

Lecture 13: Differential Amplifiers (Part 2)

(Quiz)

0. Review

1. Common mode rejection ratio

2. Current Source Biasing

3. BJT current source

Textbook reading: 15-5 Common Mode Gain

• PreLab 5b (Multisim)
due at lab session

• HW 6 due this Fri (Nov 08)

• Exam #2 next Tue (Nov 12)

→ HW 4, 5, 6

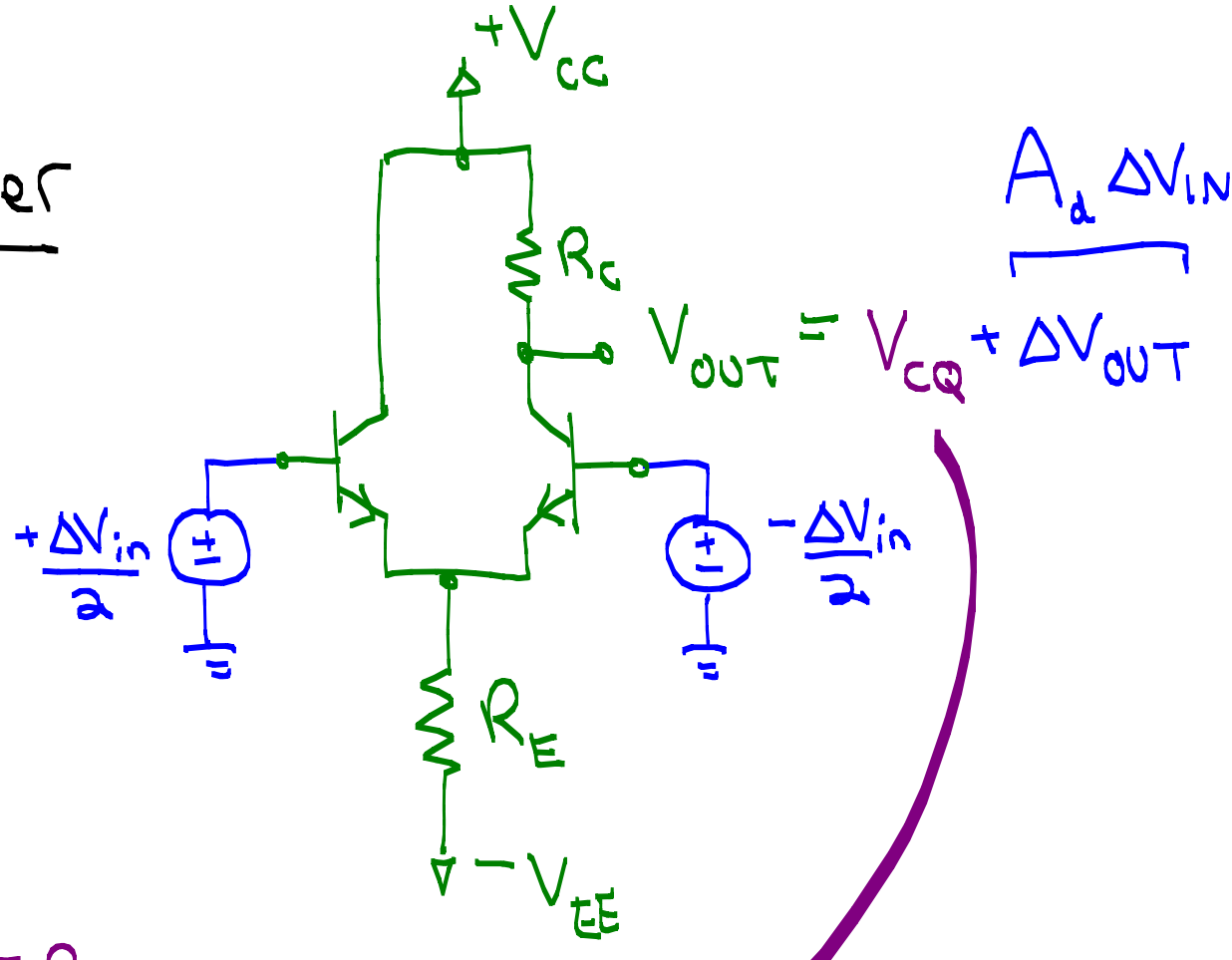
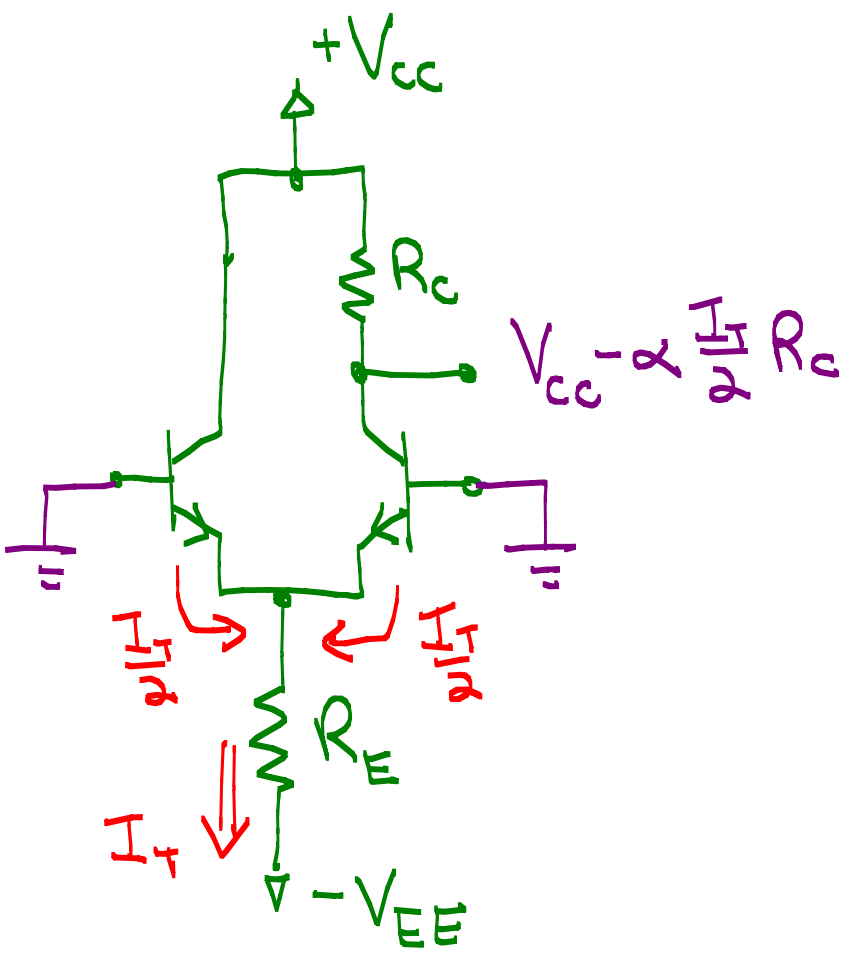
→ Q 24, 5, 6 ← sample on website

→ Sample exam on course website

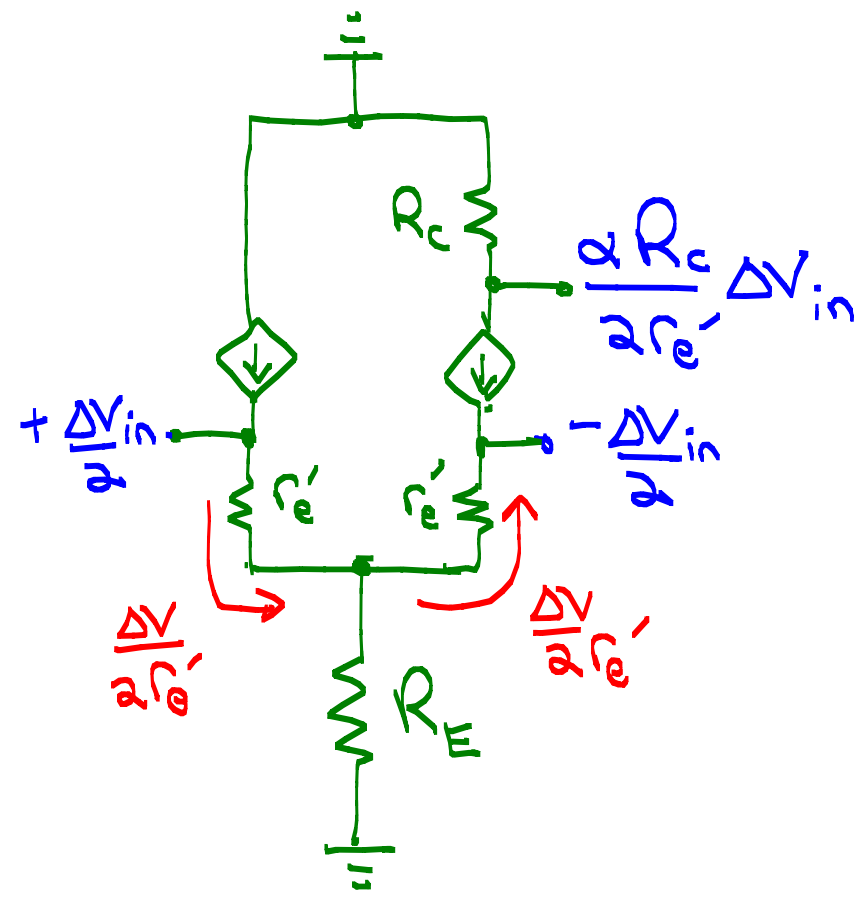
0. Review

Differential Amplifier

Quiescent



Signal



Also...

$$Z_{IN} = 2(\beta + 1)r_{e'}$$

$$Z_{OUT} = R_C$$

1. Common Mode Rejection Ratio (CMRR)

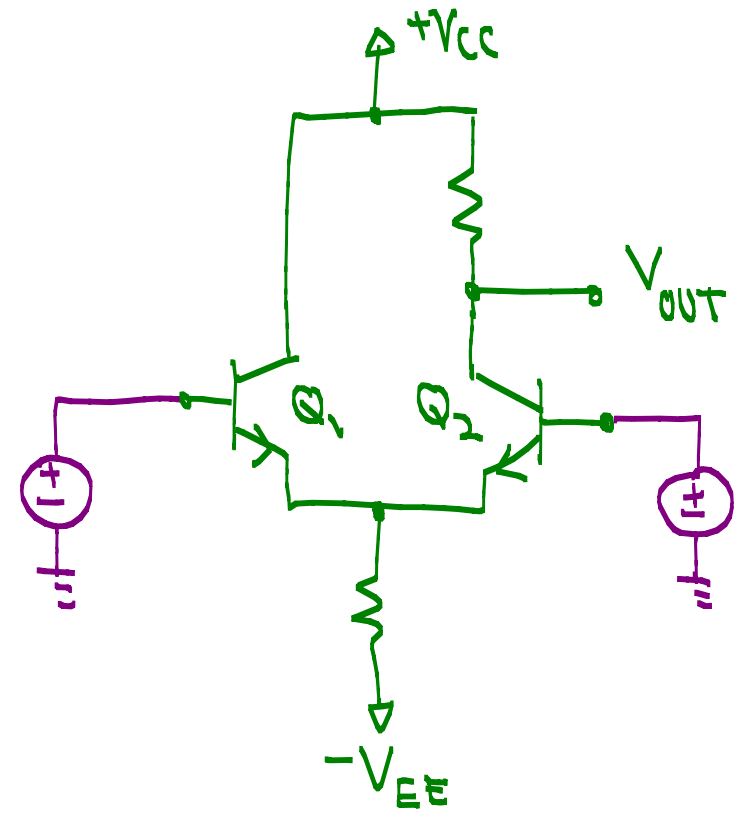
- In many situations, V_{IN1} and V_{IN2} have a large offset V_{CM} .

$$V_{IN1} =$$

$$V_{IN2} =$$

- Ideally, ΔV_{OUT}

- In reality, ΔV_{OUT}



Example

$$V_{in1} = 3.01V, \quad V_{in2} = 2.99V$$

$$A_d = 100, \quad A_{cm} = 0.01$$

What is ΔV_{out} ?

- A good differential amplifier

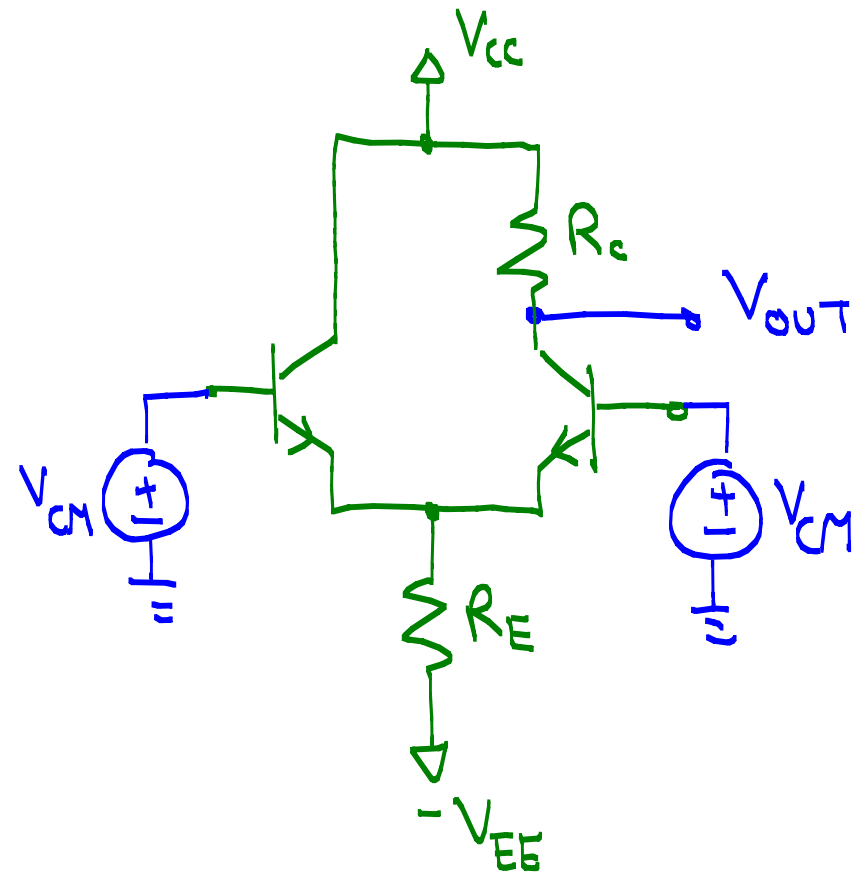
Example $A_d = 120$, $A_{cm} = .005$

3.3

- Extremely important metric of a differential amplifier is the

• Common mode gain for long-tail pair

13.4



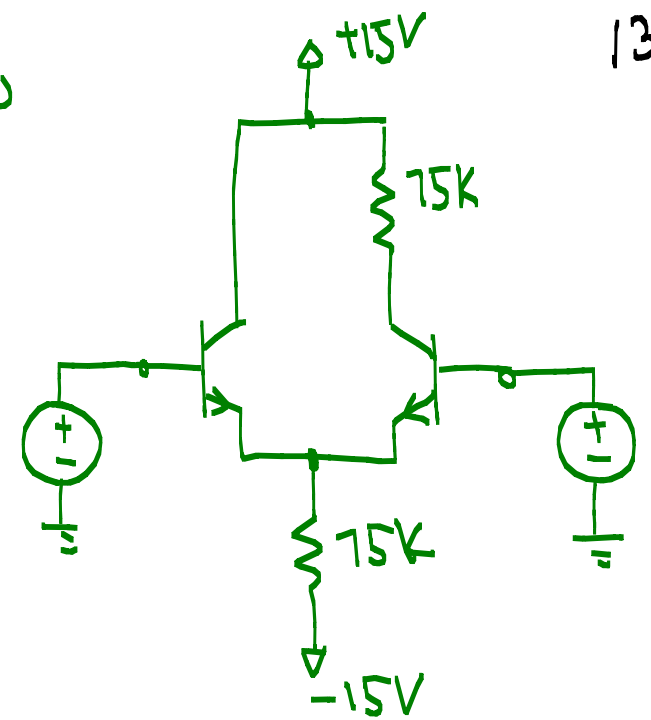
• CMRR for long-tail pair

CMRR =

Example

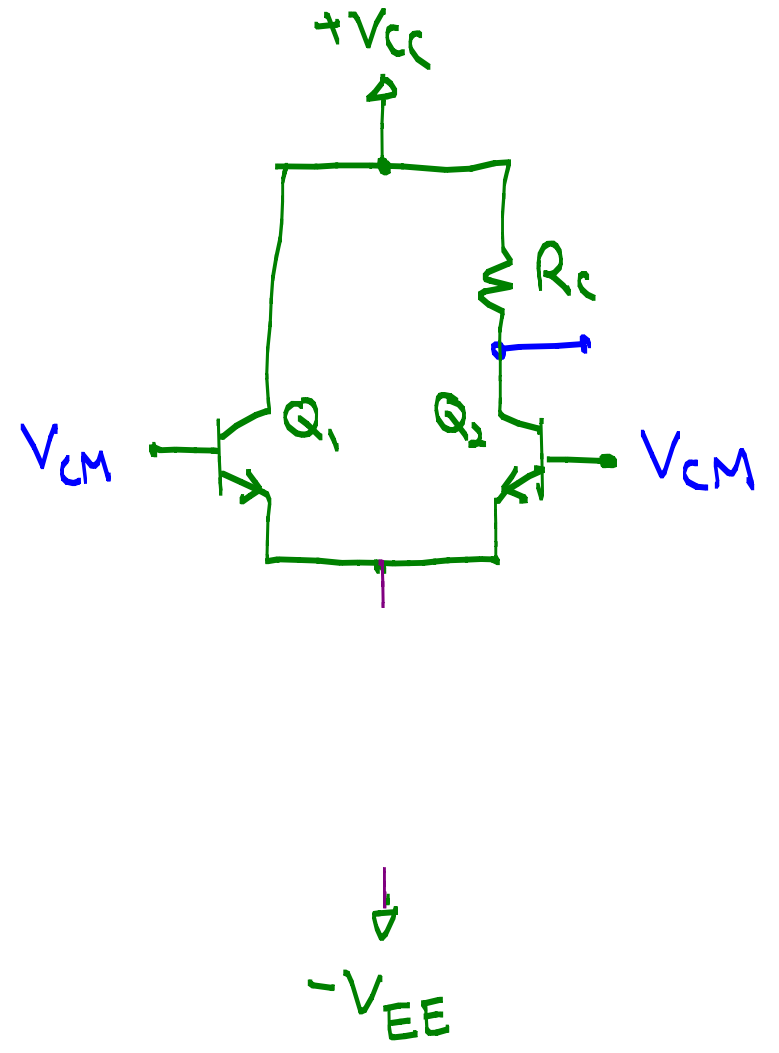
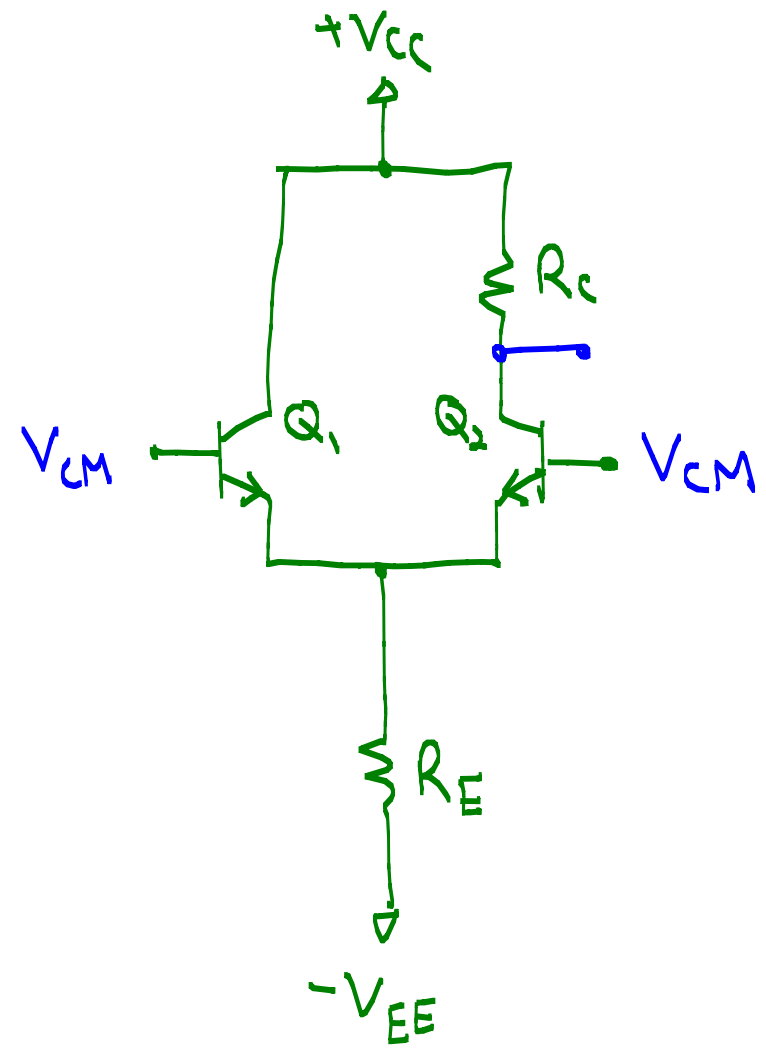
Compute A_d , A_{cm} ,
and CMRR

13.5



2. Current Source Biasing

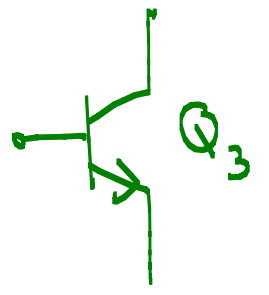
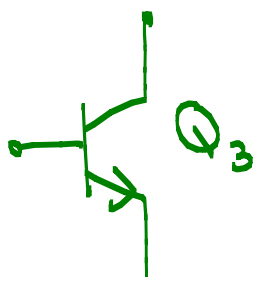
Q: How to improve CMRR?



3. BJT Current Source

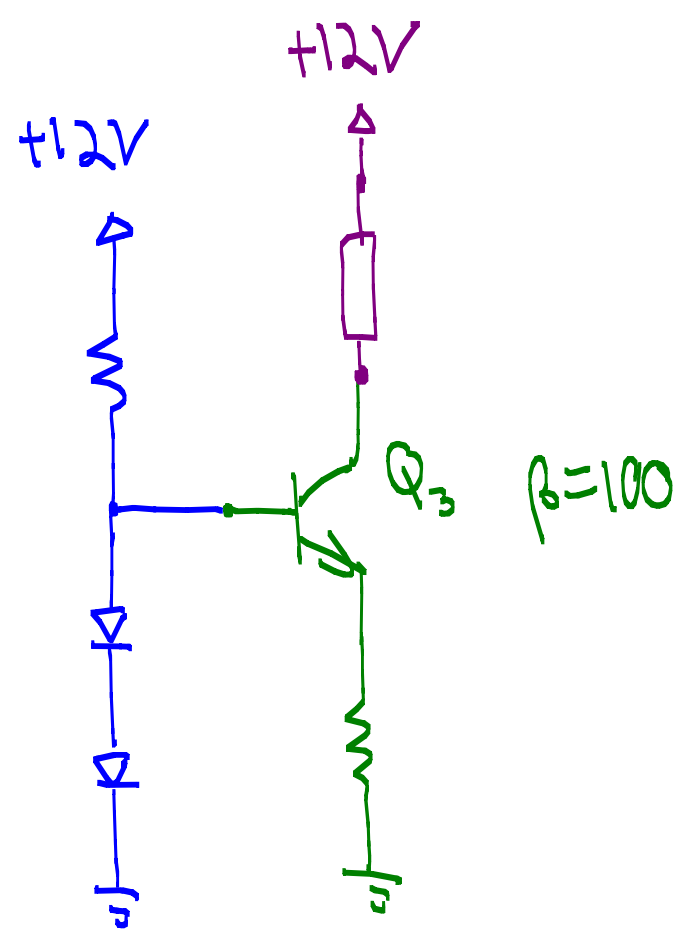
Fortunately, a good current source can be made from a BJT

Example

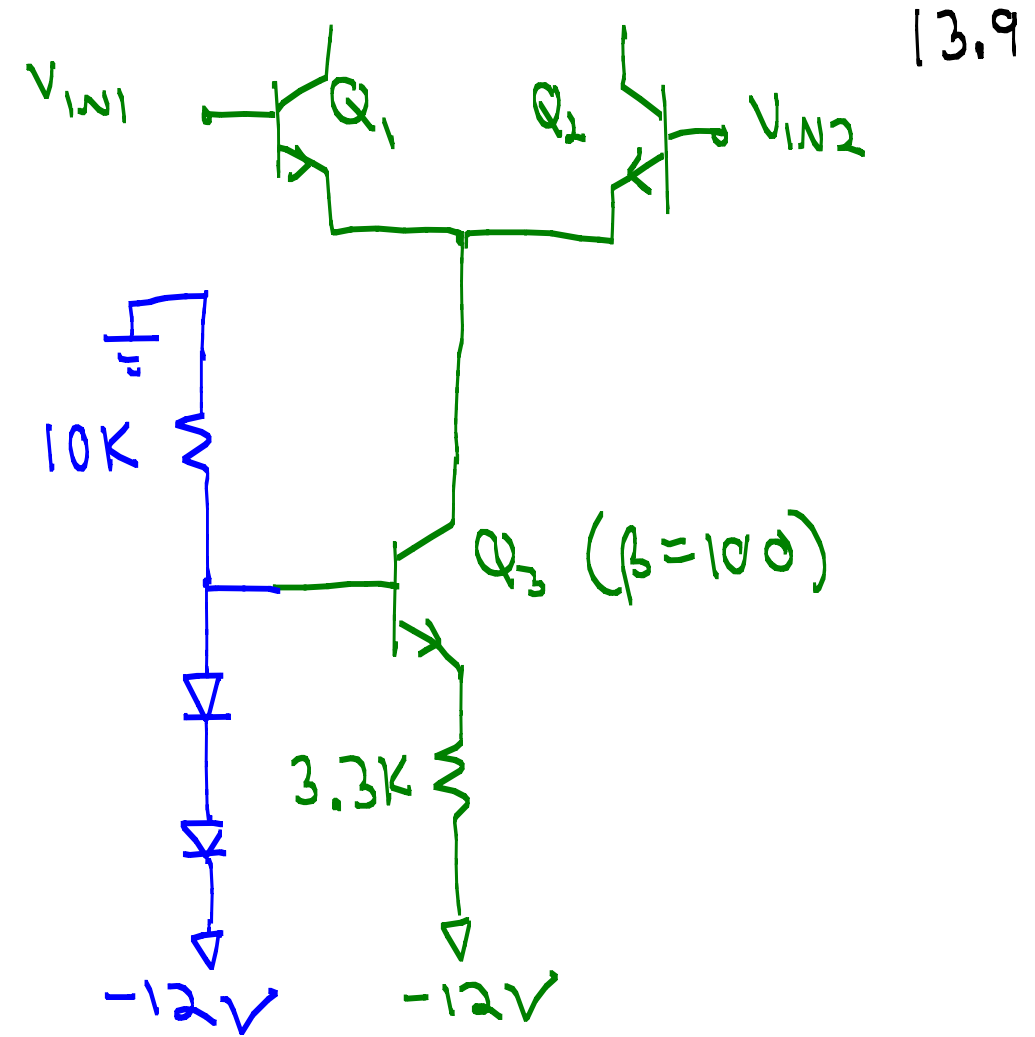


Q: How to set the Q_3 base voltage?

A common method is to use some diodes as a voltage reference.



- For BJT diff pair, the current source often operates from negative voltage.

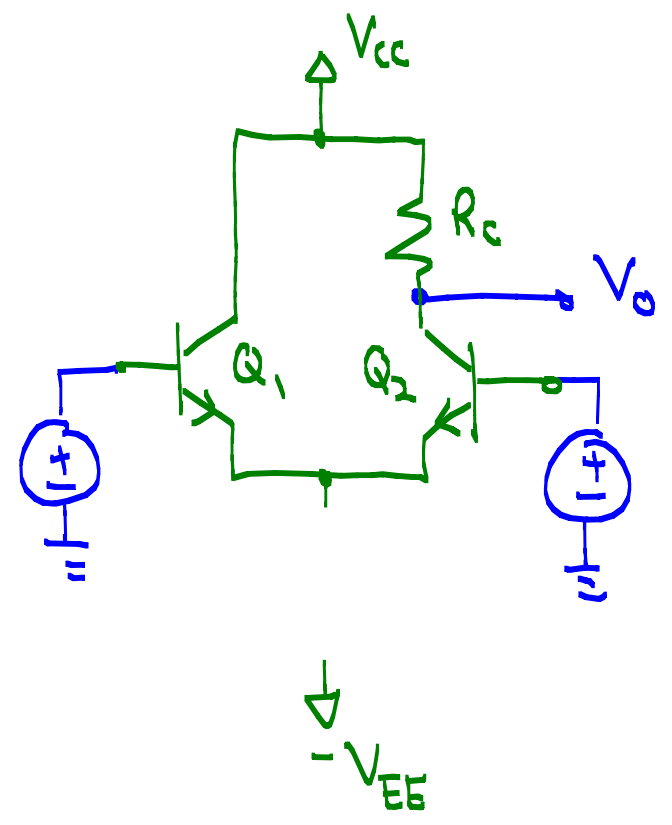


• But what is the CMRR?

Ideal
Current Source

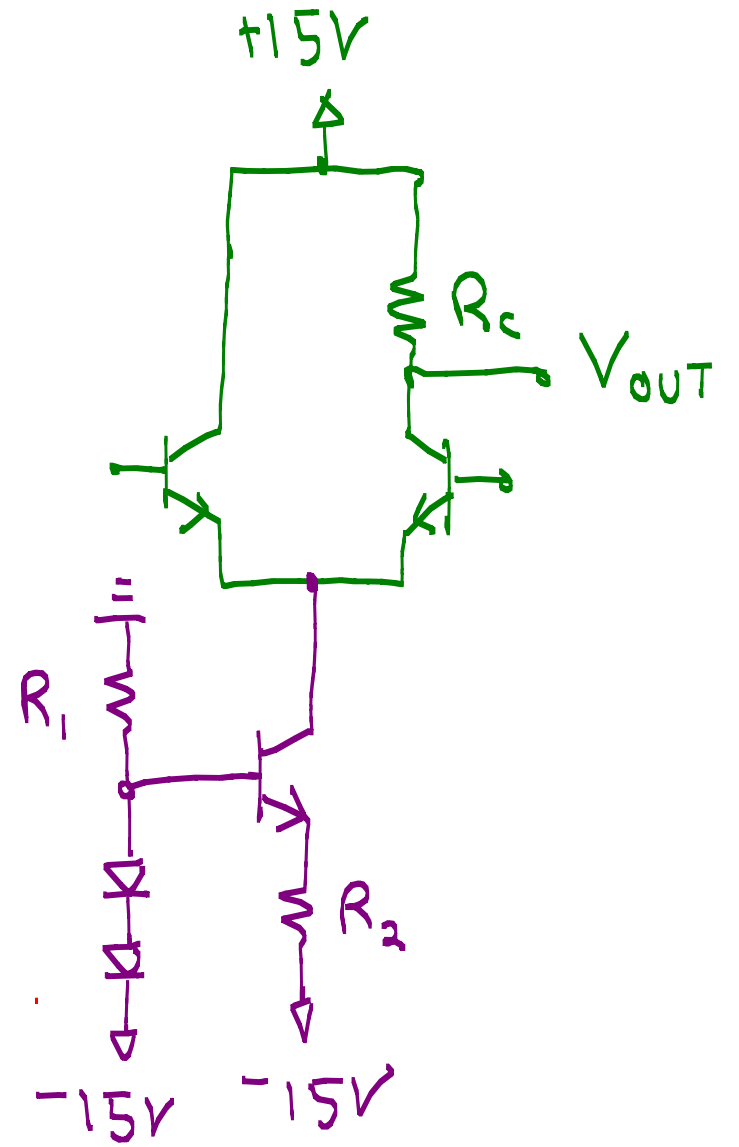
Real
Current source

13.10



• Design Example ← from Lecture 02

Gain ≥ 50 , $R_{in} \geq 10 \text{ k}\Omega$, $V_{CC} = V_{EE} = 15 \text{ V}$



• R_1 ?

• CMRR?

• R_c ?

