

11.04.2011



Midterm Exam

13 April 2011

Wednesday

1440-1630

B328-401

A3 with your handwritings. No photocopy.  
(or 2xA4) with your names and numbers on the forms (papers).

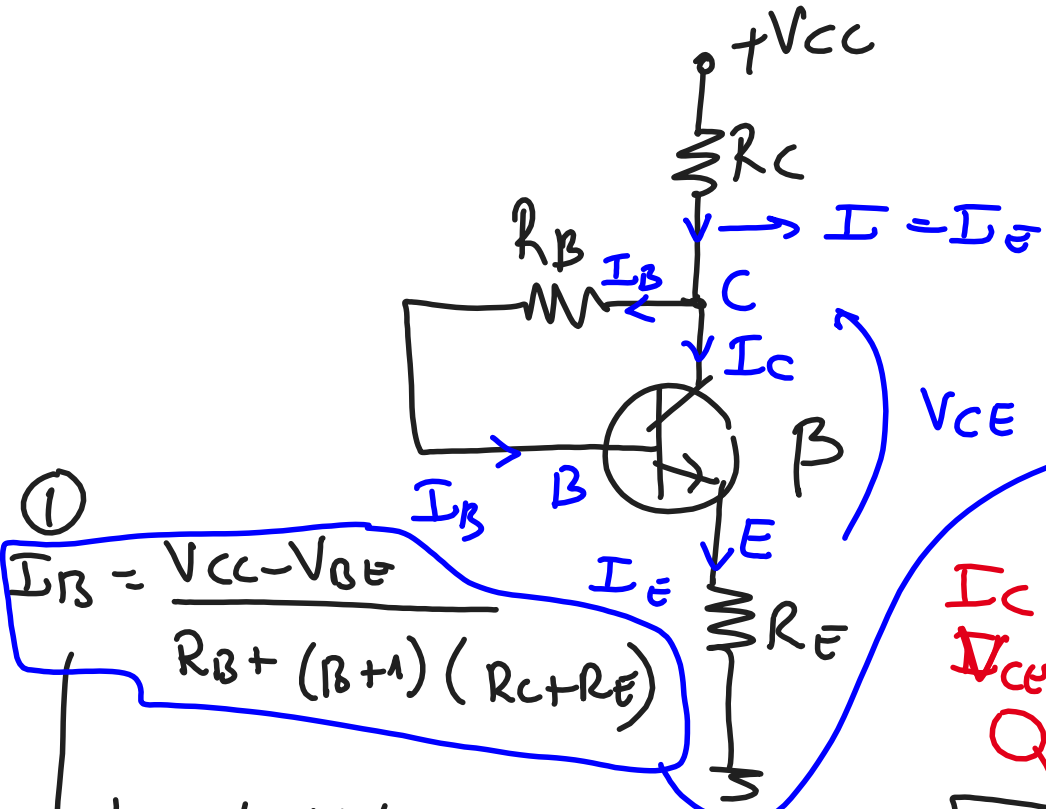
- DIODES

- TRANSISTORS (biasing).

Bring calculators.

No mobile devices!

# DC BIAS with Voltage Feedback:



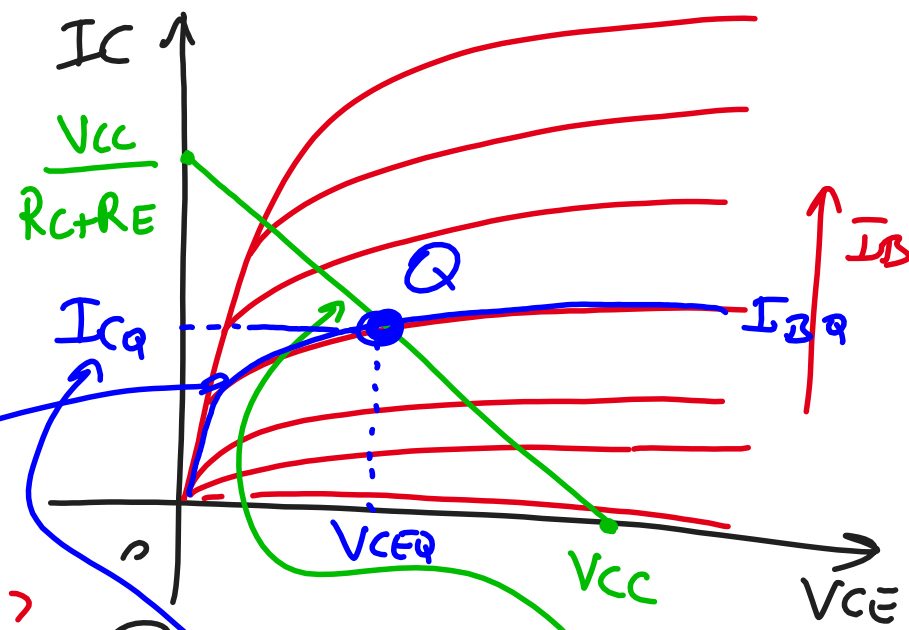
①

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta + 1)(R_C + R_E)}$$

Input KVL:

$$V_{CC} - I \cdot R_C - I_B R_B - V_{BE} - I_E \cdot R_E = 0$$

$$V_{CC} - (\beta + 1) I_B R_C - I_B R_B - V_{BE} - (\beta + 1) I_B R_E = 0$$



$I_{CQ}$   
 $V_{CEQ}$   
 $Q$

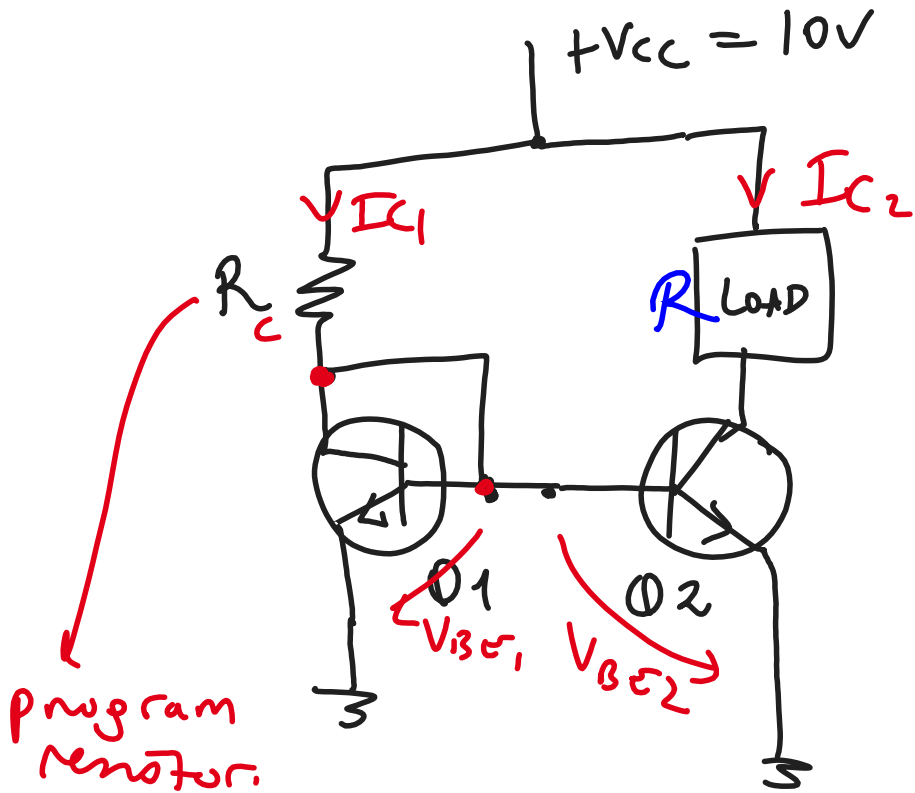
②  $I_C = \beta \cdot I_B$

③ Output KVL

$$V_{CC} - I_E \cdot R_C - V_{CE} - I_E \cdot R_E = 0$$

$\uparrow$  The load line  
 $I_E \approx I_C$

# Current Mirror



Program resistor.  
It determines  
The value of  $I_{C2}$

$Q_1$  and  $Q_2$  are identical  
(matched transistors)

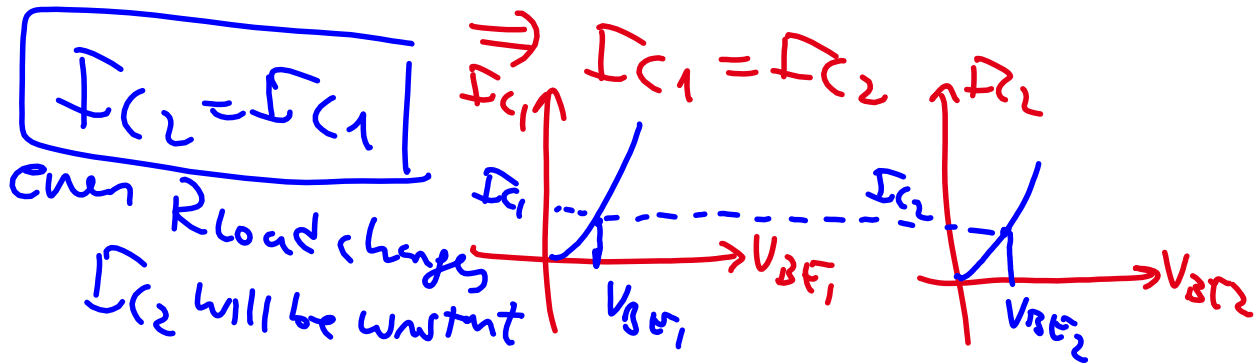
Input KVL for  $Q_1$ :

$$V_{CC} - I_{C1} \cdot R_C - V_{BE1} = 0$$

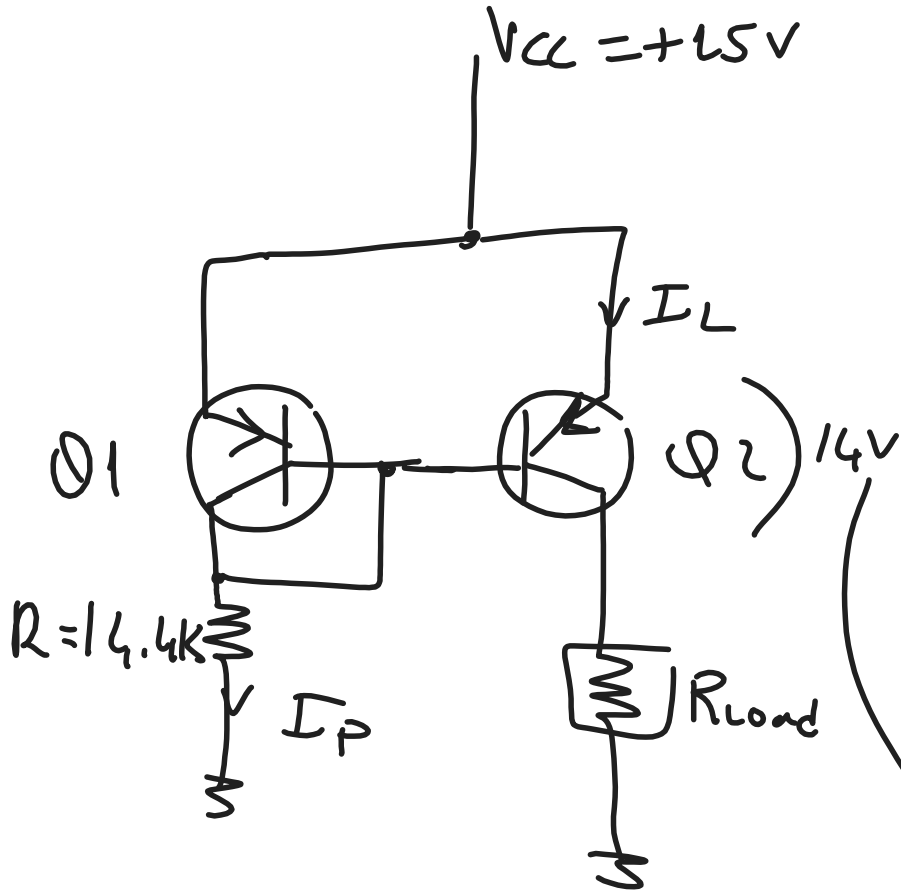
$$I_{C1} = \frac{V_{CC} - V_{BE1}}{R_C}$$

If transistors are matched.

$\Rightarrow V_{BE1} = V_{BE2}$  circuit forces this.



Current mirror with a pnp transistor:



$$V_{BE} = 0.6V$$

$$V_{CC} - V_{BE} - R \cdot I_P = 0$$

$$I_P = \frac{V_{CC} - V_{BE}}{R} = \frac{15 - 0.6V}{14.4 \times 10^3}$$

$$I_P = 1mA$$

$$I_L = I_P = 1mA$$

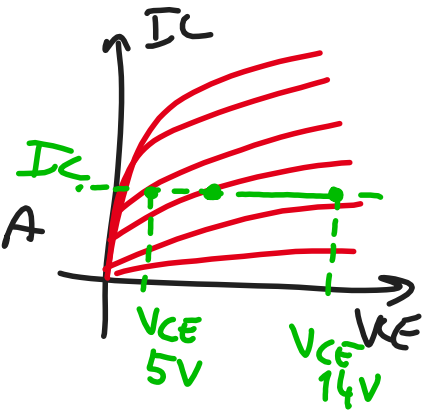
$$R_{Load} = 1K$$

$$R_{Load} \times 1mA = 1V = V_{Load}$$

$$\text{If } R_{Load} = 10K\Omega$$

$$V_{Load} = 10 \times 10^3 \times 10^{-3} = 10V$$

$$V_{CE} = 15 - 10 = 5V.$$



However, changing  $V_{CE}$  will effect  $I_C$ .  
⇒ Early Effect!

