ECE 342
Electronic Circuits

Lecture 10
Common Source Amplifiers - 2

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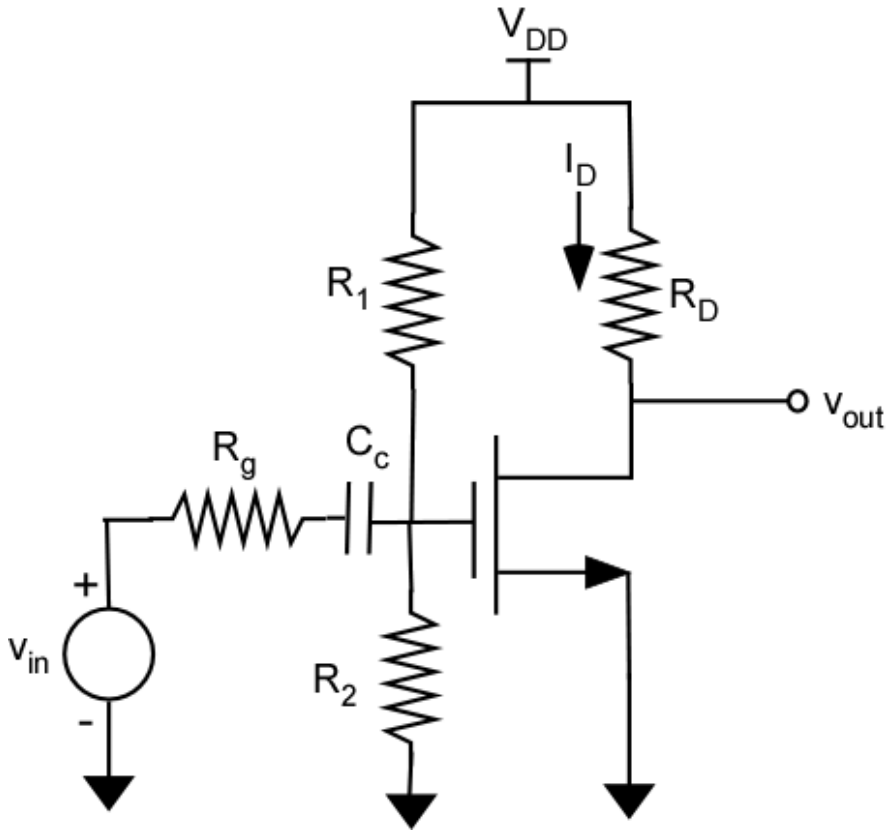
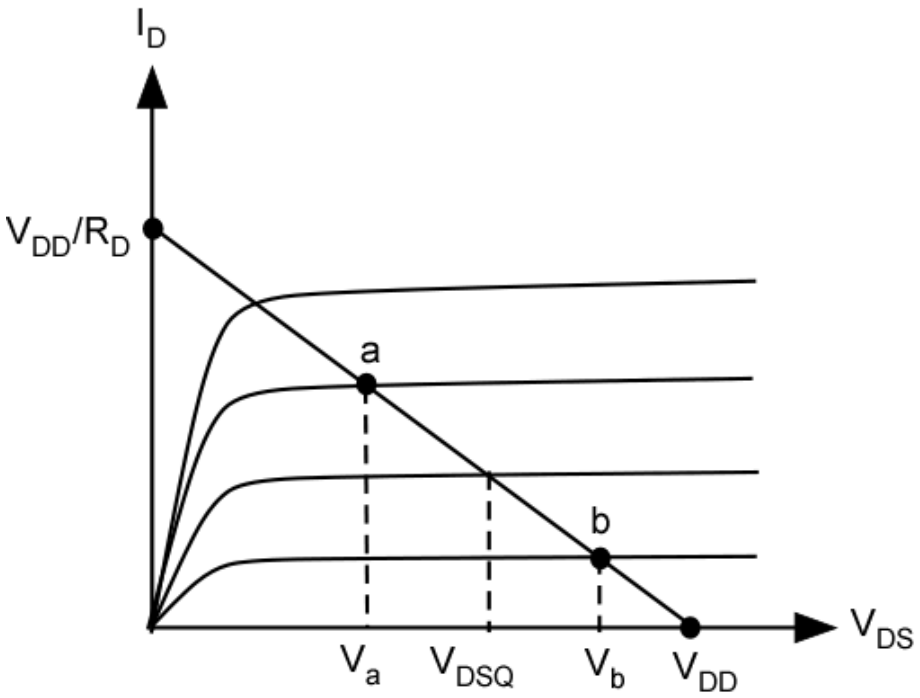
Common Source MOSFET Amplifier

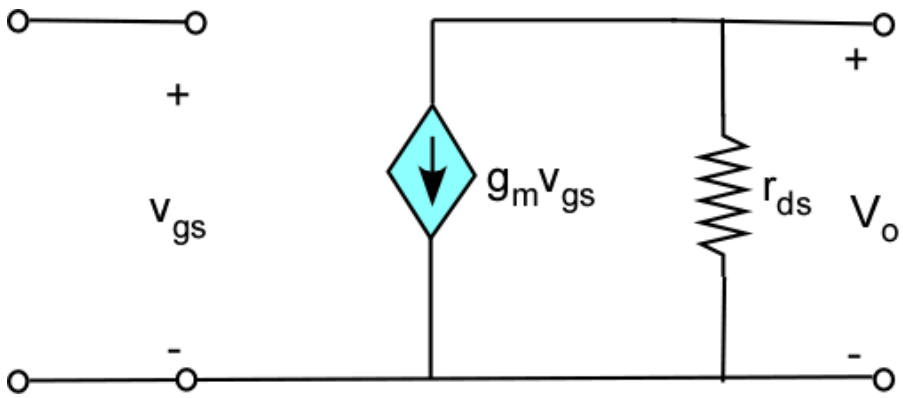




Bias is to keep MOS in saturation region

Common Source MOSFET Amplifier

Small-Signal Equivalent Circuit for MOS (device only)



$$I_D = \frac{1}{2} k_n' \frac{W}{L} (V_{GS} - V_T)^2$$

$$g_m = \left. \frac{\partial I_D}{\partial V_{GS}} \right|_{V_{GS}=V_{GSQ}} = \frac{2I_D}{V_{eff}}$$

$$where\ V_{GS} - V_T = V_{eff}$$

Which leads to

$$g_m = \sqrt{2k_n'} \sqrt{W/L} \sqrt{I_D}$$

$$g_m\ is\ proportional\ to = \sqrt{W/L}$$

MOSFET Output Impedance

To calculate r_{ds}, account for λ

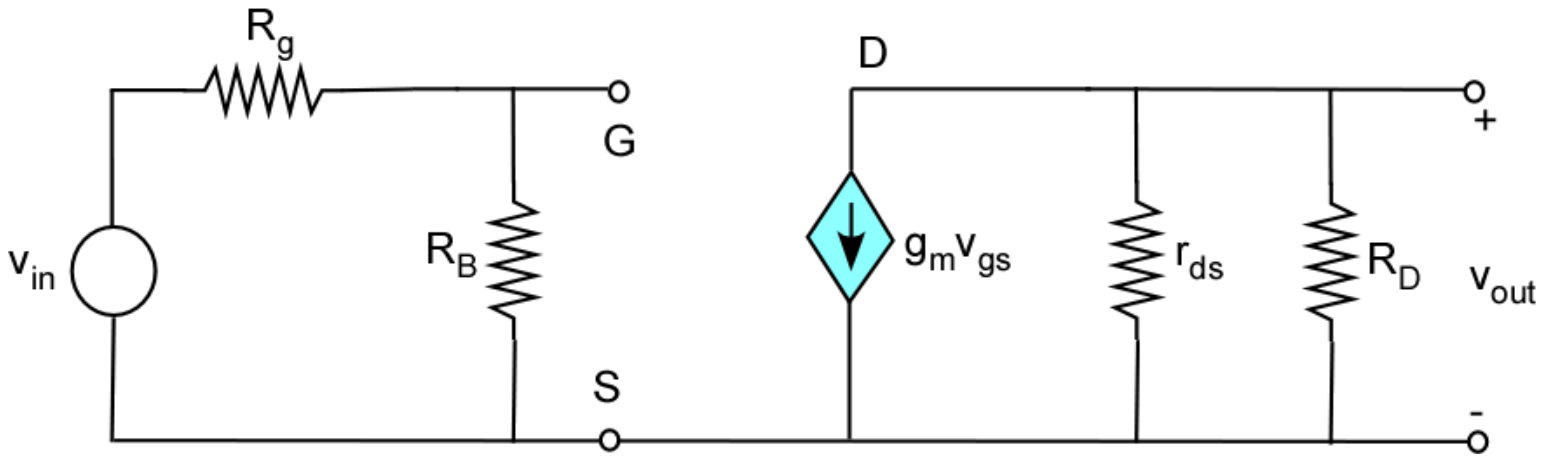
$$r_{ds} = \left.\frac{\partial V_{DS}}{\partial I_D}\right|_{V_{GS}=V_{GSQ}} = \frac{1}{\lambda\mu\frac{W}{2L}C_{ox}\left[V_{GS}-V_T\right]^2} = \frac{1}{\lambda I_{DP}}$$

$$I_{DP} = \frac{1}{2}k_n^{'}\frac{W}{L}\left(V_{GS}-V_T\right)^2$$

r_{ds}, accounts for channel width modulation resistance.

Midband Frequency Gain

Incremental model for complete amplifier



$$A_{MB} = \frac{v_{out}}{v_{in}} = -\frac{R_B}{R_B + R_g} g_m \frac{r_{ds} R_D}{r_{ds} + R_D}$$

where $$R_B = R_1 \,||\, R_2 = \frac{R_1 R_2}{R_1 + R_2}$$