

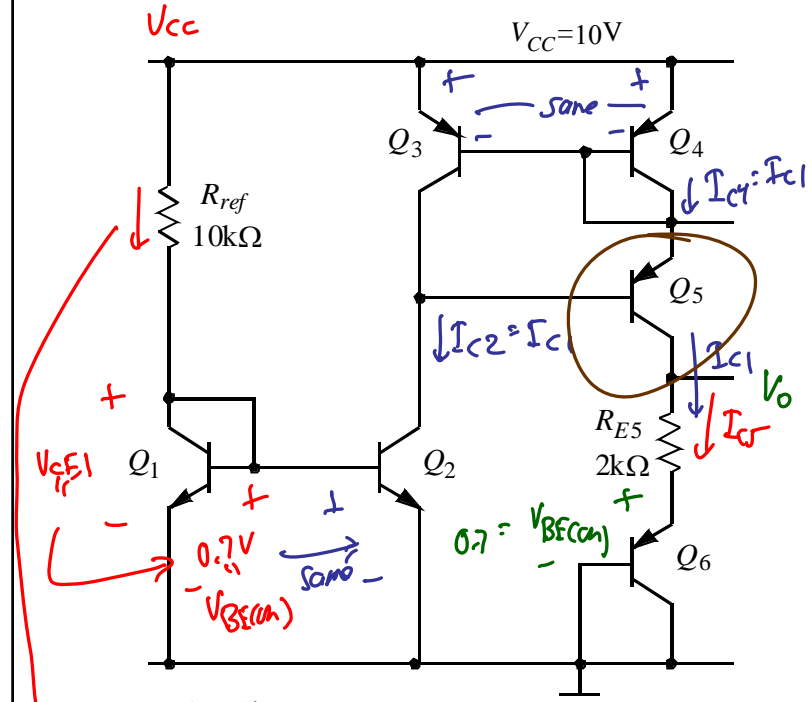
Lecture 2: Device Models I (bipolar)

- Announcements:
 - The course website was up and running, yesterday
 - ↳ Just google ee140 to get to it
 - Discussion sections start next week
 - ↳ Discussion Section 102 Time and Location
 - ↳ Th 4-5 p.m., 293 Cory
 - ↳ This is also now up on the official online schedule of classes
 - Updates to the course information sheet handed out last time:
 - ↳ TA office hours will be held in 382 Cory
 - ↳ Lingqi Wu email: change to wulingqi@berkeley.edu
- Lecture Topics:
 - ↳ Review (so fast)
 - ↳ Bipolar Junction Transistor Modeling
 - Basic Structure & Physics
 - Large Signal Models
 - DC Operating Point
 - Small Signal Models
 - Frequency Shaping Elements
 - Layout
 - Unity Gain Frequency
- Last Time: Reviewed op amps

Example) Find the DC operating point.

⇒ want I_C 's of X nodes → g_m, r_o, \dots

small-signal elements



$$I_{C1} = \frac{V_{CC} - V_{BE(on)}}{R_{ref}} = \frac{10 - 0.7}{10k} = 0.93 \text{ mA}$$

Check: $V_{CE1} = 0.7V > 0.2V$ ✓ (it's forward-active)

$$V_o = V_{BE(on)6} + I_{C1} R_{E5} = 0.7 + (0.93 \text{ mA})(2k) = 2.58 \text{ V}$$

For Q_5 to be FA, need:

$$V_o < V_{CC} - V_{BE4} - V_{CE(sat)}$$

$$10 - 0.7 - 0.2 = 9.1V$$

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$$V_o = 2.58V < 9.1V \checkmark$$

Q_5 is FA \checkmark

What if $R_{E5} = 20k\Omega$:

$$V_o = 0.7 + (0.93m)(20k) = 19.3V \quad \leftarrow \text{X}$$

Q_5 is saturated!

$$V_o = V_{CC} - V_{BE(sat)} - V_{CE(sat)} = 9.1V$$

$$I_{CS} = \frac{V_o - V_{BE(sat)}}{R_{E5}} = \frac{9.1 - 0.7}{20k} = \underline{\underline{0.42mA}}$$