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

\[ I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_T)^2 \]
Two-Supply MOS Bias

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

\( R_G \) 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 $I_D=1\, \text{mA}$, $V_D=5\, \text{V}$ and $V_{DS}=3\, \text{V}$. $V_{DD}=15\, \text{V}$ and $K=500\, \mu\text{A/V}^2$ and $V_T=0.5\, \text{V}$

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

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

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

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

$$ R_S = \frac{2}{I_D} = \frac{2}{0.001} = 2\, \text{k}\Omega $$
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

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

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

$$R_1 = 11.1 \text{ M}\Omega$$