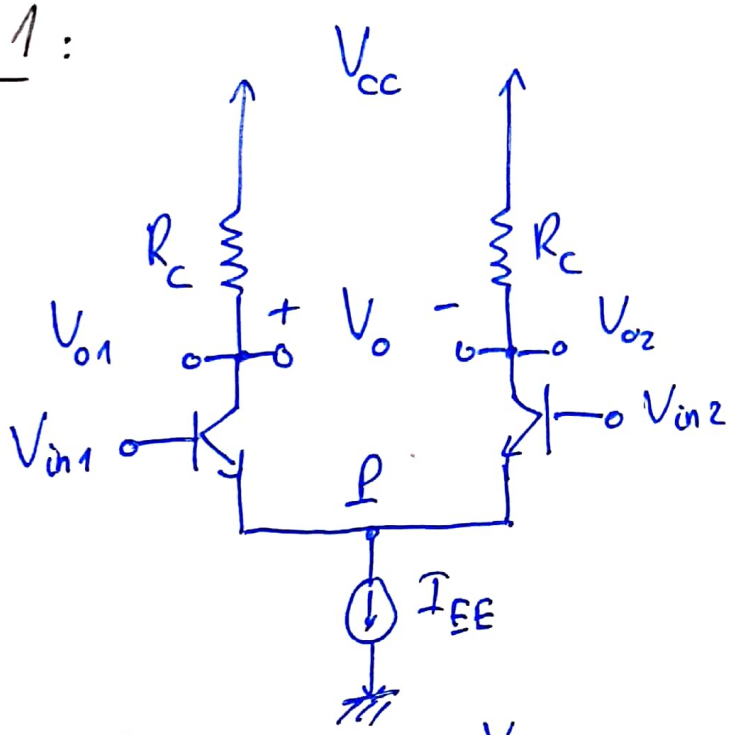
Analog Electronics

QUIZ # 3.1,2

Problem 1:



a) i) $V_E = V_{in1} - 0.7 = 2.3^V$

ii) $V_{o1} = V_{o2} \approx V_{cc} - I_{EE}/2 \cdot R_c = 10 - 1 \times 4 = 6^V$

$V_{out} = V_{o1} - V_{o2} = 0$

iii) Input signal is common mode.

b) i) $V_E = V_{in2} - 0.7 = 3 - 0.7 = 2.3^V$ (Q_1 off)

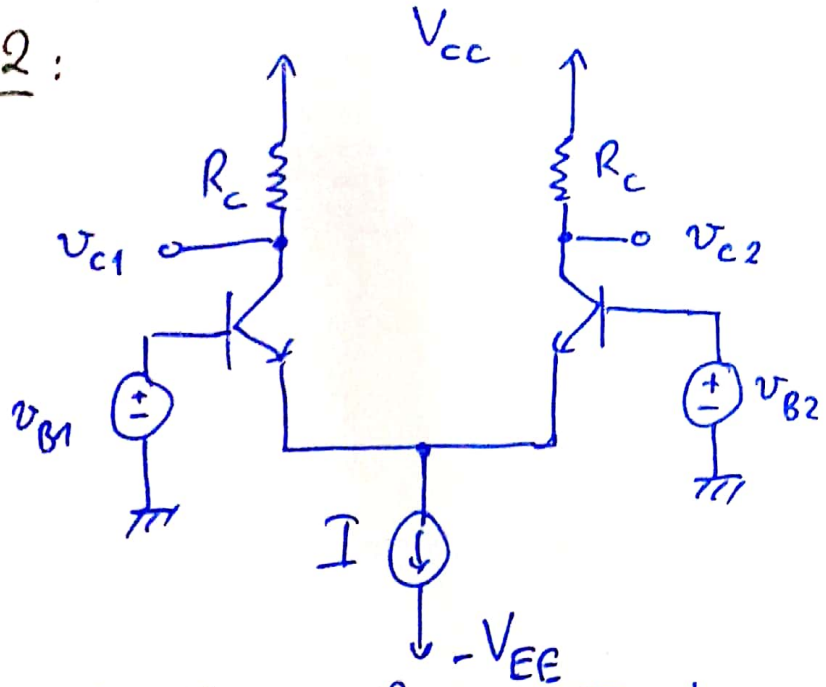
ii) $V_{o1} = V_{cc} = 10^V$

$V_{o2} = V_{cc} - I_c R_c \approx V_{cc} - I_{EE} R_c = 10 - 2 \times 2 = 6^V$

$V_{out} = V_{o1} - V_{o2} = 4^V$

iii) $V_E = V_{in2} - 0.7 = 2.3^V$

Problem 2:



a) i) $A_d = \frac{v_{c2} - v_{c1}}{v_{ab}} = \frac{\alpha R_c}{r_e}$ → Total resistance in collector
→ Total resistance in emitter

$$r_e = \frac{V_T}{I_E} = \frac{V_T}{0.5I} = \frac{25^{mV}}{0.5^{mA}} = 50^{\Omega}$$

$$\Rightarrow A_d = \frac{0.99 \times 2^k}{50} \simeq 40$$

ii) $R_{ab} = (\beta + 1) 2r_e = 100 \times 2 \times 50 = 10000^{\Omega}$

iii) $A_c = 0$ because two half-circuits match. $\Rightarrow$ CMRR = ∞ $(v_{c1} = v_{c2})$

b) i) $A_d = \frac{v_{c2} - v_{c1}}{v_{ab}} = \frac{\alpha R_c}{r_e} \simeq 40$

ii) $\frac{v_{ab}}{v_{cd}} = \frac{R_{ab}}{R_{ab} + 2R_{sig}} = \frac{10000}{10000 + 2 \times 200} \simeq 0.96$

iii) $A_v = \frac{v_{c2} - v_{c1}}{v_{cd}} = A_d \times \frac{v_{ab}}{v_{cd}} = 40 \times 0.96 = 38.4$

iv) $A_c = 0$ because 2 half-circuits match. $\Rightarrow$ CMRR = ∞ $(v_{c1} = v_{c2})$

c) i) $A_d = \frac{v_{c2} - v_{c1}}{v_{ab}} = \frac{\alpha R_c}{r_e + R_E} = \frac{0.99 \times 2^k}{50 + 50} \simeq 20$

ii) $\frac{v_{ab}}{v_{cd}} = \frac{R_{ab}}{R_{ab} + 2R_{sig}} = \frac{200^k}{200^k + 2 \times 200} \simeq 0.98$

with $R_{ab} = 2(\beta + 1)(r_e + R_E) = 20000\ \Omega$

iii) $A_v = A_d \frac{v_{ab}}{v_{cd}} = 20 \times 0.98 = 19.6$

iv) $A_c = 0 \Rightarrow CMRR = \infty$

d) i) $A_d = \frac{v_{c2} - v_{c1}}{v_{cd}} = \frac{\alpha R_c}{r_e} = \frac{0.99 \times 4^k}{50} \simeq 80$

ii) $|A_c| = \frac{R_c}{2R_{EE}} \times \frac{\Delta R_c}{R_c} = \frac{4^k}{2 \times 100^k} \cdot 0.2 = 4 \times 10^{-3}$

iii) $CMRR = 20 \lg \left| \frac{A_d}{A_c} \right| \simeq 86\ dB$