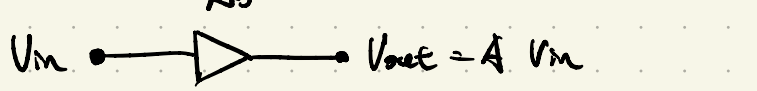
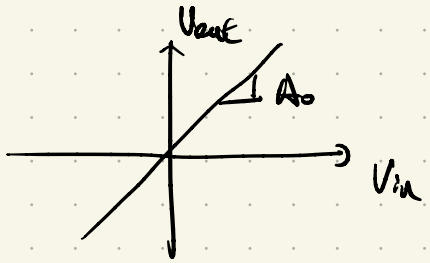
Lec 8.

- Intuitive study of Bipolar Differential Pair
- Common mode and Differential characteristics.

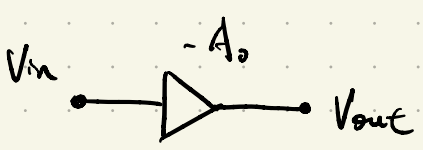
Example:

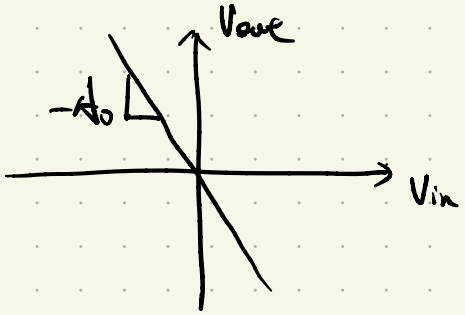


Construct the input-output relationship of this circuit.



slope = gain

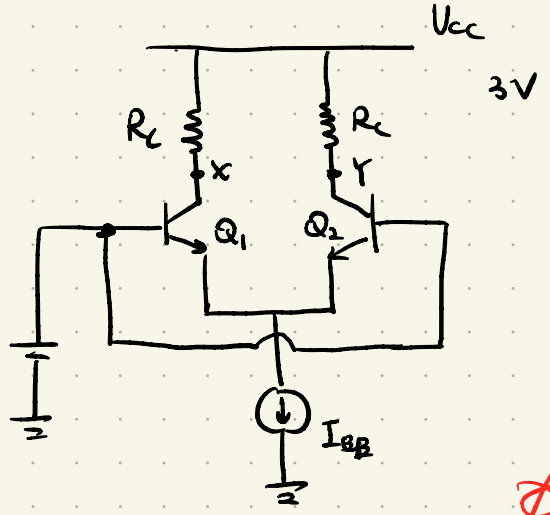




- Bipolar Differential Pair

Case I:

I_{C1}, I_{C2}, V_X, V_Y ?



Due to symmetry

$I_{C1} = I_{C2} = \frac{1}{2} I_{BB}$

$V_X = V_Y = V_{CC} - \frac{1}{2} I_{BB} R_C$

The differential pair rejects perturbations in the input common mode level

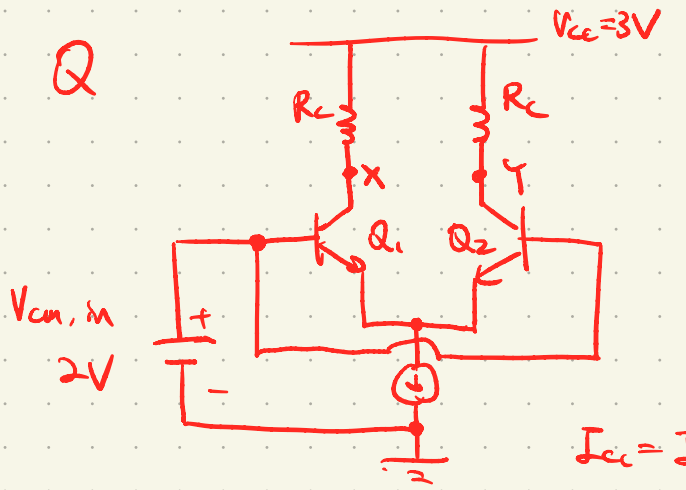
$\Rightarrow$

If $V_{in1} - V_{in2} = 0$ then $V_X - V_Y = 0$

$V_{in1} - V_{in2}$: Differential Input Voltage

$V_X - V_Y$: Differential Output Voltage

Q



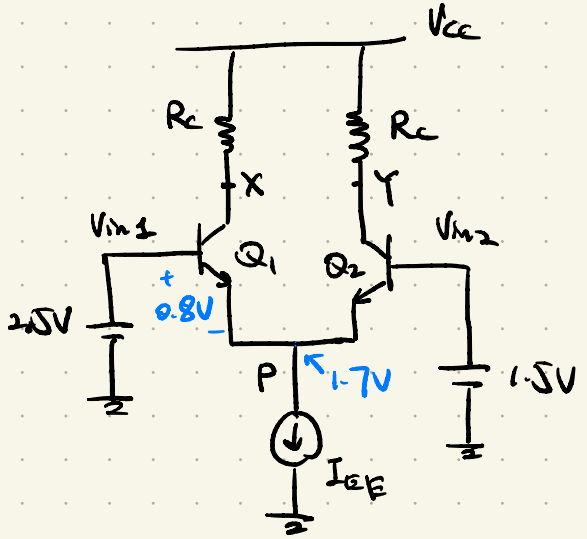
$$I_c = I_s e^{V_{BE}/V_T}$$

$$I_{c1} = I_{c2} = I_{EE}/2$$

$$V_X = V_{cc} - \frac{1}{2} I_{EE} R_c$$

$$V_Y = V_{cc} - \frac{1}{2} I_{EE} (R_c + \Delta R)$$

Case II:



Guess: Q_1 is on and has some current

$\Rightarrow V_p = 2.5 - 0.8 = 1.7V \Rightarrow Q_2$ off

then

$$I_{c1} = I_{EE} \qquad I_{c2} = 0$$

then

$$V_X = V_{cc} - R_c \cdot I_{EE}$$

$$V_Y = V_{cc}$$

$\Rightarrow$ $V_X - V_Y$ is a function of $V_{in1} - V_{in2}$

Case III

$$V_{in1} = 1.5V, \quad V_{in2} = 2.5V$$

$\Rightarrow$ $I_{c1} = 0 \quad I_{c2} = I_{EE}$

$$V_X = V_{cc}, \quad V_Y = V_{cc} - I_{EE} R_c$$

First, Input - Output charac.