COMMON DRAIN AMPLIFIER.

7 FEBRUARY 2006

COMMON DRAIN AMPLIFIER.

The output voltage is

$$V_{out} = V_{in} - V_{gs} \tag{1}$$

$$V_{out} = V_{in} - V_T - \sqrt{\frac{I_{bias}}{\frac{\mu_n C_{ox} W}{2L}}} \tag{2}$$

$$V_T = f(V_{BS}) \tag{3}$$

SMALL SIGNAL EQUIVALENT.

$$v_{gs} = v_{in} - v_{out} \tag{4}$$

$$v_{bs} = -v_{out} \tag{5}$$

$$v_{ds} = -v_{out} \tag{6}$$

$$\tag{7}$$

Writing KCL at the source node

$$g_m(v_{in} - v_{out}) - g_{mbs}v_{out} - g_{ds}v_{out} = 0 \tag{8}$$

$$\frac{v_{out}}{v_{in}} = \frac{g_m}{g_m + g_{mbs} + g_{ds}} \tag{9}$$

- Therefore gain is less than one.
- Typically g_{mbs} varies from $\frac{g_m}{4}$ to $\frac{g_m}{2}$

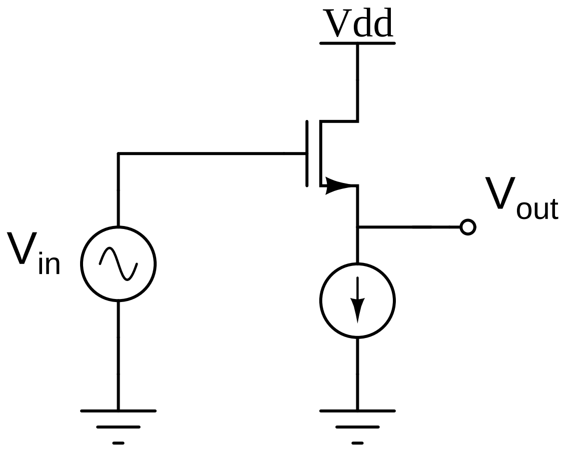

Figure 1: COMMON DRAIN AMPLIFIER

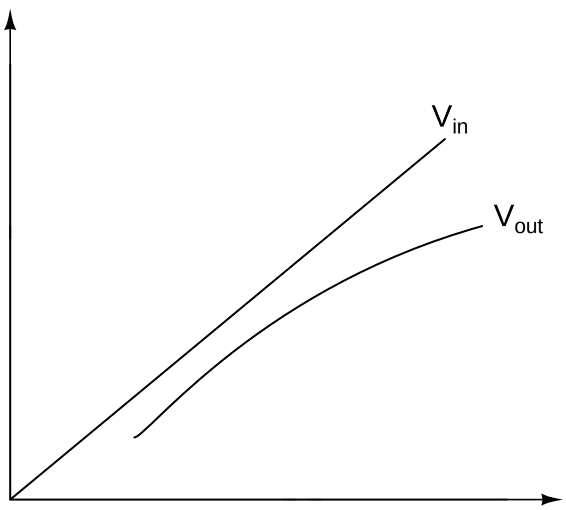

Figure 2: VARIATION OF Vout WITH Vin

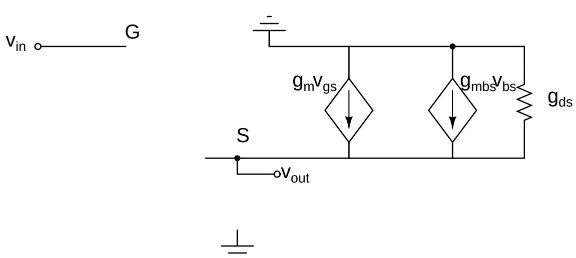

Figure 3: SMALL SIGNAL EQUIVALENT

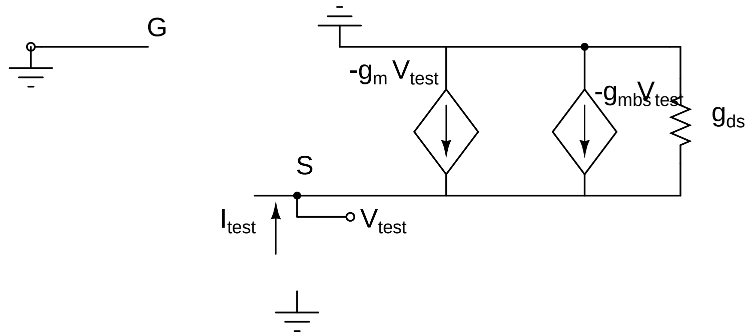

Figure 4: EQUIVALENT CIRCUIT TO FIND OUTPUT RESISTANCE

INPUT AND OUTPUT RESISTANCE.

Input resistance

$$R_{in} = \infty \tag{10}$$

Output resistance

To find the output resistance we apply a test voltage V_{test} and find the current I_{test} through it.

$$\begin{aligned} I_{test} &= g_m V_{test} + g_{mbs} V_{test} + g_{ds} V_{test} & (11) \\ G_{out} &= g_m + g_{mbs} + g_{ds} & (12) \end{aligned}$$

☛ It is mostly used as a buffer.

HIGH FREQUENCY ANALYSIS.

For High frequency analysis we have to include the effect of C_{gs},C_{gd},C_{sb} and C_{db}

The transfer function is obtained as

$$\frac{V_{out}}{V_{in}} = \frac{g_m + sC_{gs}}{g_m + g_{mbs} + g_{ds} + s(C_{gs} + C_{sb})} \tag{13}$$

INPUT AND OUTPUT ADMITTANCE.

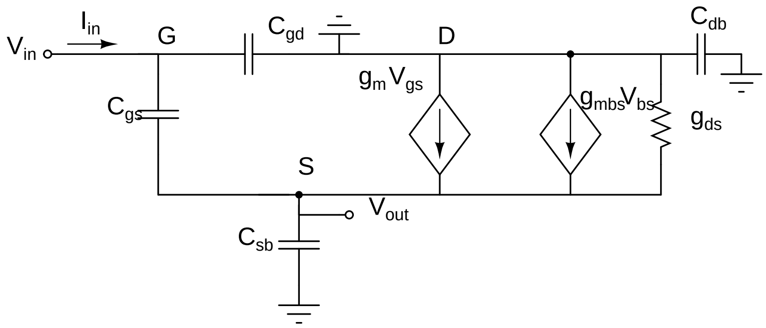

Figure 5: HIGH FREQUENCY EQUIVALENT CIRCUIT

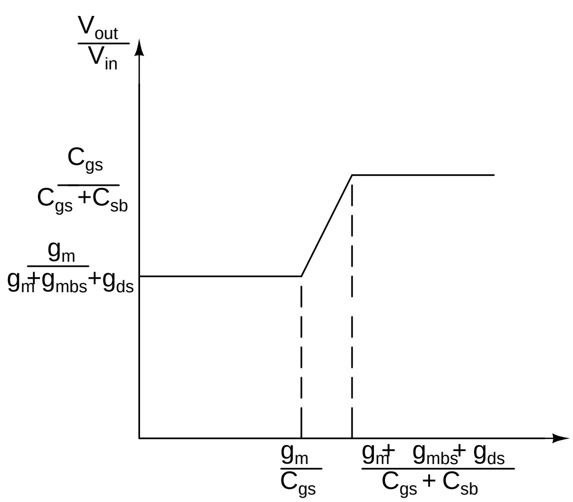

Figure 6: BODE PLOT FOR GAIN

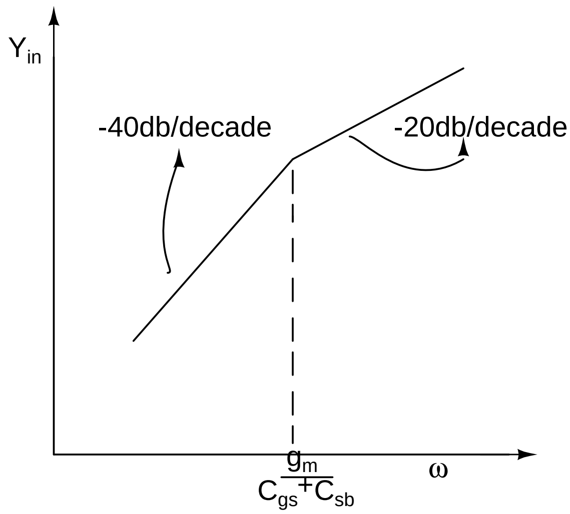

Figure 7: BODE PLOT OF OUTPUT ADMITTANCE

Output admittance

$$Y_{out} = g_m + g_{mbs} + g_{ds} + s(C_{gs} + C_{sb}) \tag{14}$$

Input admittance

$$I_{in} = (V_{in} - V_{out})sC_{gs} \tag{15}$$

$$I_{in} = V_{in}\frac{g_{mbs} + g_{ds} + sC_{sb}}{g_m + g_{mbs} + g_{ds} + s(C_{gs} + C_{sb})}sC_{gs} \tag{16}$$

Approximating,

$$I_{in} = V_{in}\frac{s^2 C_{sb} C_{gs}}{g_m + s(C_{gs} + C_{sb})} \tag{17}$$

$$Y_{in} = \frac{s^2 C_{sb} C_{gs}}{g_m + s(C_{gs} + C_{sb})} \tag{18}$$

- This shows it acts as a negative resistance and can be used in oscillators