

ECE 523/421 – Analog Electronics

Lecture 6: Analog IC Building Blocks: Basic Gain Cells

Payman Zarkesh-Ha

Office: ECE Bldg. 230B

Office hours: Tuesday 2:00-3:00PM or by appointment

E-mail: pzarkesh@unm.edu

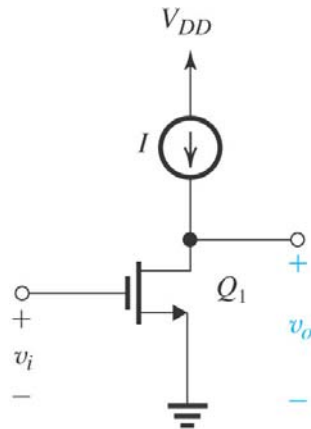
Review of Last Lecture

- ☐ **AC analysis on BJT Circuits**
- ☐ **Basic BJT Amplifier Configurations**
- ☐ **Some Examples**

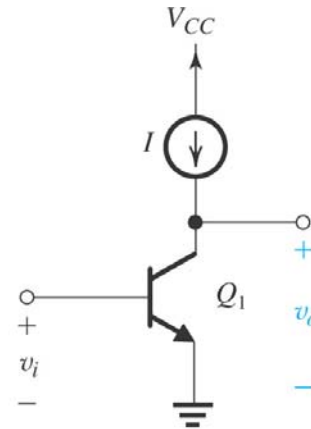
Today's Lecture

- ☐ **Intrinsic NMOS and BJT Gain**
- ☐ **CS and CE Amplifiers with Active Load**

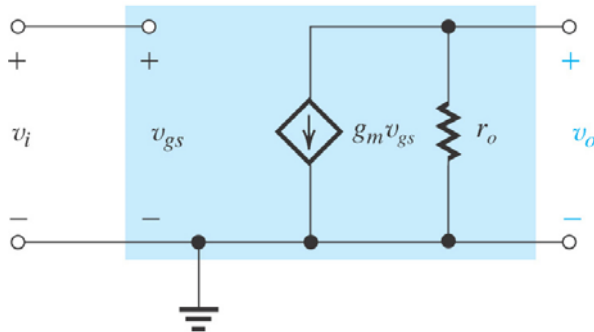
Basic CS and CE Amplifiers with Active Load



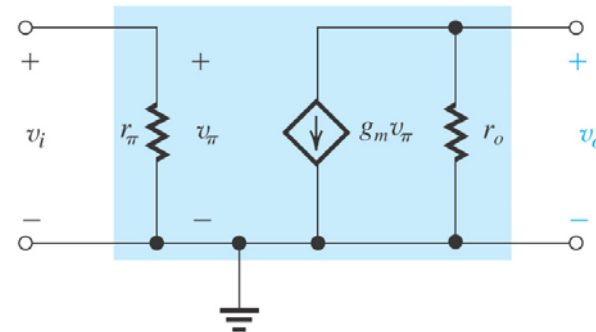
(a)



(b)

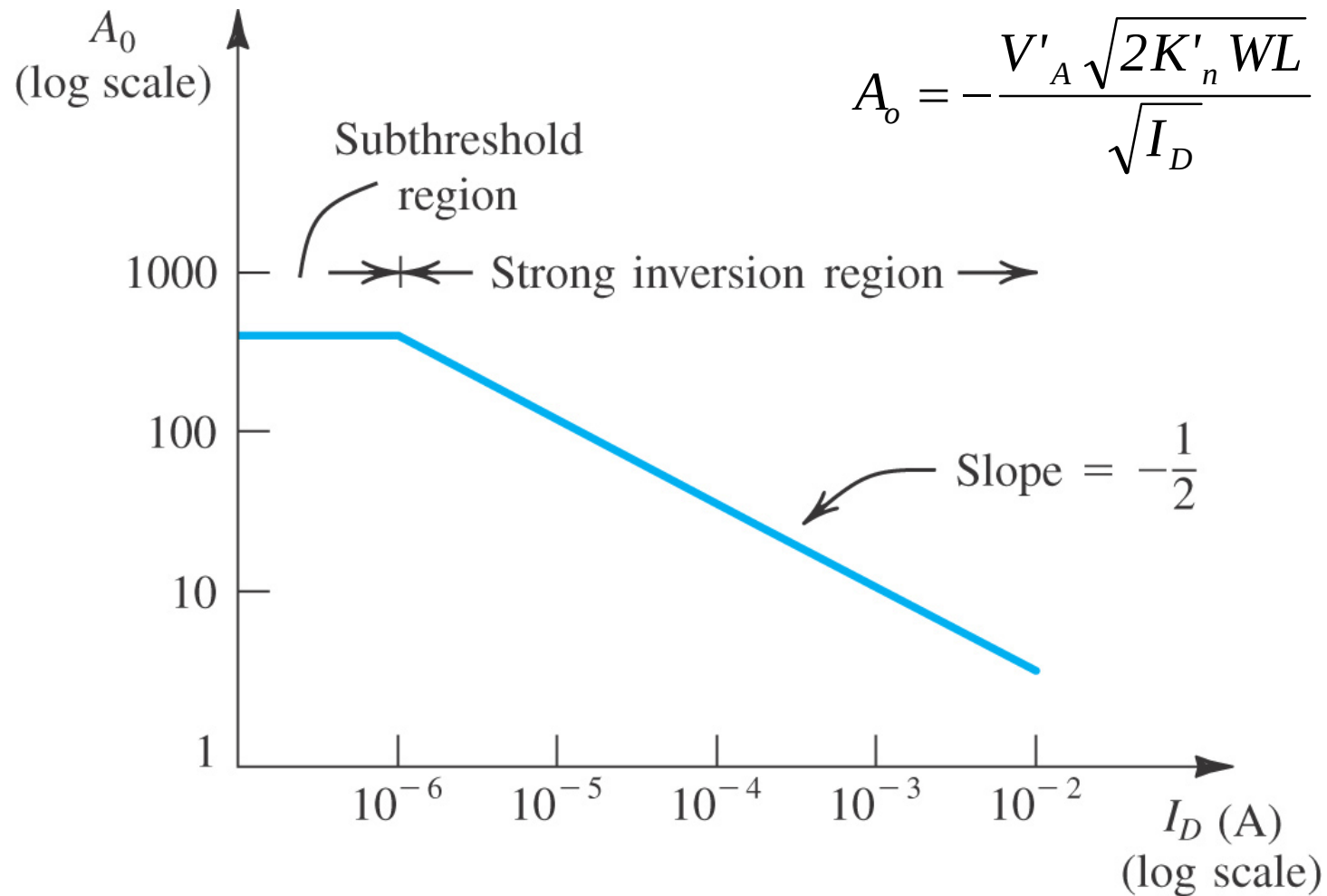


$$A_o = -\frac{V'_A \sqrt{2K'_n WL}}{\sqrt{I_D}}$$



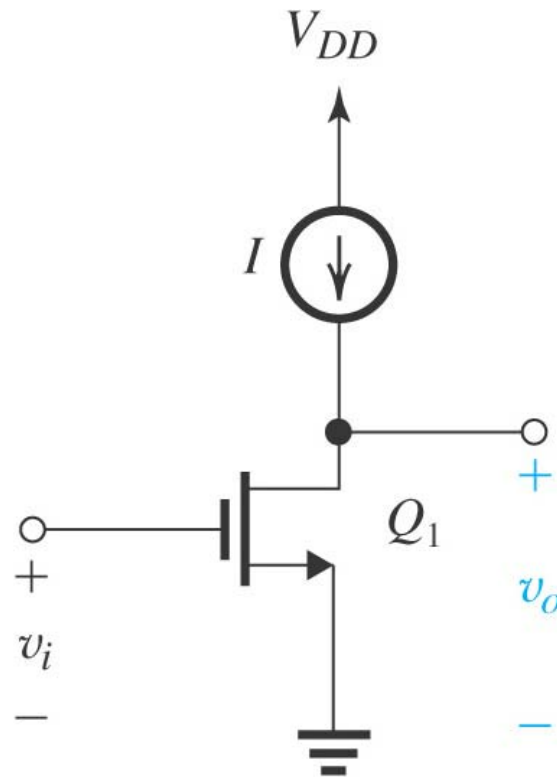
$$A_o = -\frac{A_A}{V_T}$$

Intrinsic Gain of a MOSFET

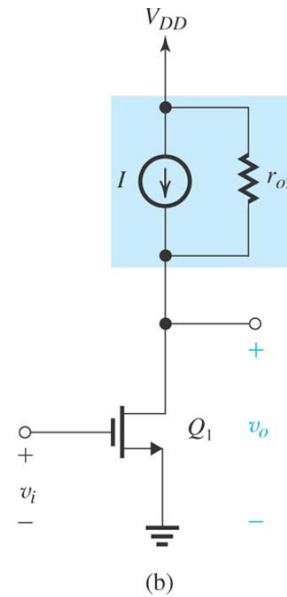
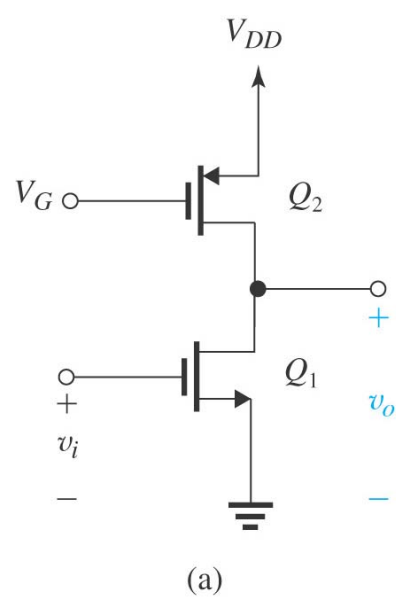


Example: Common Source Design I

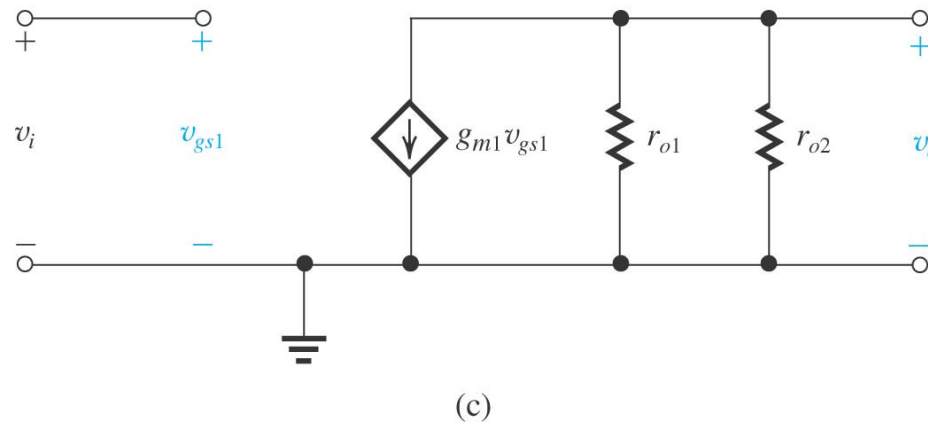
- 1) A CS amplifier uses an NMOS with $L=0.36\mu\text{m}$, $W/L=10$, $K'_n=387\mu\text{A/V}^2$, $V'_A=5\text{ V}/\mu\text{m}$. Find, g_m and A_o , when $I_D=10\mu\text{A}$, $100\mu\text{A}$, and 1mA .



Effect of Current Source Output Resistance

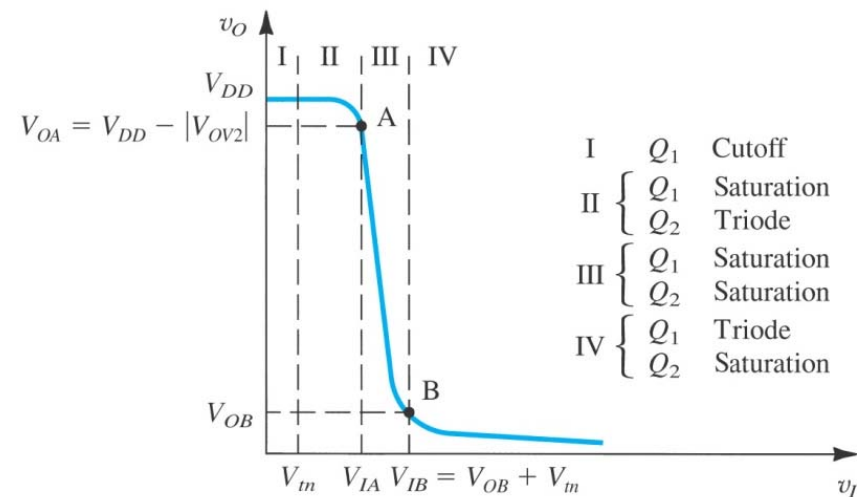
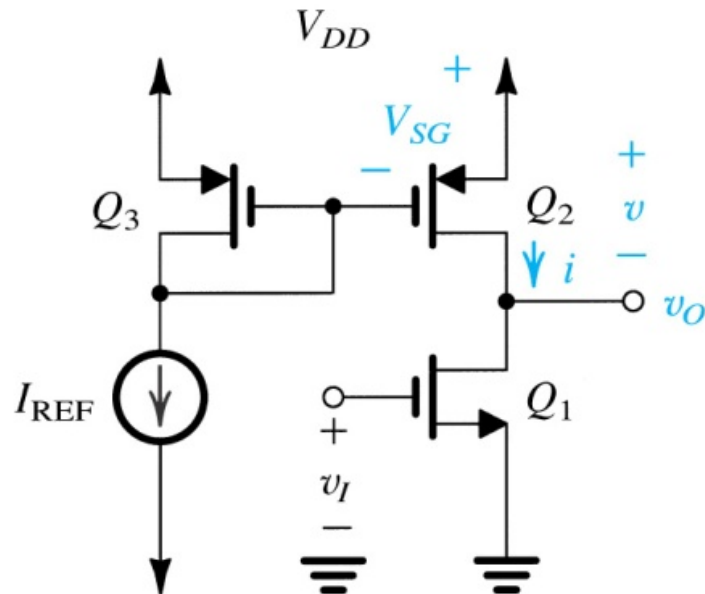


$$A_o \approx -\frac{1}{2} g_m r_o$$



Example: CS Amplifier with Active Load

- 1) Find the gain of the following CS amplifier with active load. Assume that $V_{DD}=3V$, $V_{tn}=-V_{tp}=0.6V$, $K'_n=200\mu A/V^2$, $K'_p=65\mu A/V^2$, $L=0.4\mu m$, $W=4\mu m$, $V_{An}=20V$, $V_{Ap}=-10V$, $I_{REF}=100\mu A$.



Example: CE Amplifier with Active Load

- 1) Find the gain, R_{in} , r_o , and g_m of CE amplifier with active load (similar to previous example but using BJT devices). Assume that $V_{An} = -V_{Ap} = 50V$, $I_{REF} = 0.1mA$, and $\beta = 100$.