Lecture 27

- Last time:
  - Current-source supplies
  - Common-gate amplifier
- Today :
  - Finish common-gate
  - Common-drain amplifier

Common-Gate Output Resistance

Substituting $v_s = i_t R_S$

$$i_t R_S \left(\frac{1}{R_S} + g_m + g_{mb} + \frac{1}{r_o} \right) = \frac{v_t}{r_o}$$

The output resistance is $(v_t / i_t) \| r_{oc}$

$$R_{out} = r_{oc} || (R_S [r_o / R_S + g_m r_o + g_{mb} r_o + 1])$$

Approximating the CG R_{out}

$$R_{out} = r_{oc} \,||\, [r_o + g_m r_o R_S + g_{mb} r_o R_S + R_S]$$

The exact result is complicated, so let's try to make it simpler:

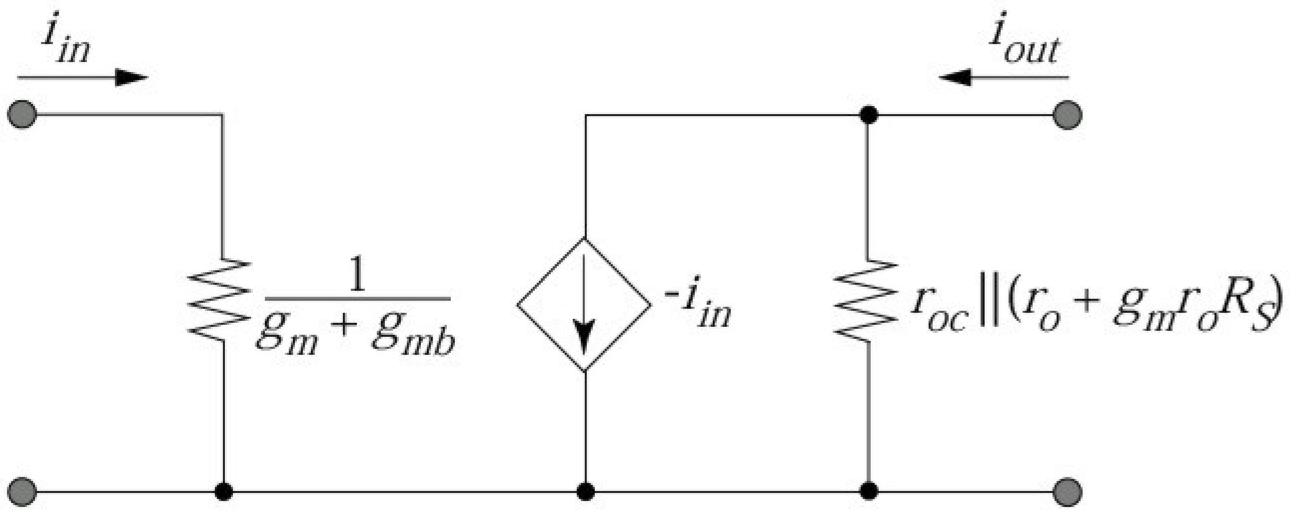
$$g_m \approx 500\mu S \quad g_{mb} \approx 50\mu S \quad r_o \approx 200k\Omega$$

$$R_{out} \cong r_{oc} \,||\, [r_o + g_m r_o R_S + R_S]$$

Assuming the source resistance is less than r_o,

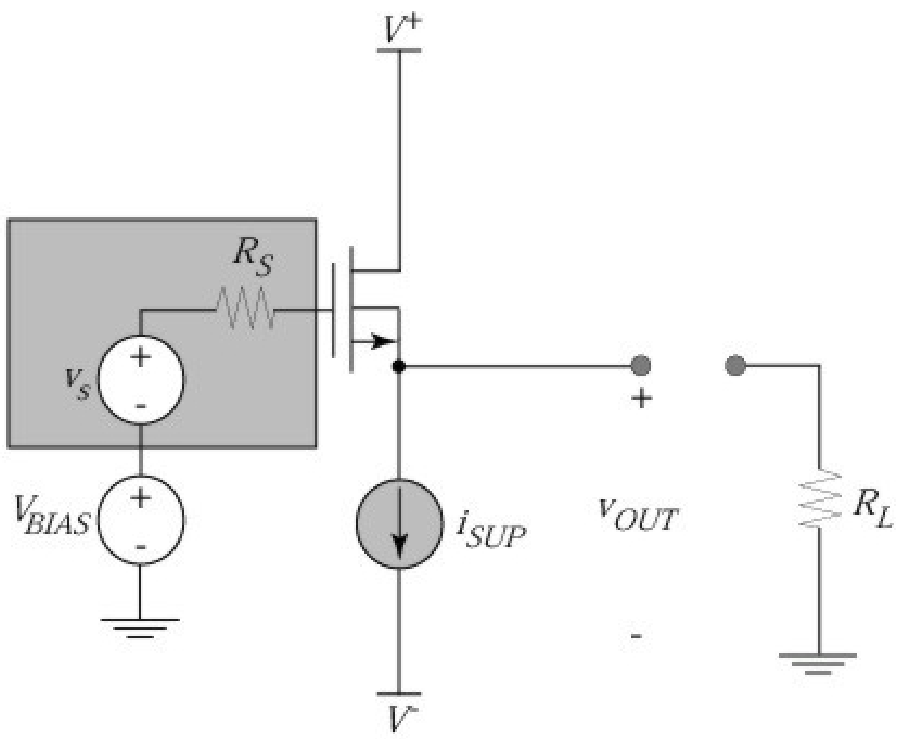
$$R_{out} \approx r_{oc} \,||\, [r_o + g_m r_o R_S] = r_{oc} \,||\, [r_o (1 + g_m R_S)]$$

Common-Gate Two-Port Model



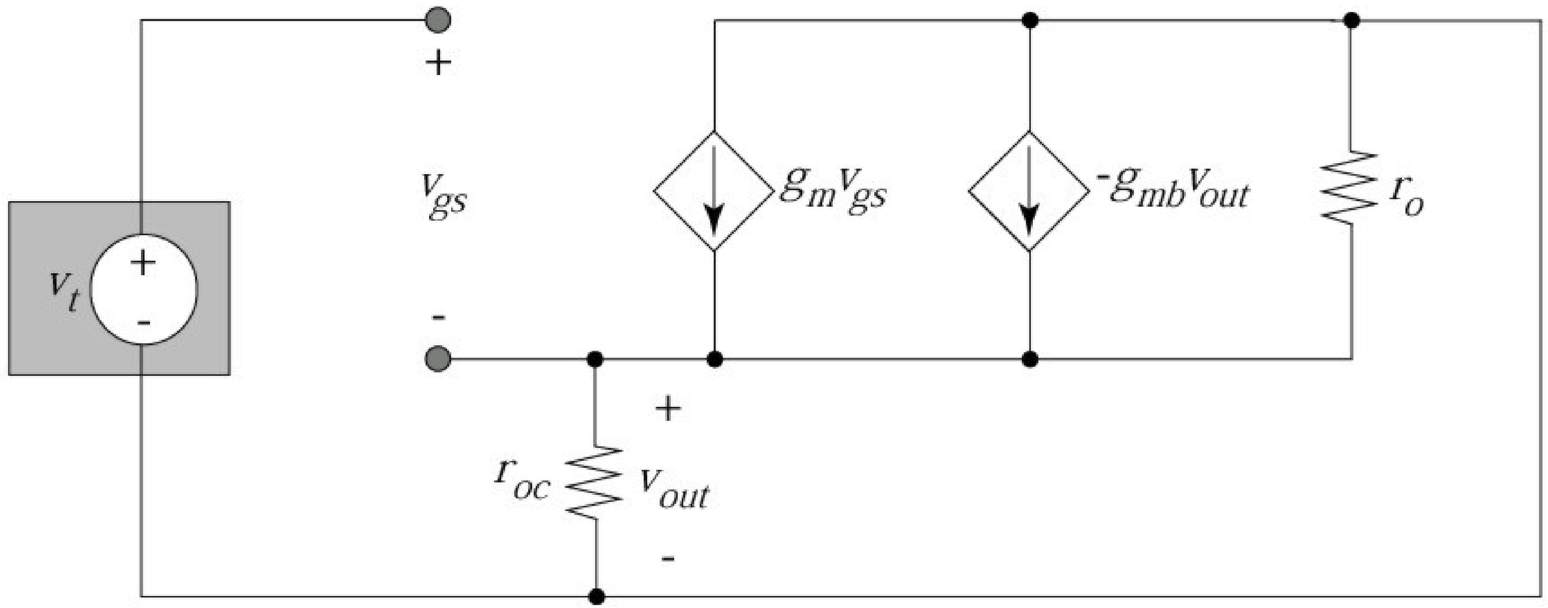
Function: a current buffer

Common-Drain Amplifier



Backgate terminal

CD Voltage Gain



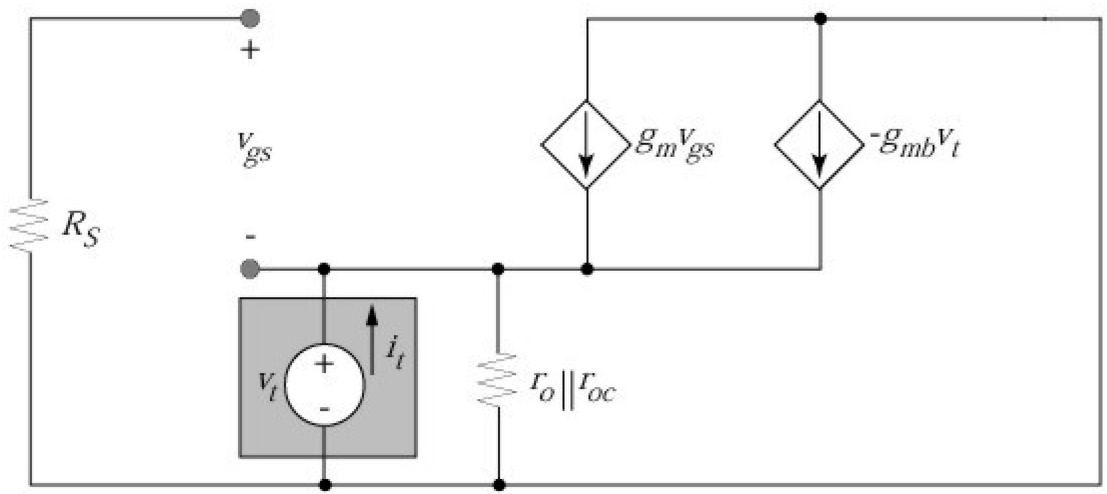
Note $v_{gs} = v_t - v_{out}$

CD Voltage Gain (Cont.)

KCL at source node:

Voltage gain (for v_{SB} not zero):

CD Output Resistance

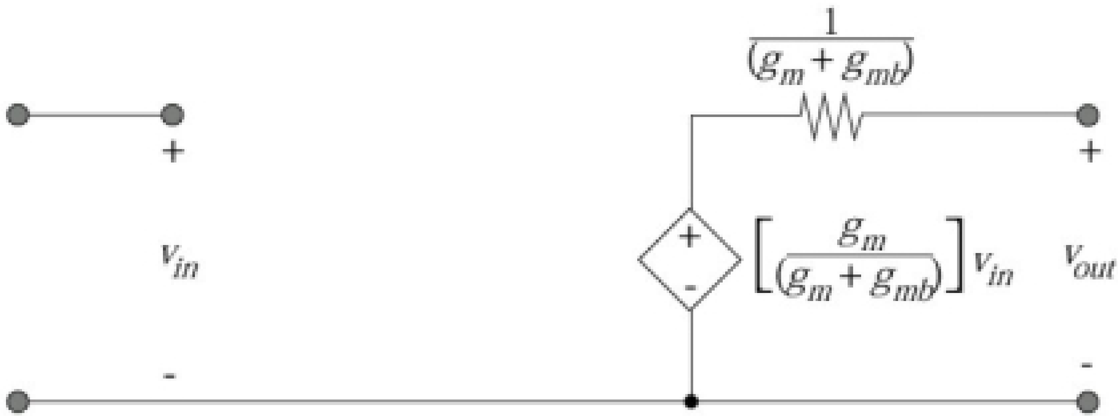


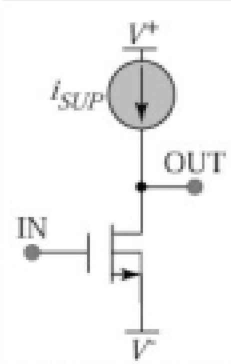
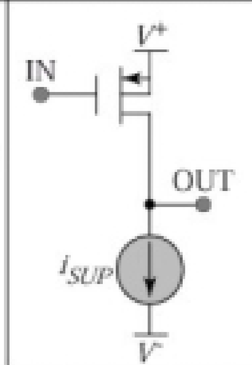
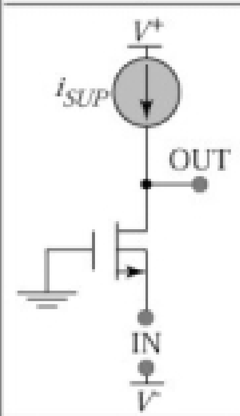
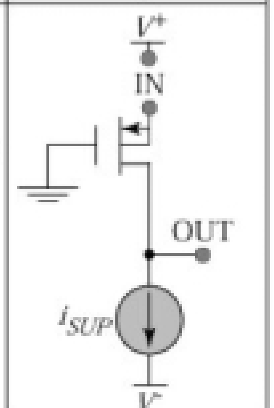
Sum currents at output (source) node:

CD Output Resistance (Cont.)

$r_o \| r_{oc}$ is much larger than the inverses of the transconductances → ignore

$R_{out} =$



	Transistor Type	
	NMOS	PMOS
Common Source/ Common Emitter (CS/CE)		
Common Gate/ Common Base (CG/CB)		
Common Drain/ Common Collector (CD/CC)