# ECE 342
# Electronic Circuits

# Lecture 9
# Common Source Amplifiers - 1

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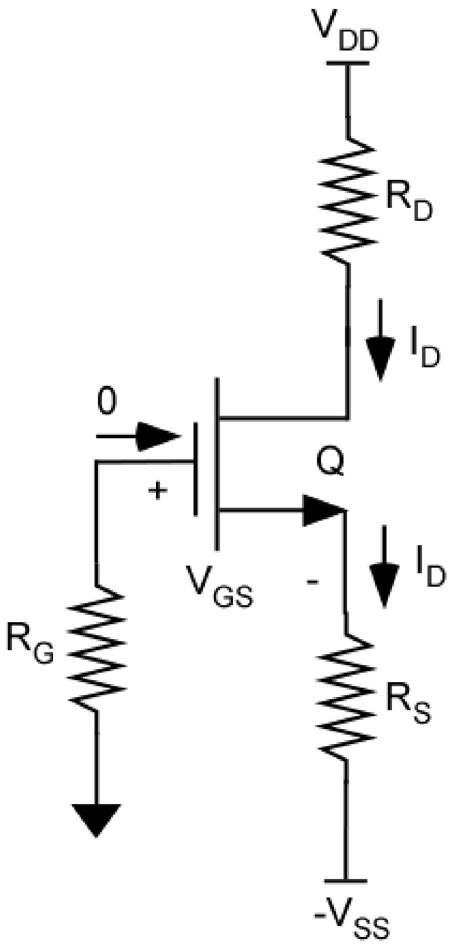
# Biasing of MOS Transistors

- **Bias Characteristics**
  - Operation in saturation region
  - Stable and predictable drain current

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}\left(V_{GS} - V_T\right)^2$$

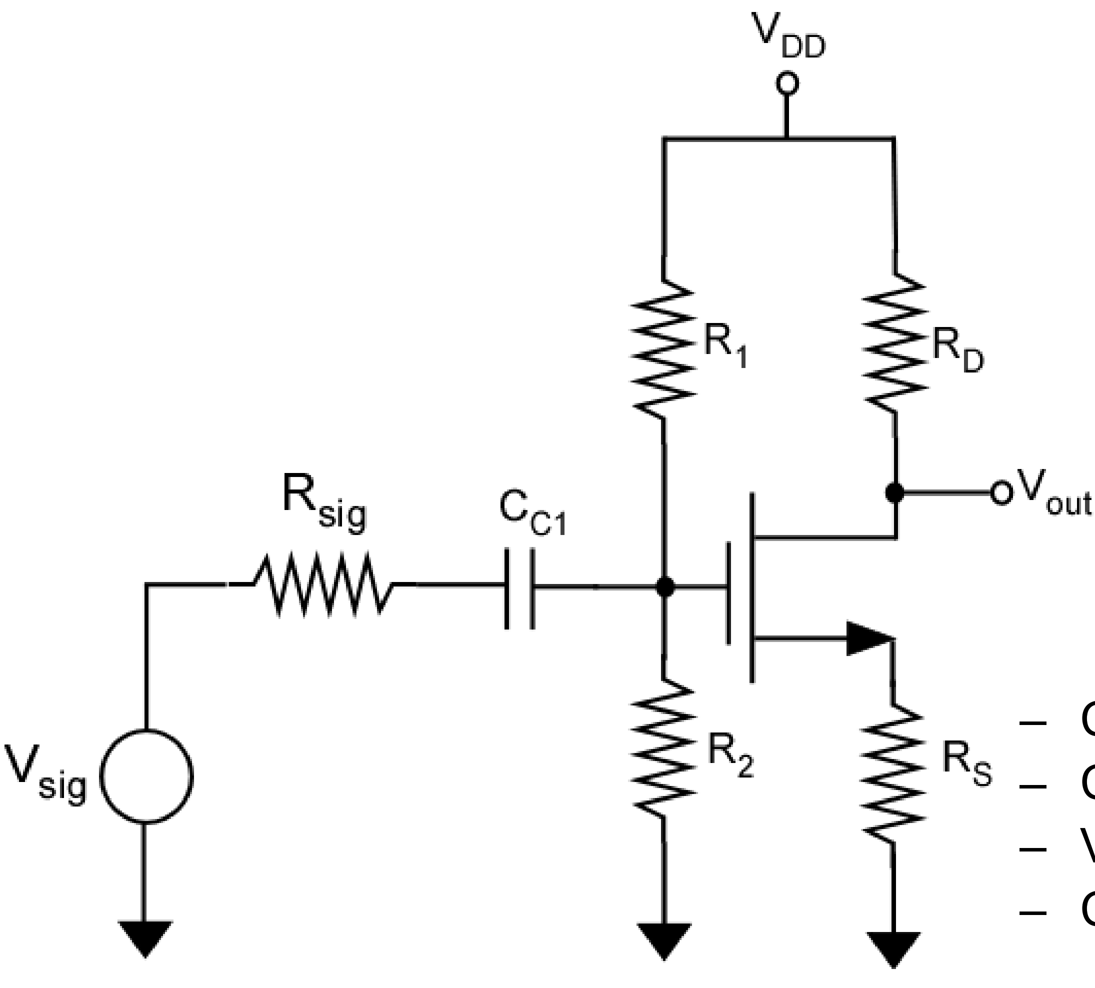
# Two-Supply MOS Bias




$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}\left(V_{GS} - V_T\right)^2$$

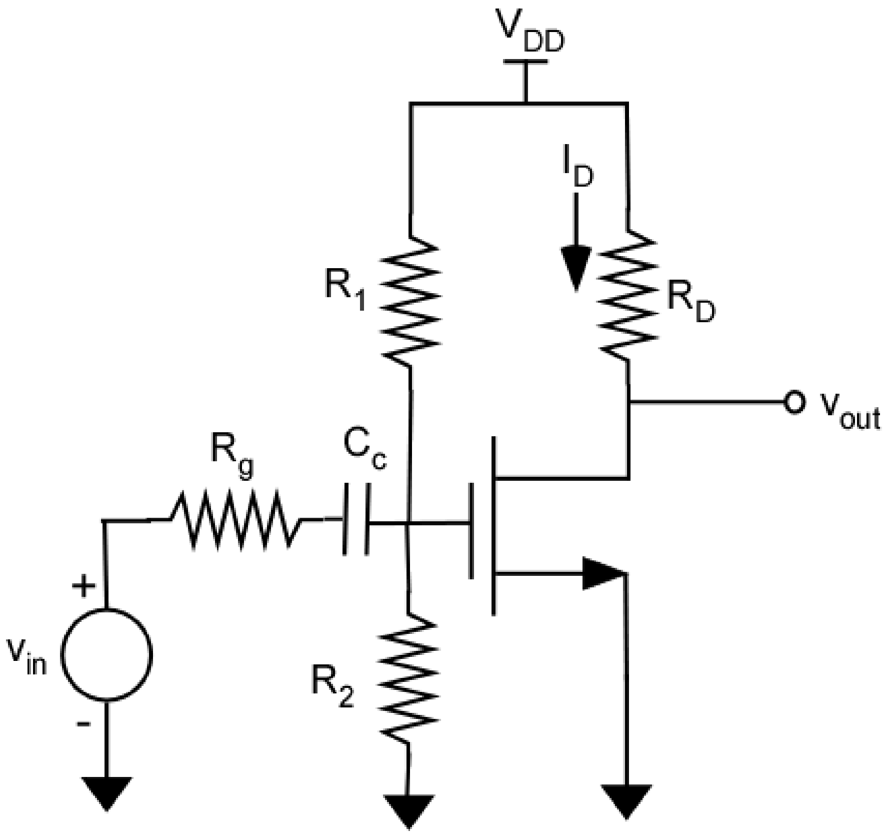
$R_G$ provides DC ground at gate and high input resistance to signal source.

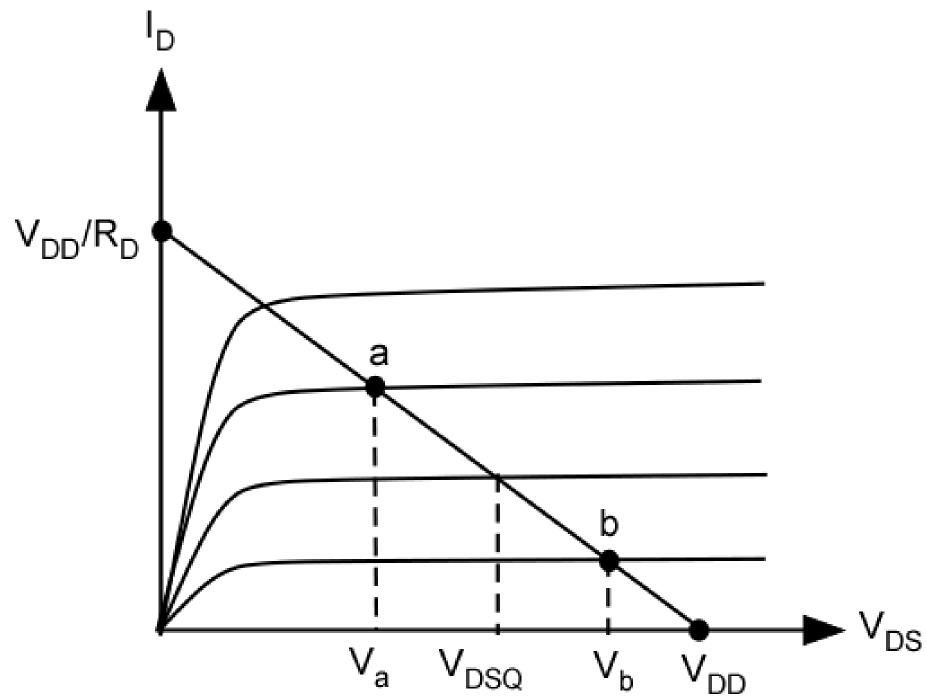
# Single-Supply MOS Bias




- Choose $R_1$ and $R_2$ to fix $V_G$
- Choose $R_S$ and $R_2$ to fix $V_S$
- $V_{GS}$ determines $I_D$
- Choose $R_D$ to fix $V_D$

# Common Source MOSFET Amplifier



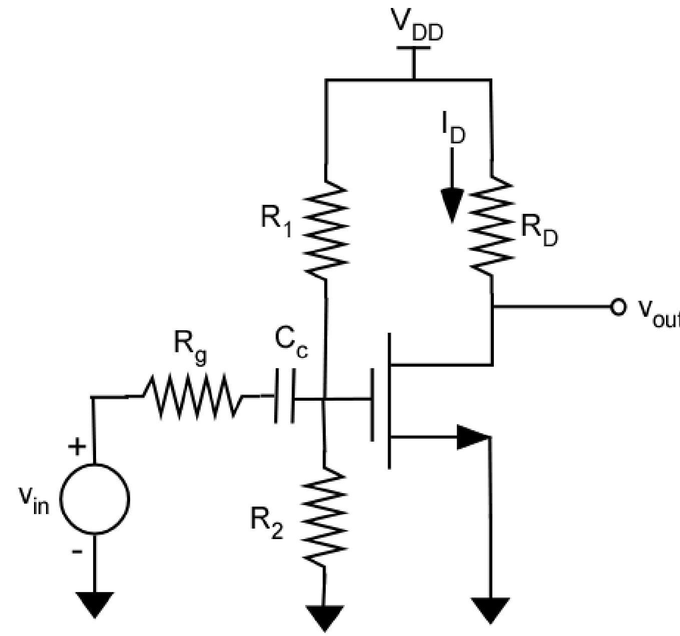




**Bias is to keep MOS in saturation region**

# Common Source MOSFET Amplifier

$$V_{DS} = V_{DD} - I_D R_D$$

$$V_{GS} = V_{GSQ} + v_{in}$$




$v_{in}$ **is a sinusoid**

$$V_{GS} = V_{GSQ} + B\sin\omega t$$

**For small-signal operation,**
**the value of $B$ must be much smaller than $V_{GSQ}$**

# CS Amplifier – DC Analysis

Find component values to establish a bias point of $I_D$=1 mA, $V_{DQ}$ = 5V and $V_{DS}$ = 3V. $V_{DD}$ = 15V and $K$ = 500 μA/V$^2$ and $V_T$ = 0.5 V

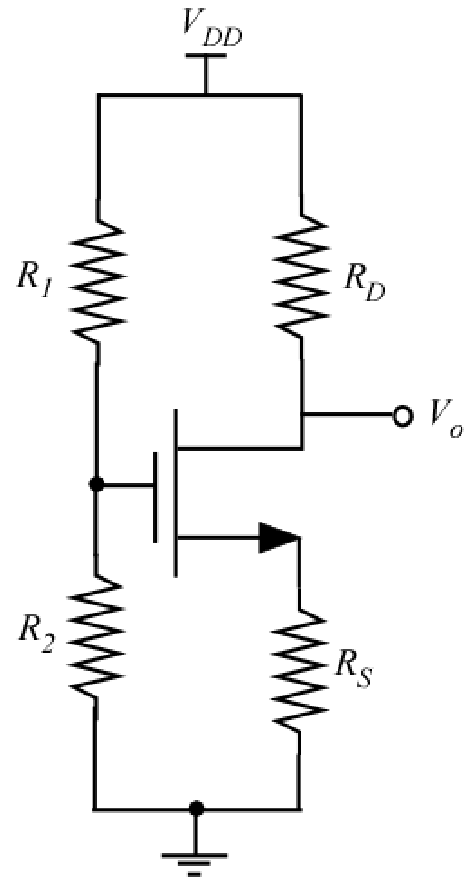
$$I_D = K\left(V_{GS} - V_T\right)^2$$

$$V_{GS} = V_T + \sqrt{\frac{I_D}{K}} = 0.5 + \sqrt{\frac{0.001}{0.0005}} = 1.91\,V$$

$$R_D = \frac{V_{DD} - V_{DQ}}{I_D} = \frac{15-5}{I_D} = \frac{10}{0.001} = 10\,k\Omega$$

$$V_S = V_{DQ} - V_{DS} = 5 - 3 = 2\,V$$

$$R_S = \frac{V_S}{I_D} = \frac{2}{1} = 2\,k\Omega$$



# CS Amplifier – DC Analysis

Need to find $R_1$ and $R_2$. First get $V_{GQ}$

$$V_{GQ} = V_{GS} + I_D R_S = 1.91 + 2 = 3.91V$$

Choose current through $R_1$ and $R_2$ to be 1 μA. Then, we have

$$R_1 + R_2 = \frac{15}{10^{-6}} = 15\ M\Omega$$

$$R_2 = (R_1 + R_2)\frac{V_{GQ}}{V_{DD}} = (15M\ )\frac{3.9}{15} = 3.9\ M\Omega$$

$$R_1 = 11.1\ M\Omega$$