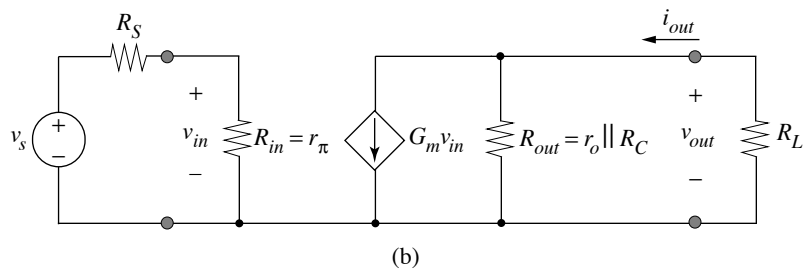
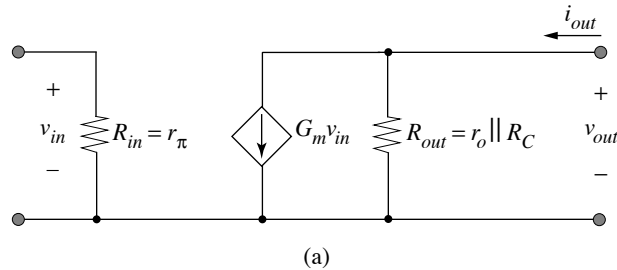


Two-Port Model: CE Amplifier

- Use transconductance amplifier form for model (*not* mandatory)
- $R_{in} = r_{\pi}$, $R_{out} = r_o \parallel R_C$, $G_m = g_m$ by inspection



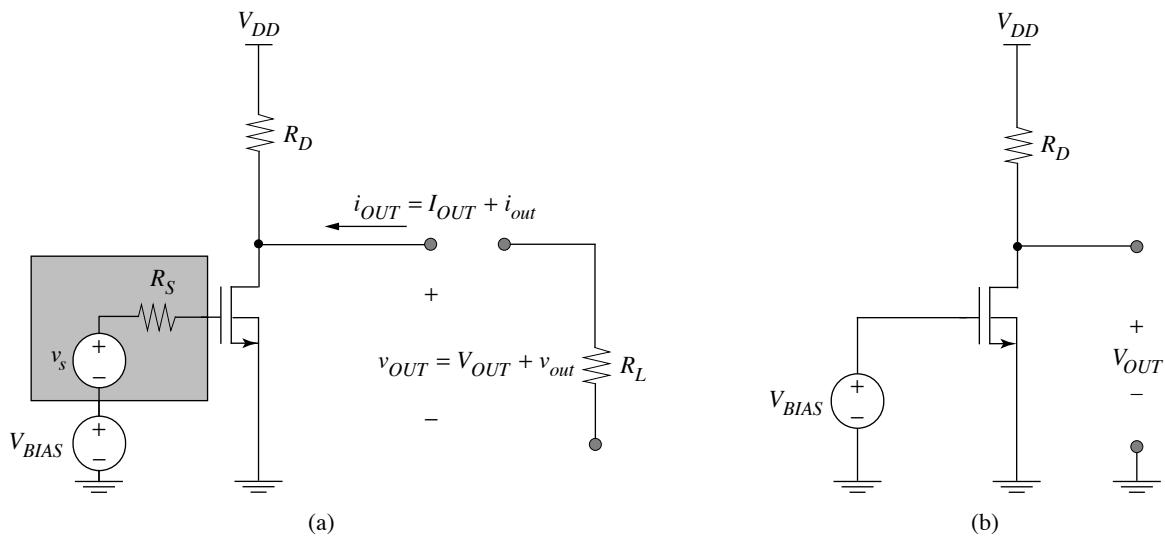
- Loaded ratio of i_{out} to v_{in}

$$G_m \left(\frac{R_{out}}{R_{out} + R_L} \right) = g_m \left(\frac{r_o \parallel R_C}{r_o \parallel R_C + R_L} \right)$$

Increasing R_C seems desirable for increasing i_{out} / v_{in} ... but note that the DC collector current decreases for a fixed V_{CC} --> g_m decreases

Common-Source Amplifier

- Configuration is similar to common-emitter

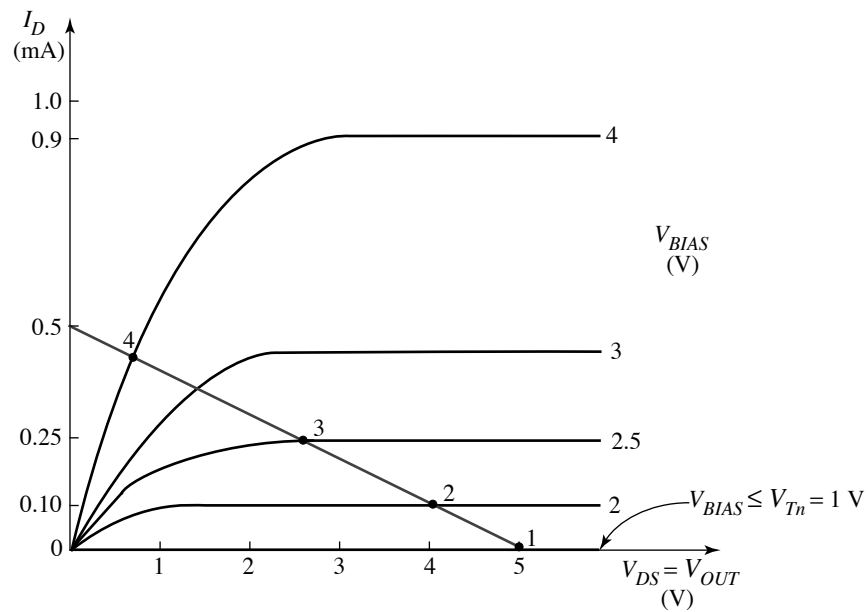


- Bias: remove source and load resistances (b)

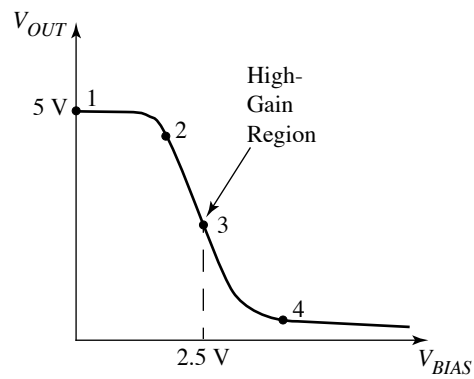
Graphical Load-Line Analysis

- Load line is given by:

$$I_D = (V_{DD} - V_{OUT})/R_D$$



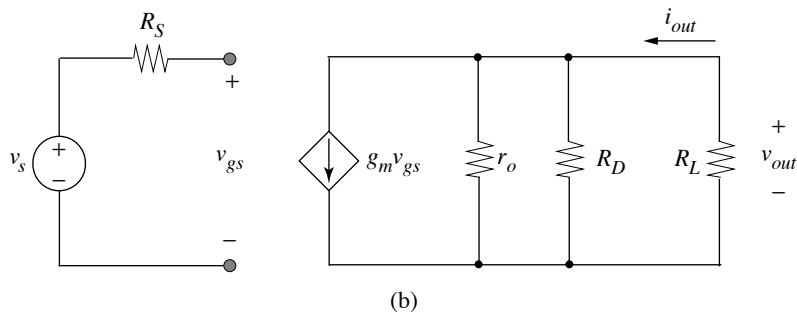
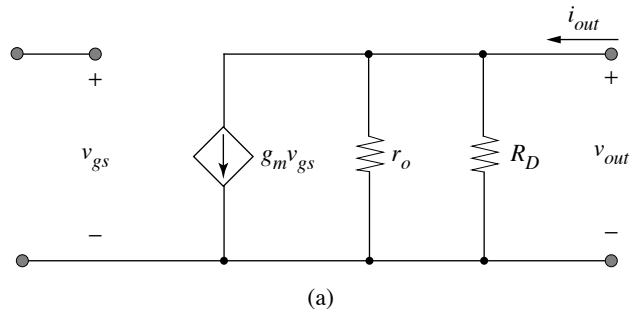
(a)



(b)

Small-Signal Model of CS Amplifier

- Substitute parameters at operating point selected so that $V_{OUT} \approx V_{DD}/2$

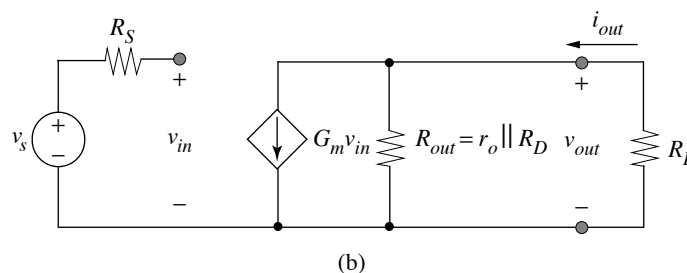
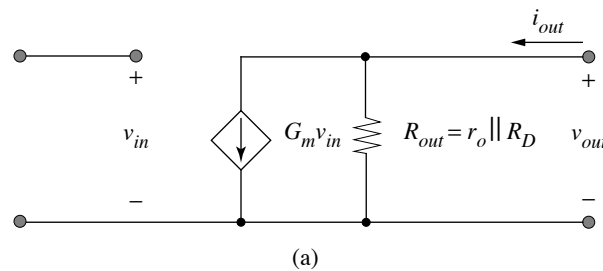


Transconductance is proportional to $I_D^{1/2}$ unlike bipolar transistor

Two-Port Model of Common-Source Amplifier

- Use transconductance amplifier form for model (most natural choice)

$R_{in} = \infty$, $R_{out} = r_o \parallel R_D$, $G_m = g_m$ by inspection

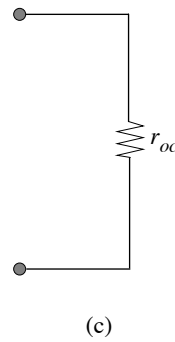
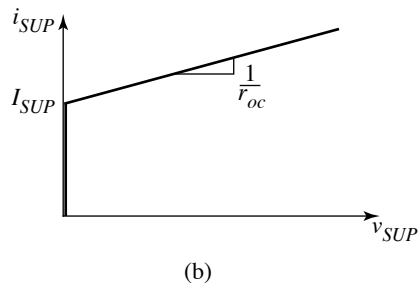
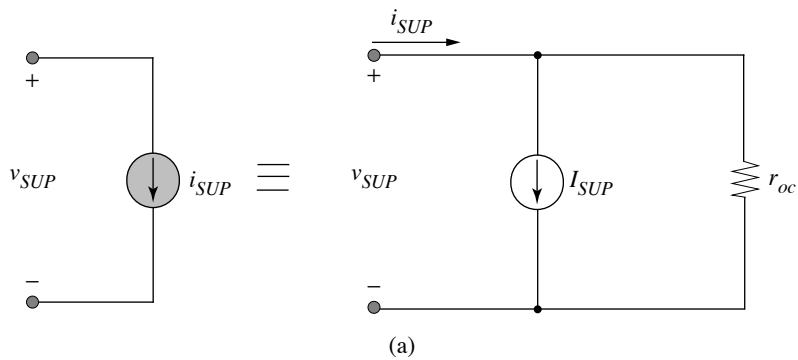


Infinite input resistance is ideal for a voltage input

Output resistance increases with R_D increasing, but DC drain current I_D will decrease and g_m will decrease with $I_D^{1/2}$

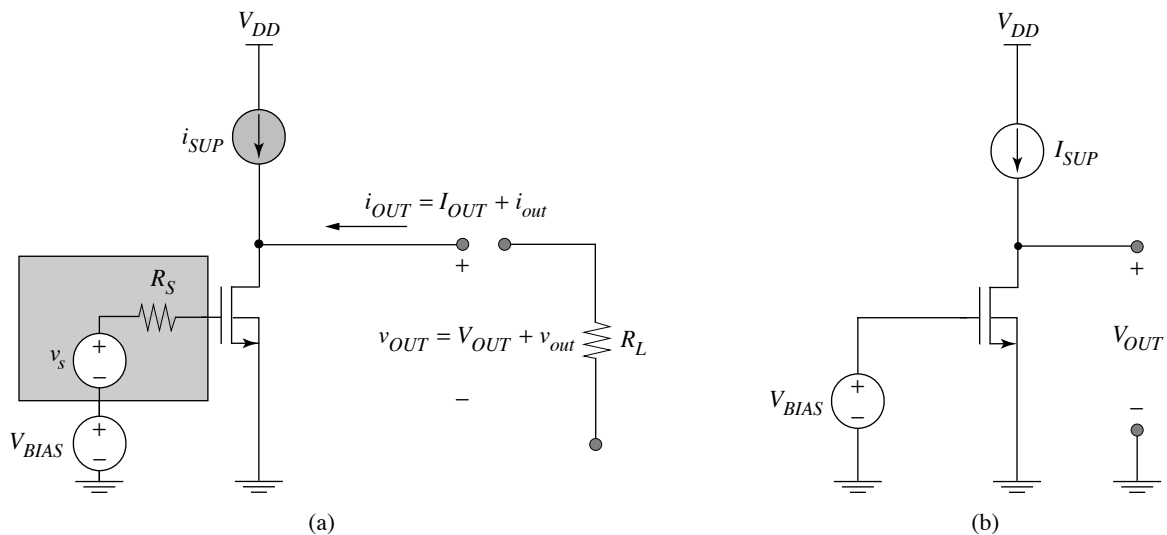
Current-Source Supplies

- A current source to supply current, rather than a resistor, allows a high DC current for the device with a large incremental (small-signal) resistance



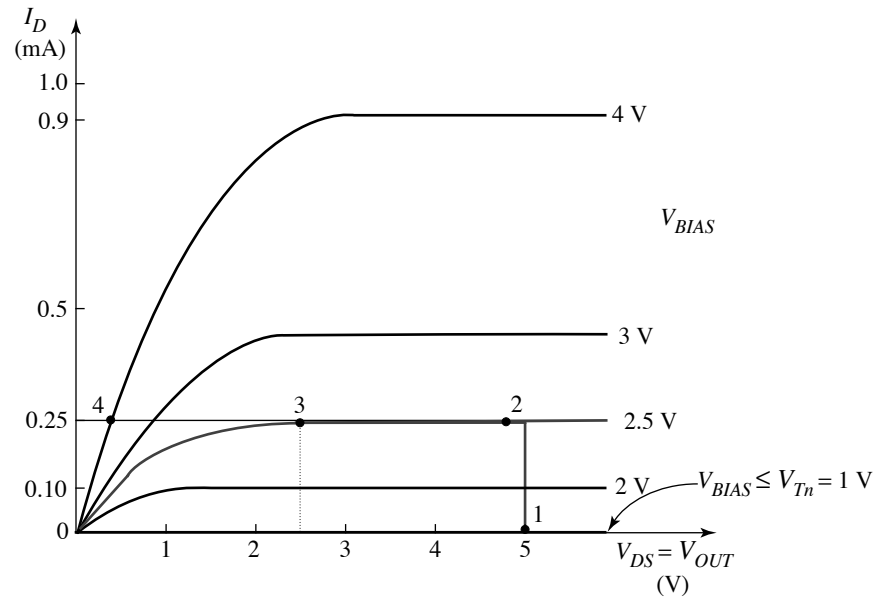
Common-Source with Current Source Supply

- R_D is replaced with idealized current source with internal resistance

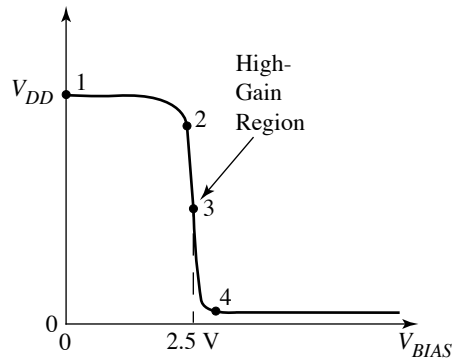


- For DC bias analysis, the small-signal source (with R_S) and the load resistor R_L are eliminated, along with the internal resistance r_{oc} of the current source

Graphical Analysis of CS Amplifier with Current-Source Supply



(a)

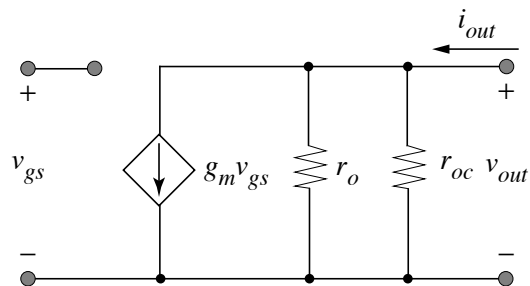


(b)

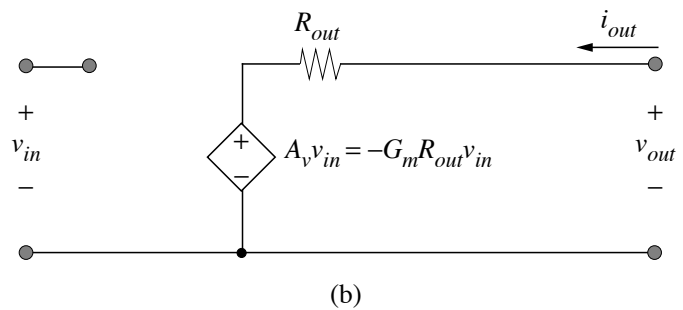
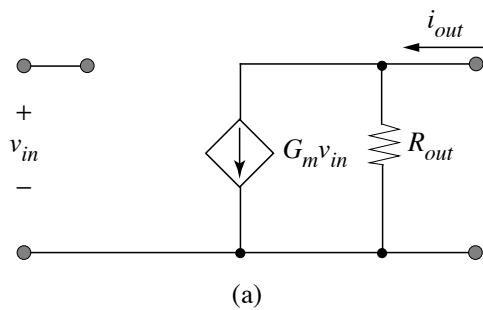
- The region of input bias voltage V_{BIAS} for which the current source and the MOSFET are in their constant-current regions is *extremely* small

Common-Source/Current-Source Supply Models

- The small-signal model is identical to the resistor supply, except that the current source's internal resistance r_{oc} replaces R_D

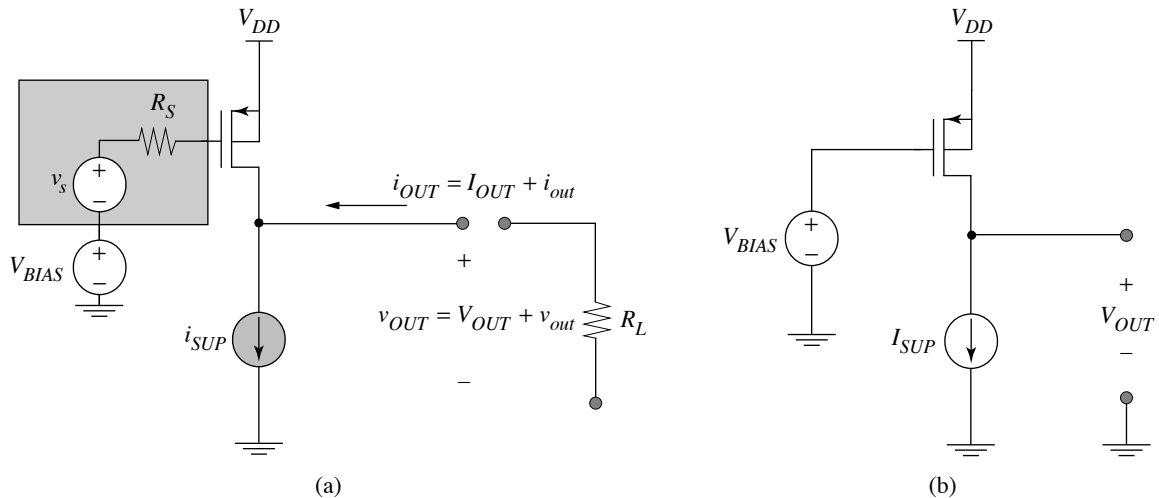


- Two-port model in both transconductance and voltage amplifier forms (the latter by direct conversion from the former ... by applying procedure for finding A_v)



p-Channel Common-Source Amplifier

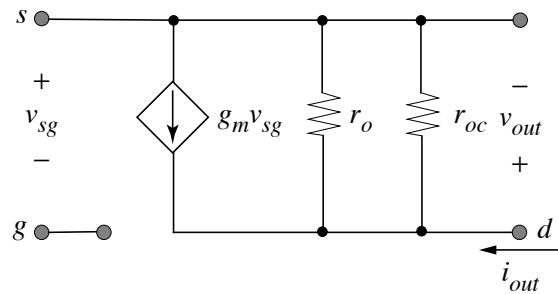
- Source of p-channel is tied to positive supply; current supply sinks I_{SUP} to ground or to lower supply



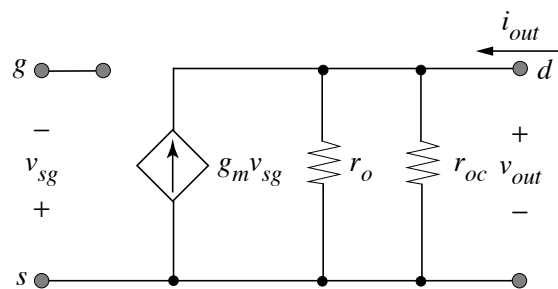
- Small-signal model: substitute p-channel model directly

p-Channel CS Small-Signal Model

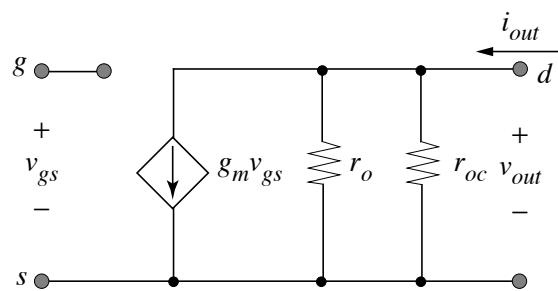
- Source is at top, but circuit can be inverted to show correspondence with n-channel common-source amplifier



(a)



(b)



(c)

