EE105 – Fall 2015
Microelectronic Devices and Circuits

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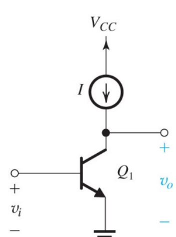
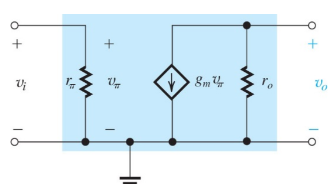
Basic BJT Gain Cells with Ideal Current Source Load





$$R_{in} = r_\pi$$
$$R_o = r_o$$
$$A_{vo} = -g_m r_o$$

$$g_m = \frac{I_C}{V_T} \quad , \quad r_o = \frac{V_A}{I_C}$$

$$A_{vo} = -\frac{V_A}{V_T}$$

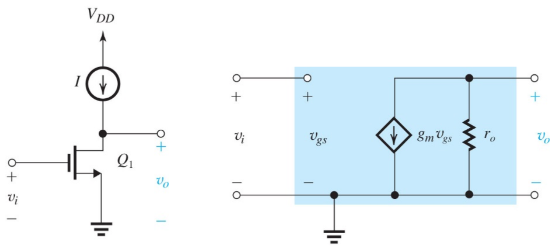
In modern IC, V_A ranges from 5 to 35V

$|A_{vo}| \sim 200$ to 1400 V/V

In discrete BJT, V_A ranges from 100 to 130V

$|A_{vo}|$ up to 5000 V/V

Basic Gain Cells with Ideal Current Source Load



$R_{in} = \infty$

$R_o = r_o$

$A_{vo} = -g_m r_o$

$$g_m = \frac{2I_D}{V_{OV}} = \sqrt{2\mu_n C_{ox}(W/L)I_D}$$

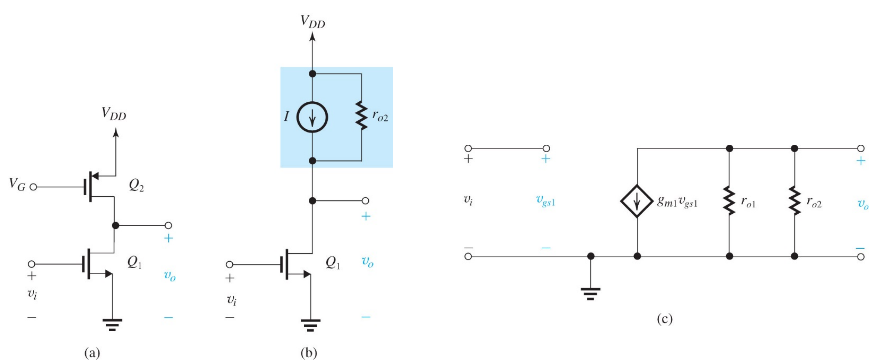
$$r_o = \frac{V_A}{I_D}$$

$$|A_{vo}| = \frac{2V_A}{V_{OV}}$$

$V_{OV} \sim 0.15$ to 0.3 V $\Rightarrow$ MOSFET gain is about 5x lower than BJT

Note: Early voltage in MOSFET is proportional to channel length, $V_A = V_A' L$

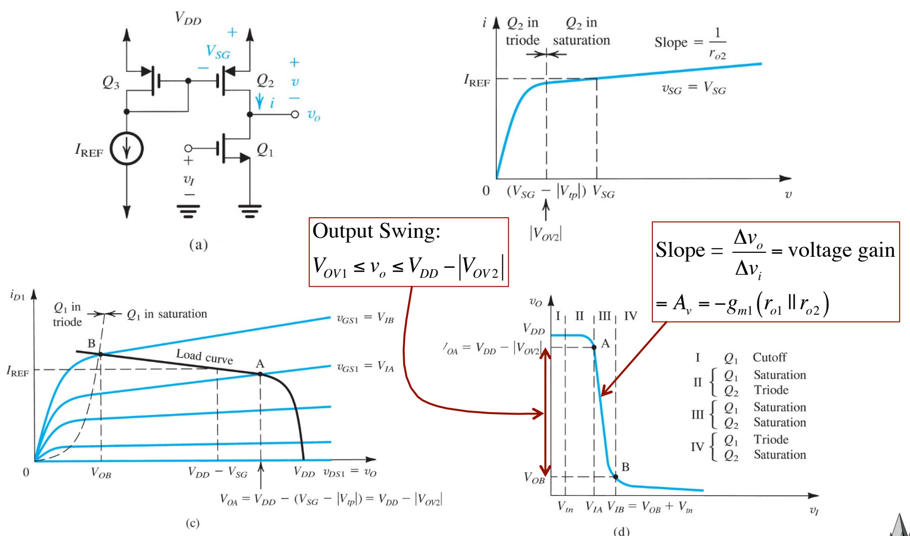
Output Resistance of Current Source Load



Active load behaves like current source with finite output resistance, r_{o2}

$A_v = -g_{m1}(r_{o1} \parallel r_{o2})$

Graphical Solution of Voltage Transfer Curve



Output Swing:

$$V_{OV1} \le v_o \le V_{DD} - |V_{OV2}|$$

$$\text{Slope} = \frac{\Delta v_o}{\Delta v_i} = \text{voltage gain}$$

$$= A_v = -g_{m1}\left(r_{o1} \,\|\, r_{o2}\right)$$