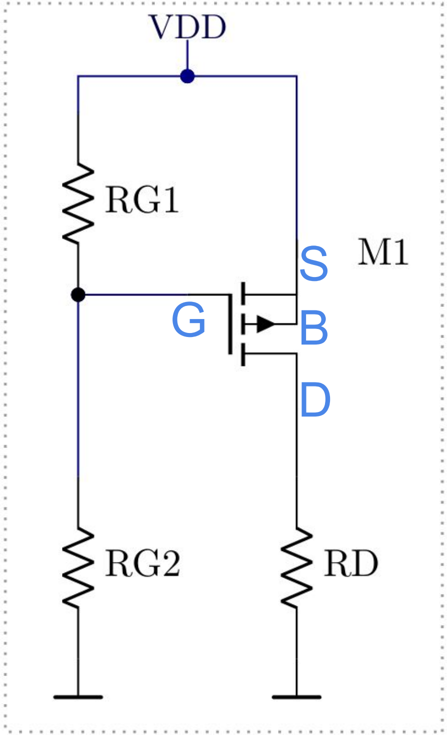
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Ahora sí pasamos al circuito de pequeña señal:

- Dejamos las fuentes de señal

3. Circuito de Peq. Señal

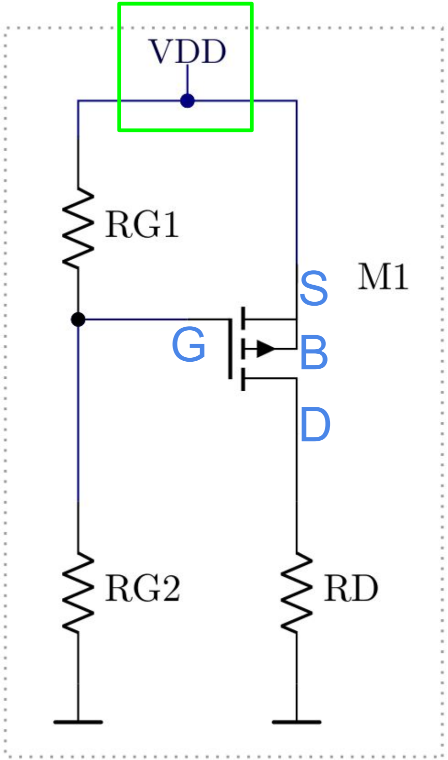
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, V_{DS-sat} = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Ahora sí pasamos al circuito de pequeña señal:

- Dejamos las fuentes de señal
- Pasivamos las fuentes de continua

3. Circuito de Peq. Señal

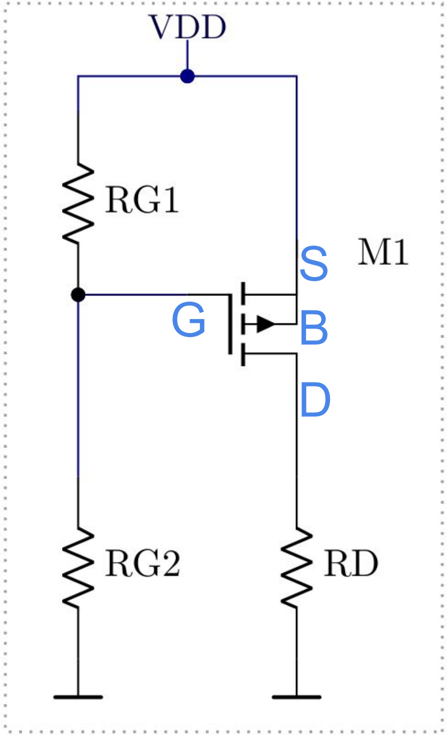
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Ahora sí pasamos al circuito de pequeña señal:

- Dejamos las fuentes de señal
- Pasivamos las fuentes de continua
- Capacitores = Circuitos cerrados

3. Circuito de Peq. Señal

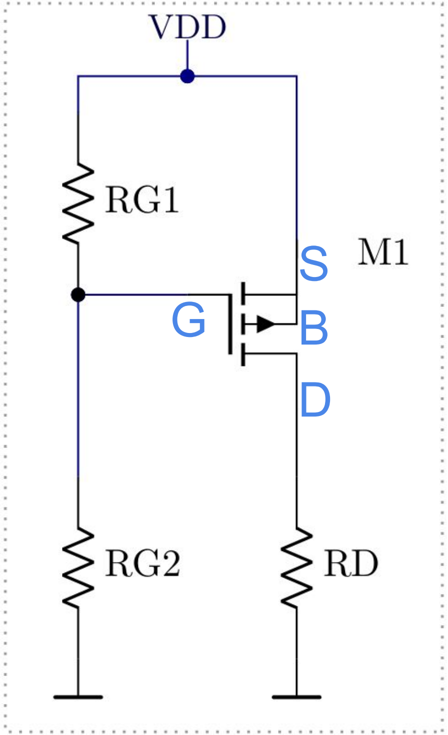
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



Ahora sí pasamos al circuito de pequeña señal:

- Dejamos las fuentes de señal
- Pasivamos las fuentes de continua
- Capacitores = Circuitos cerrados
- Utilizamos el modelo de pequeña señal

3. Circuito de Peq. Señal

V_{GS} = -1.3 V

I_D = -85.5 μA

V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2

I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos

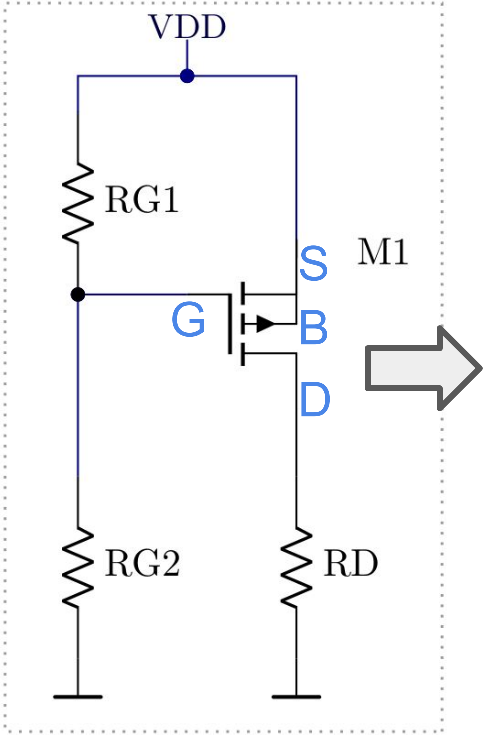
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 μA/V^2

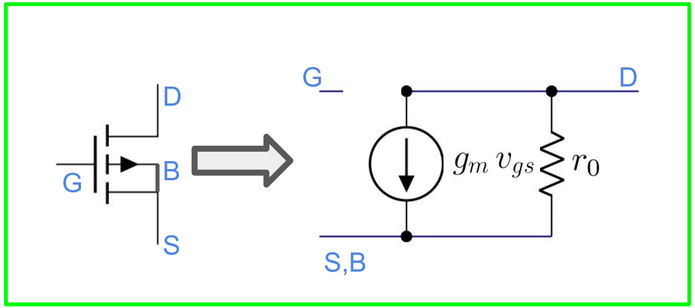
W = 32 μm, L = 4 μm

λ = 0.02 V^{-1}, γ^2 = 0.5 V

R_{G1} = 130 kΩ, R_{G2} = 370 kΩ

R_D = 18kΩ, V_{DD} = 5 V





3. Circuito de Peq. Señal

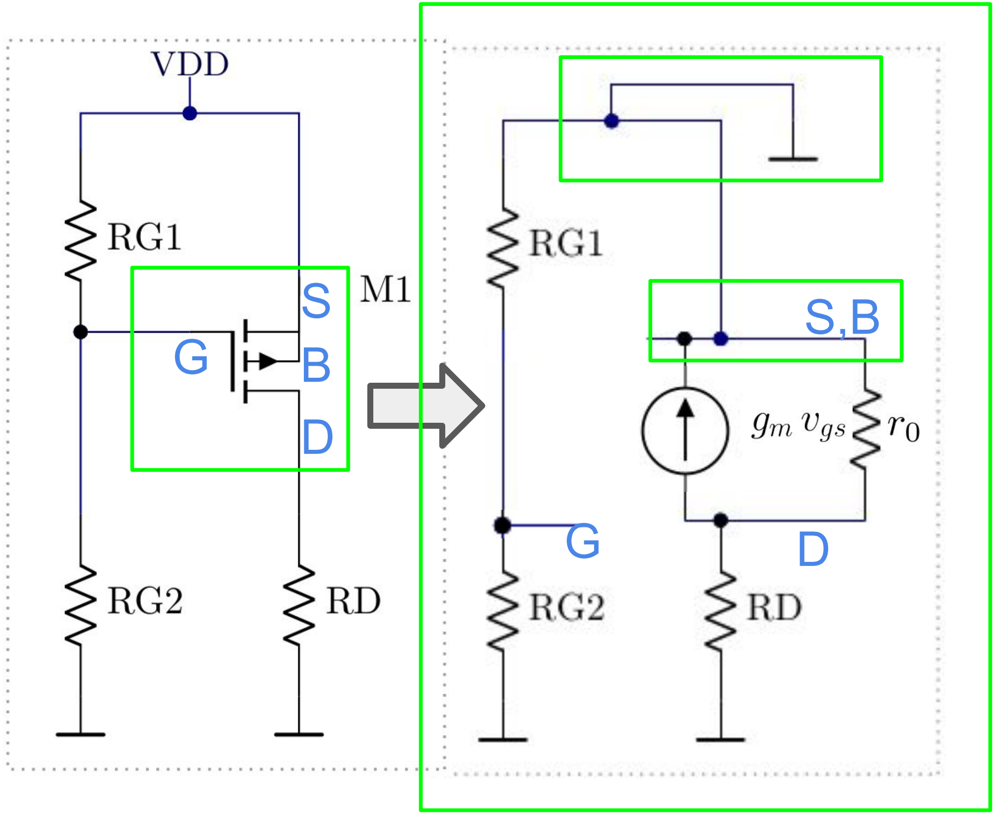
V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

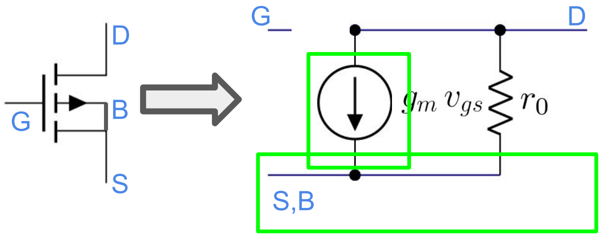
V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

g_m = 320 µA/V, g_{mb} = 293 µA/V

r_o = 625 kΩ , C_{gs} = 1.4x10^{17}µF

Datos
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V





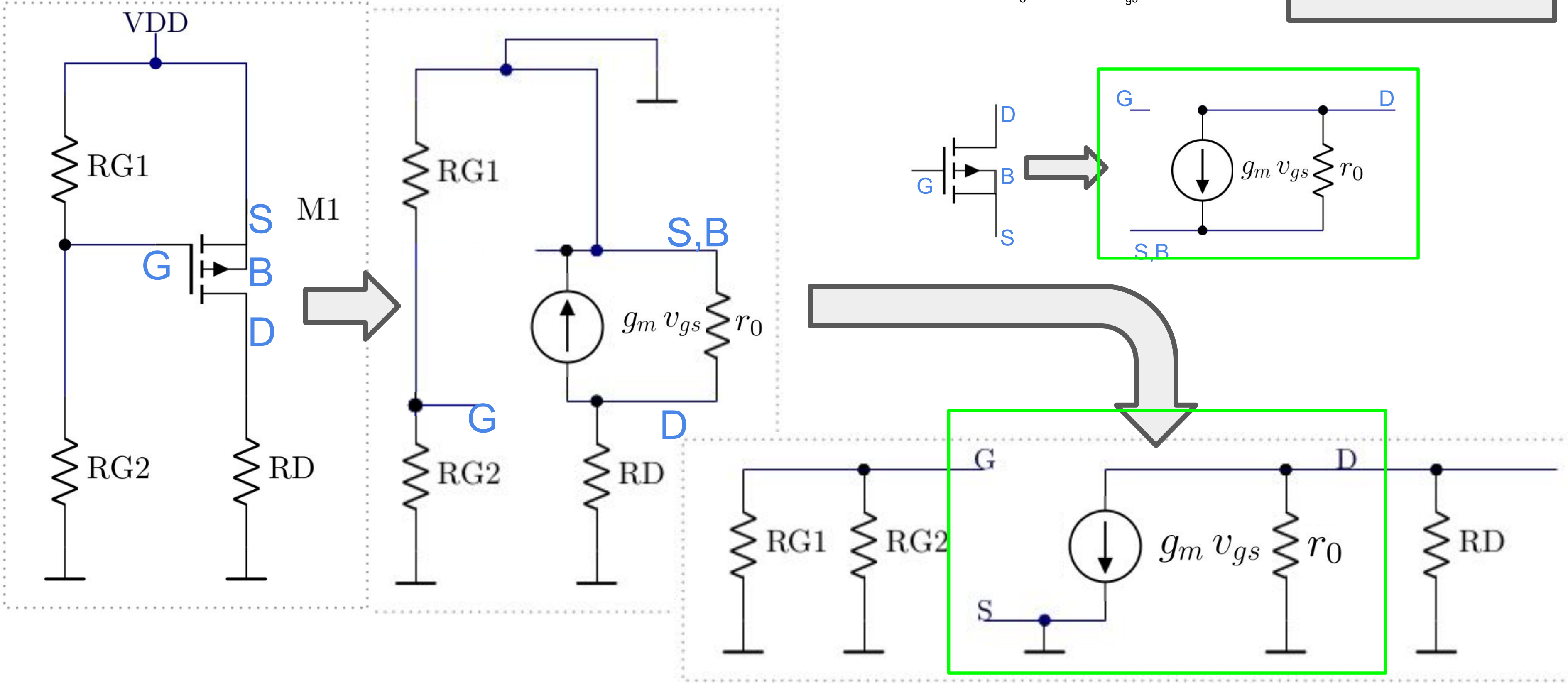
3. Circuito de Peq. Señal

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V
r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V



3. Circuito de Peq. Señal

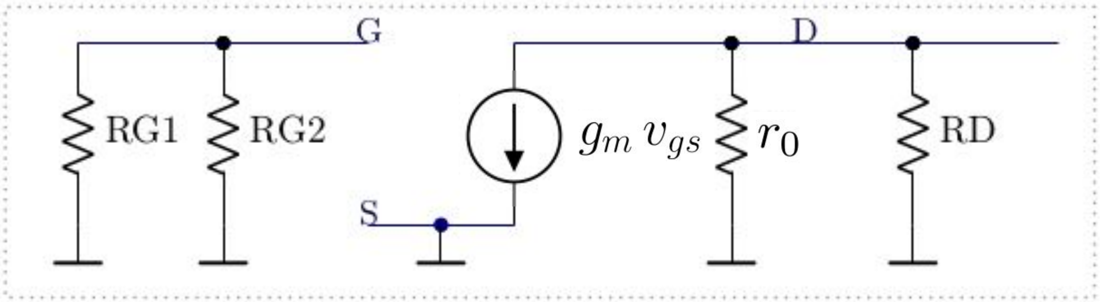
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, V_{DS-sat} = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V
r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



3. Circuito de Peq. Señal

V_{GS} = -1.3 V

I_D = -85.5 μA

V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2

I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos

$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2

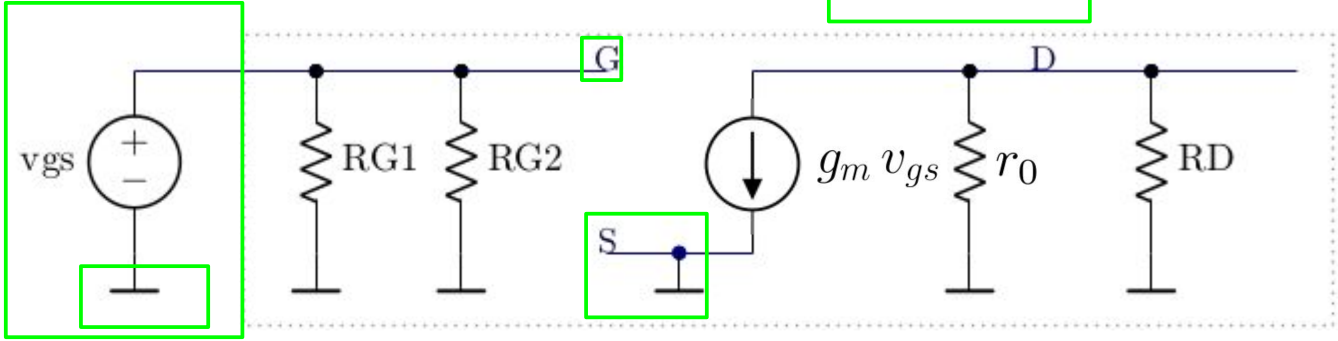
W = 32 μm, L = 4 μm

λ = 0.02 V^{-1}, γ^2 = 0.5 V

R_{G1} = 130 kΩ, R_{G2} = 370 kΩ

R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



3. Circuito de Peq. Señal

V_{GS} = -1.3 V

I_D = -85.5 µA

V_{DS} = -3.46V

V_T = -0.8 V, k = 320 µA/V^2

I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 µA/V, g_{mb} = 293 µA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}µF

Datos

$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 µA/V^2

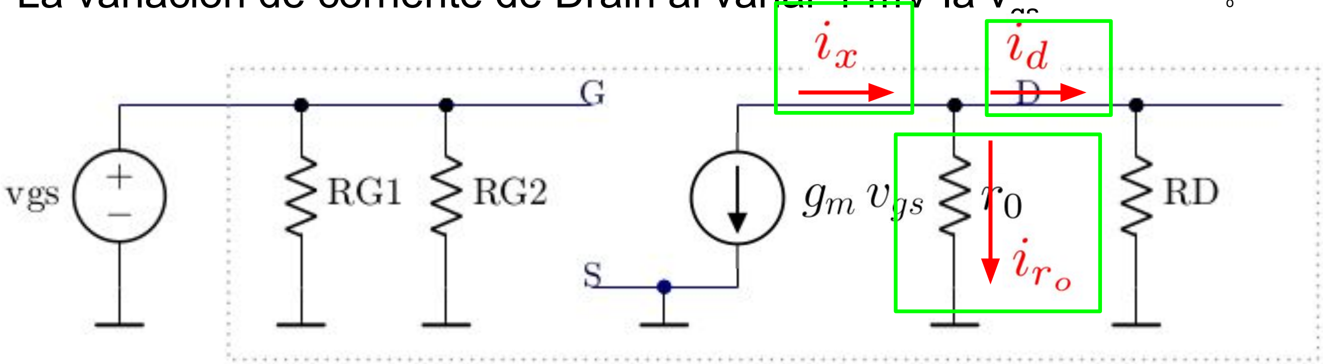
W = 32 µm, L = 4 µm

λ = 0.02 V^{-1}, γ^2 = 0.5 V

R_{G1} = 130 kΩ, R_{G2} = 370 kΩ

R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



3. Circuito de Peq. Señal

V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

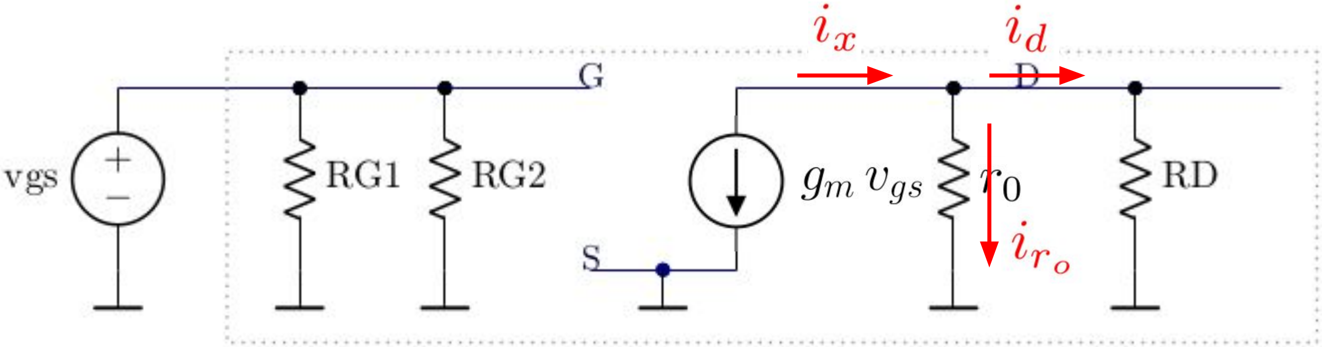
V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_P C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



$$i_d = i_x - i_{r_o}$$

3. Circuito de Peq. Señal

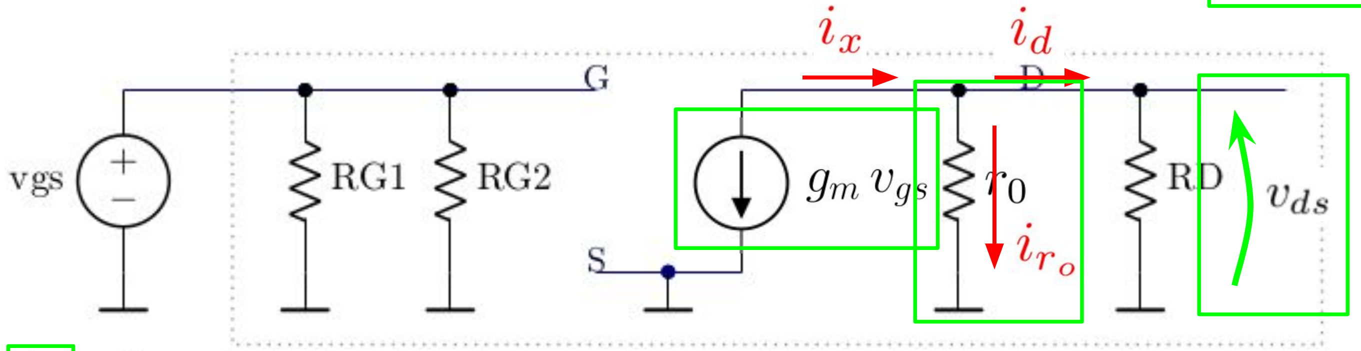
V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 µA/V²
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 µA/V, g_{mb} = 293 µA/V
r_o= 625 kΩ , C_{gs} = 1.4x10^17 µF

Datos
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 µA/V²
W = 32 µm, L = 4 µm
λ = 0.02 V⁻¹, γ² = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



$$i_d = i_x - i_{r_o}$$

$$i_x = -g_m v_{gs}$$

$$i_{r_o} = \frac{v_{ds}}{r_o}, \quad v_{ds} = i_x (r_o // R_D) \approx i_x R_D = g_m v_{gs} R_D$$

3. Circuito de Peq. Señal

V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

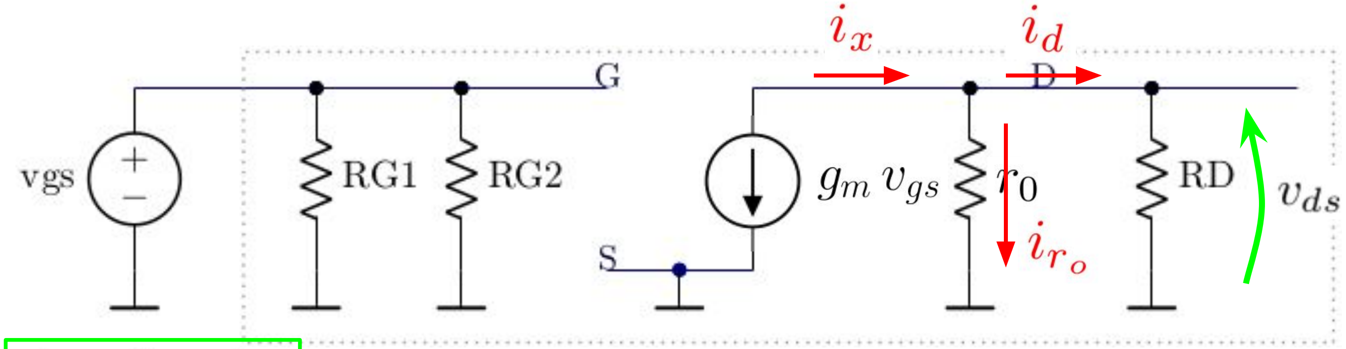
V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 µA/V, g_{mb} = 293 µA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}µF

Datos
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



$$i_d = i_x - i_{r_o}$$

$$i_x = -g_m v_{gs}$$

$$i_{r_o} = \frac{v_{ds}}{r_o}, \quad v_{ds} = i_x (r_o // R_D) \approx i_x R_D = g_m v_{gs} R_D$$

$$i_d = -g_m v_{gs} \underbrace{\left(1 + \frac{(r_o // R_D)}{r_o}\right)} \approx -g_m v_{gs} = -320\,\text{nA}$$

3. Circuito de Peq. Señal

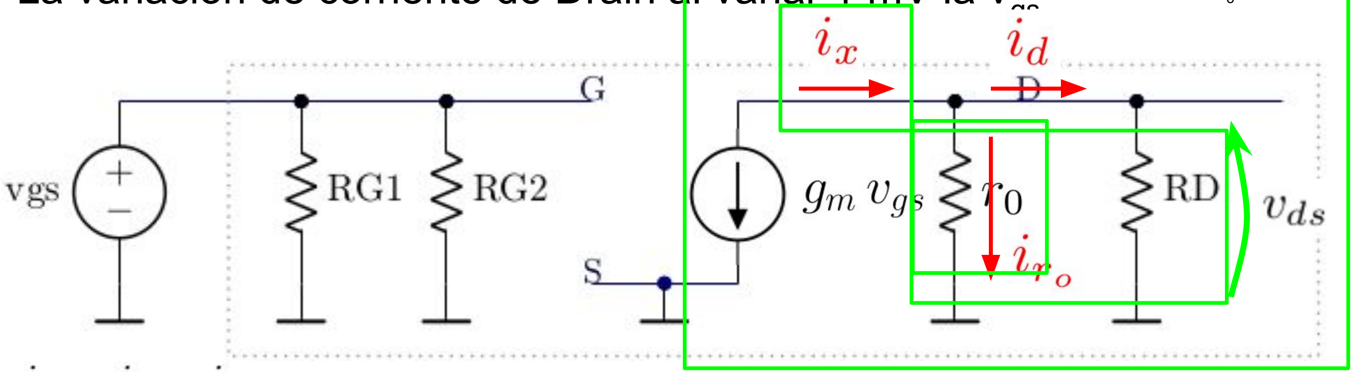
V_{GS} = -1.3 V
I_D = -85.5 μA
V_{DS} = -3.46V

V_T = -0.8 V, k = 320 μA/V^2
I_{Dsat} = -80 μA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 μA/V, g_{mb} = 293 μA/V
r_o= 625 kΩ , C_{gs} = 1.4x10^{17}μF

Datos
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 μA/V^2
W = 32 μm, L = 4 μm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



$$i_d = i_x - i_{r_o}$$

$$i_x = -g_m v_{gs}$$

$$i_{r_o} = \frac{v_{ds}}{r_o}, \quad v_{ds} = i_x (r_o // R_D) \approx i_x R_D = g_m v_{gs} R_D$$

$$i_d = -g_m v_{gs} \underbrace{\left(1 + \frac{(r_o//R_D)}{r_o}\right)}_{1.03} \approx -g_m v_{gs} = -320\,\text{nA}$$

$$v_{ds} \approx -g_m v_{gs} R_D = -5.76\,\text{mV}$$

3. Circuito de Peq. Señal

V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

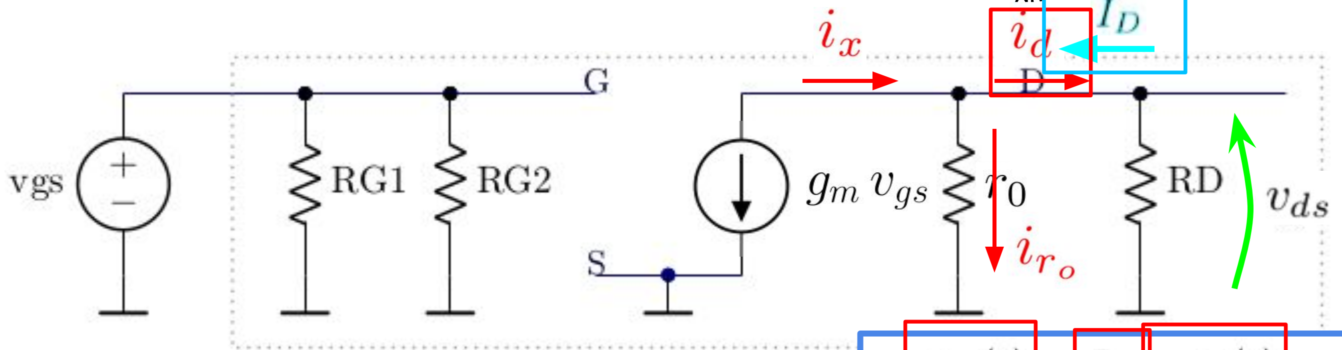
V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 µA/V, g_{mb} = 293 µA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}µF

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



$$i_d = i_x - i_{r_o}$$

$$i_x = -g_m\, v_{gs}$$

$$i_{r_o} = \frac{v_{ds}}{r_o}, \qquad v_{ds} = i_x\,(r_o//R_D) \approx i_x\, R_D = g_m\, v_{gs}\, R_D$$

$$i_d = -g_m\, v_{gs} \underbrace{\left(1 + \frac{(r_o//R_D)}{r_o}\right)}_{1.03} \approx -g_m\, v_{gs} = -320\,\text{nA}$$

$$v_{ds} \approx -g_m\, v_{gs}\, R_D = -5.76\,\text{mV}$$

$$i_D(t) = I_D - i_d(t) = -(88.5 - 0.32\, u(t))\,\mu\text{A}$$

$$v_{DS}(t) = V_{DS} + v_{ds}(t) = -(3.46 + 0.00576\, u(t))\ \text{V}$$

3. Circuito de Peq. Señal

V_{GS} = -1.3 V
I_D = -85.5 µA
V_{DS} = -3.46V

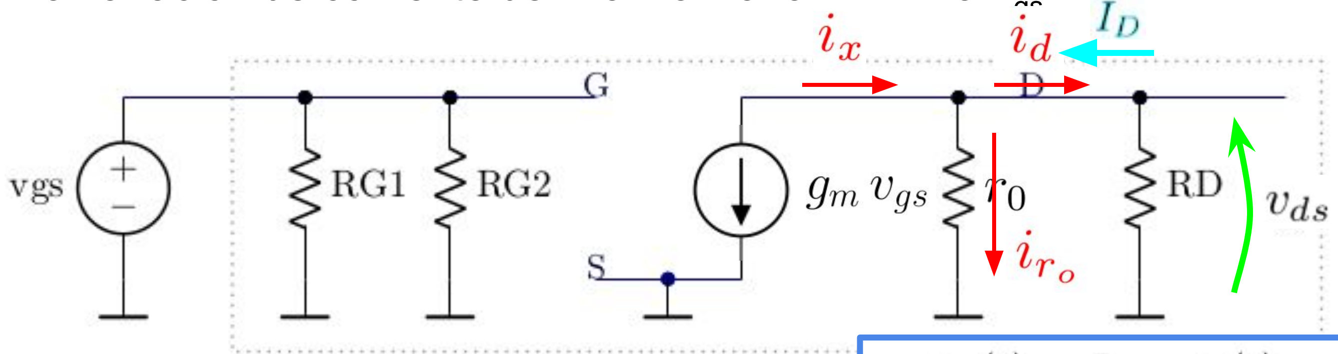
V_T = -0.8 V, k = 320 µA/V^2
I_{Dsat} = -80 µA, $V_{DS\text{-}sat}$ = -0.5V

g_m= 320 µA/V, g_{mb} = 293 µA/V

r_o= 625 kΩ , C_{gs} = 1.4x10^{17}µF

<u>Datos</u>
$|V_T|$ = 0.8 V, $\mu_p C'_{ox}$ = 80 µA/V^2
W = 32 µm, L = 4 µm
λ = 0.02 V^{-1}, γ^2 = 0.5 V
R_{G1} = 130 kΩ, R_{G2} = 370 kΩ
R_D = 18kΩ, V_{DD} = 5 V

La variación de corriente de Drain al variar 1 mV la v_{gs}



$$i_d = i_x - i_{r_o}$$

$$i_x = -g_m v_{gs}$$

$$i_{r_o} = \frac{v_{ds}}{r_o}, \quad v_{ds} = i_x (r_o // R_D) \approx i_x R_D = g_m v_{gs} R_D$$

$$i_d = -g_m v_{gs} \underbrace{\left(1 + \frac{(r_o//R_D)}{r_o}\right)}_{1.03} \approx -g_m v_{gs} = -320\,\text{nA}$$

$$v_{ds} \approx -g_m v_{gs} R_D = -5.76\,\text{mV}$$

$$i_D(t) = I_D - i_d(t) = -(88.5 - 0.32\, u(t))\, \mu\text{A}$$

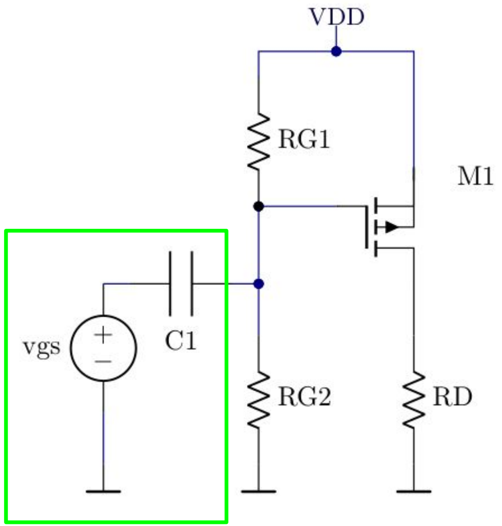
$$v_{DS}(t) = V_{DS} + v_{ds}(t) = -(3.46 + 0.00576\, u(t))\, \text{V}$$

Recordemos que solo vale cuando ...

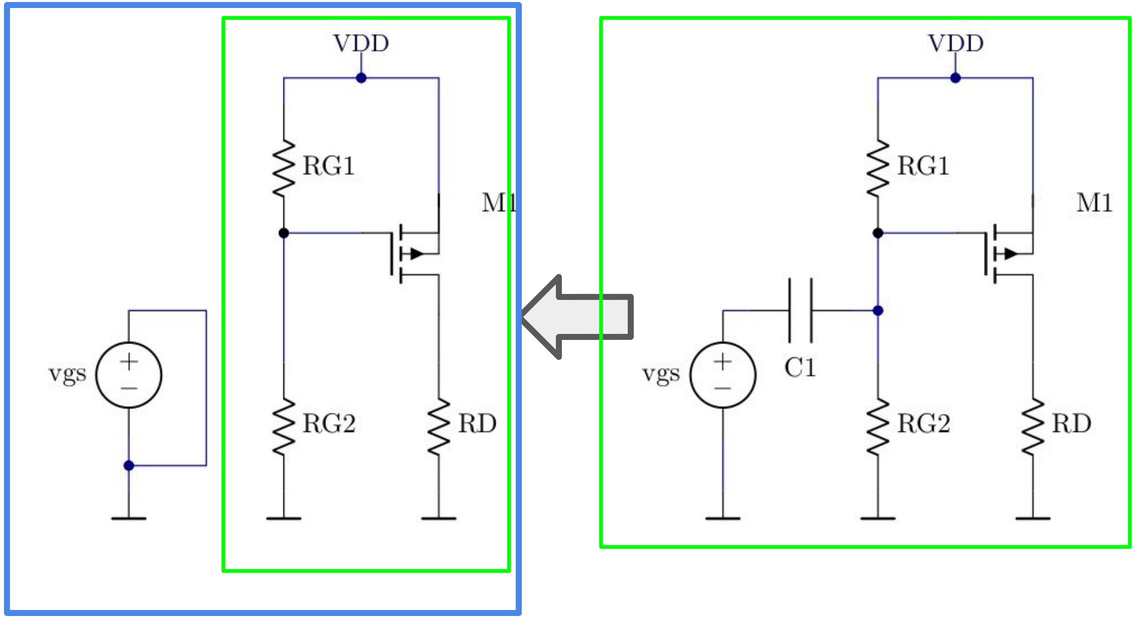
$$|v_{gs}| < \frac{|V_{GS} - V_T|}{5}$$

4. Extra: Como conseguir la variación de 1 mV sobre v_{gs}

4. Extra: Como conseguir la variación de 1 mV sobre v_{gs}

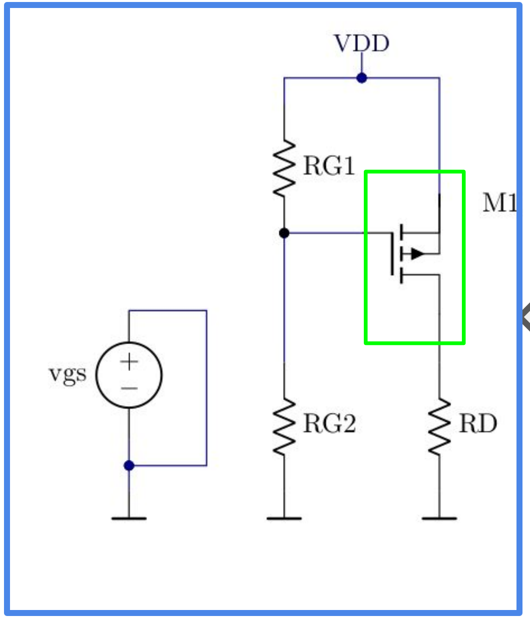


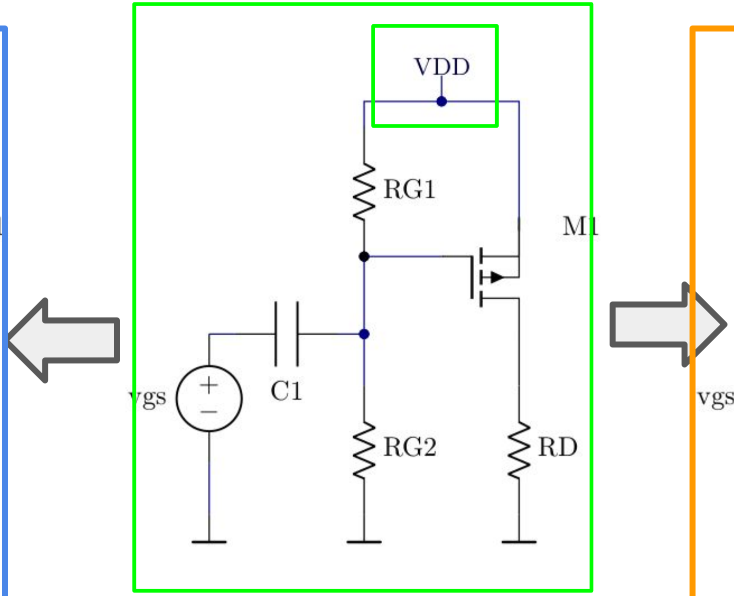
4. Extra: Como conseguir la variación de 1 mV sobre v_{gs}

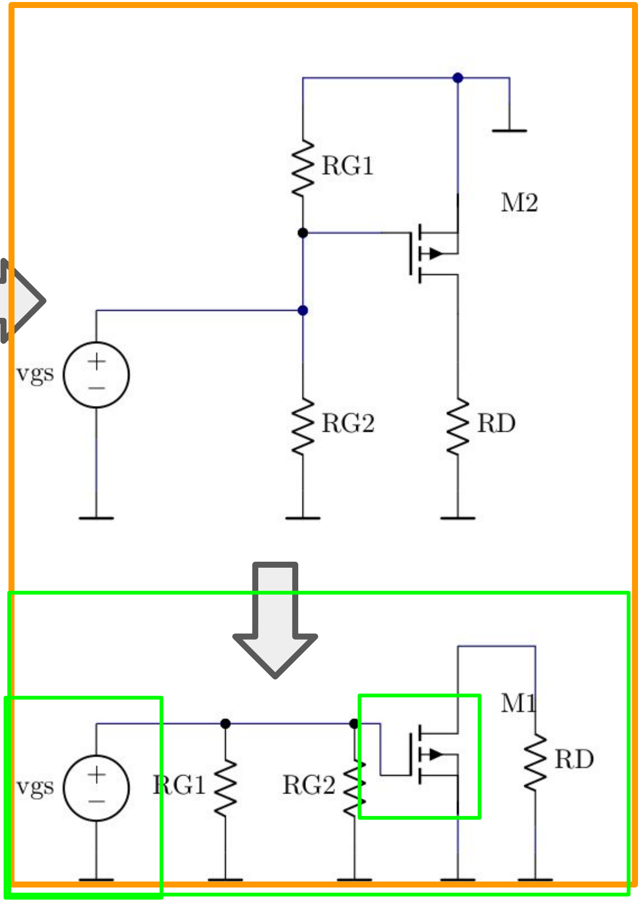


POLARIZACIÓN

4. Extra: Como conseguir la variación de 1 mV sobre v_{gs}



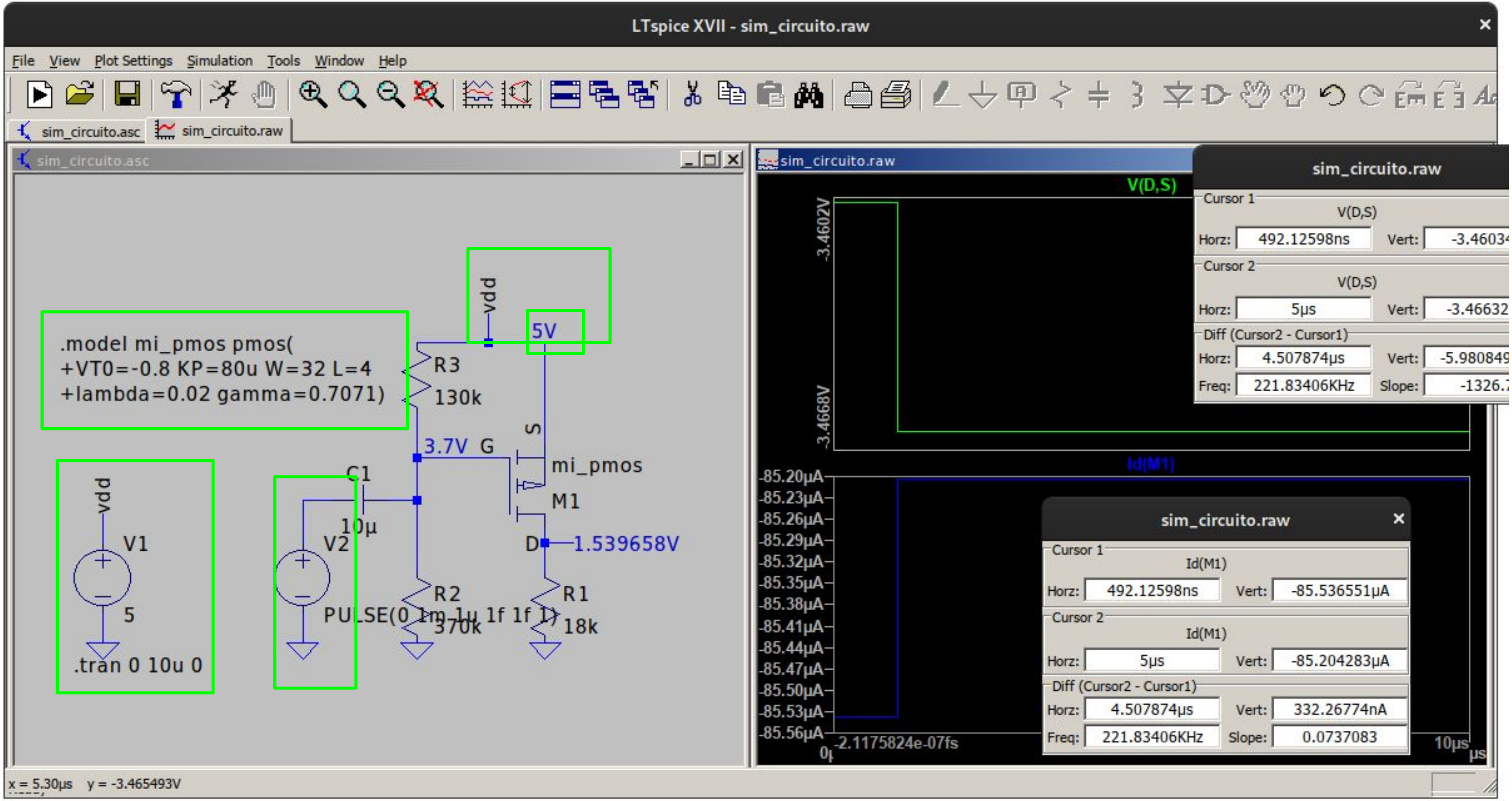




POLARIZACIÓN

PEQUEÑA SEÑAL

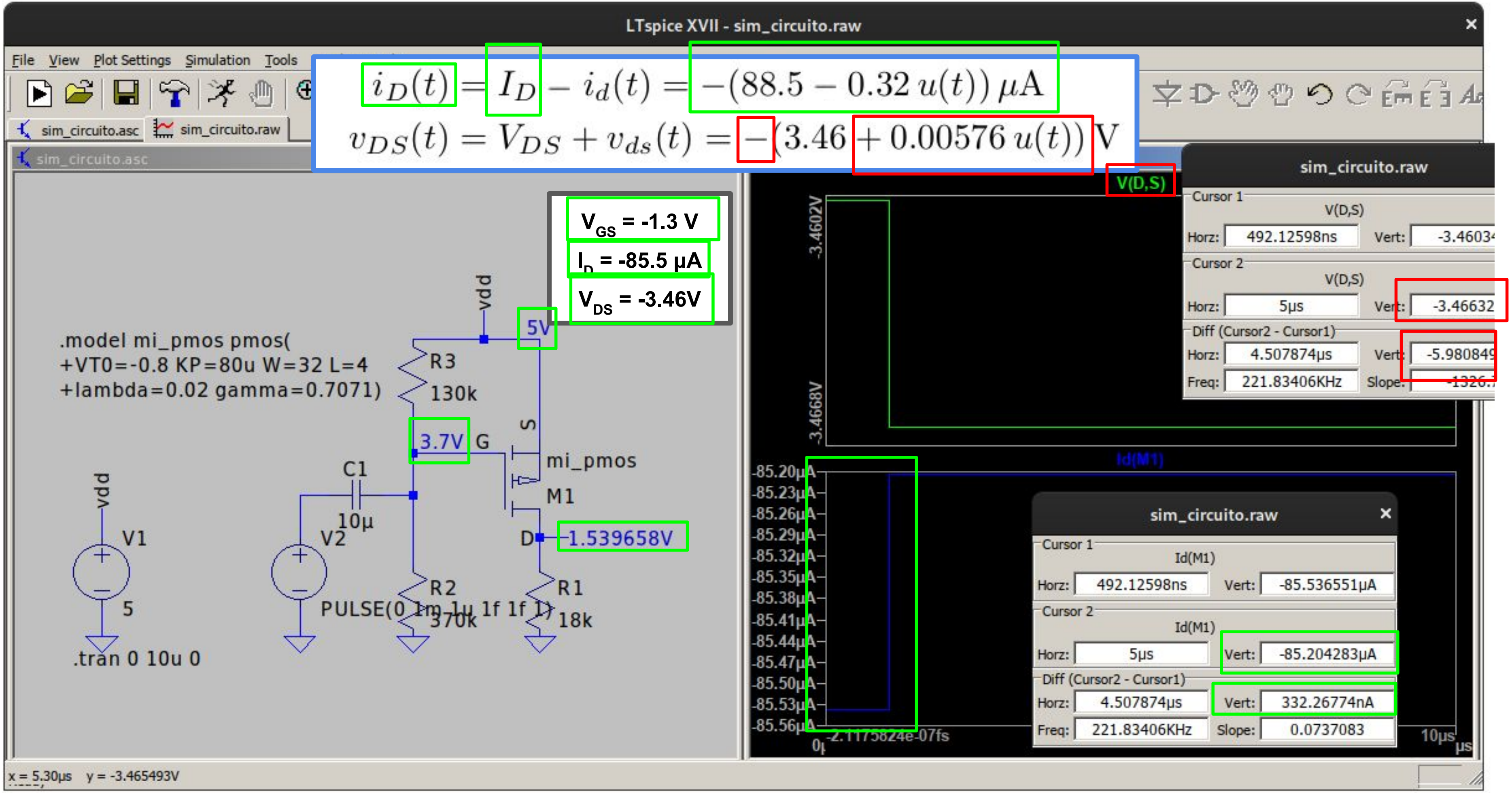
5. Extra: Simulación



5. Extra: Simulación

$$i_D(t) = I_D - i_d(t) = -(88.5 - 0.32\,u(t))\,\mu A$$

$$v_{DS}(t) = V_{DS} + v_{ds}(t) = -(3.46 + 0.00576\,u(t))\,V$$



FIN