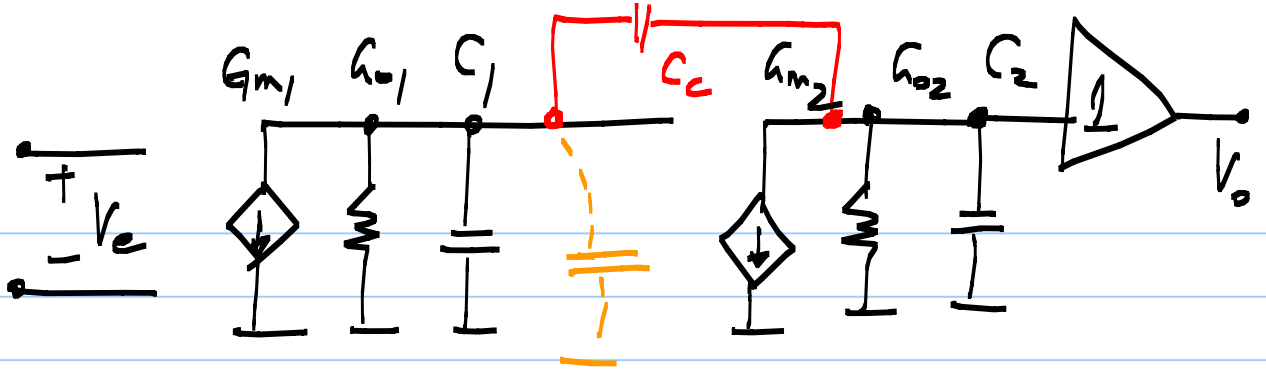
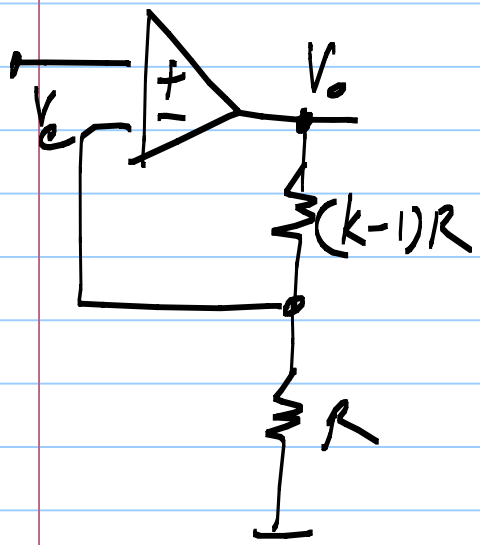
Lecture 13



$K = 10$



$$\frac{V_o}{V_e} = \frac{G_{m1}\left(G_{m2} - sC_c\right)}{s^2\left(C_1C_c + C_cC_2 + C_2C_1\right) + s\left[G_{m2}C_c + G_{o1}\left(C_2 + C_c\right) + G_{o2}\left(C_1 + C_c\right)\right] + G_{o1}G_{o2}}$$

$$as^2 + bs + c = 0 \;;\quad s_1 = -\frac{c}{b} \;;\quad s_2 = -\frac{b}{a}$$

without C_c

$$s_1 = -\frac{G_{o1}}{C_1} \qquad s_2 = -\frac{G_{o2}}{C_2}$$

output of the 1st stage

output of the 2nd stage

$$s_2 \simeq -\frac{G_{m_2} C_c + G_{o1}(C_2+C_c) + G_{o2}(C_1+C_c)}{C_1 C_c + C_c C_2 + C_2 C_1}$$

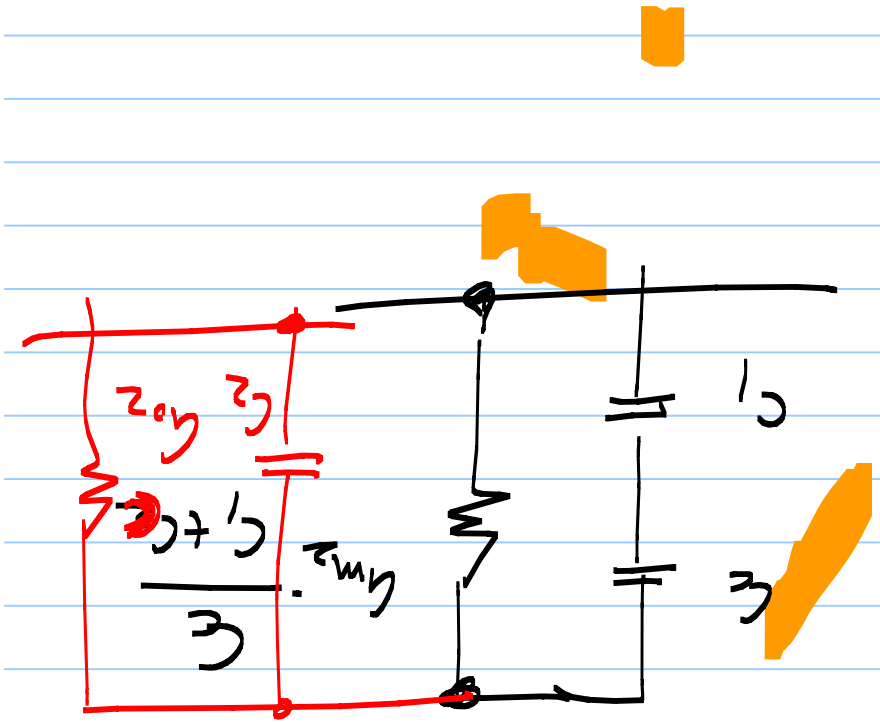
$$= -\frac{G_{o2} + G_{m_2}\dfrac{C_c}{C_1+C_c} + G_{o1}\dfrac{C_2+C_c}{C_1+C_c}}{C_2 + \dfrac{C_1 C_c}{C_1+C_c}}$$

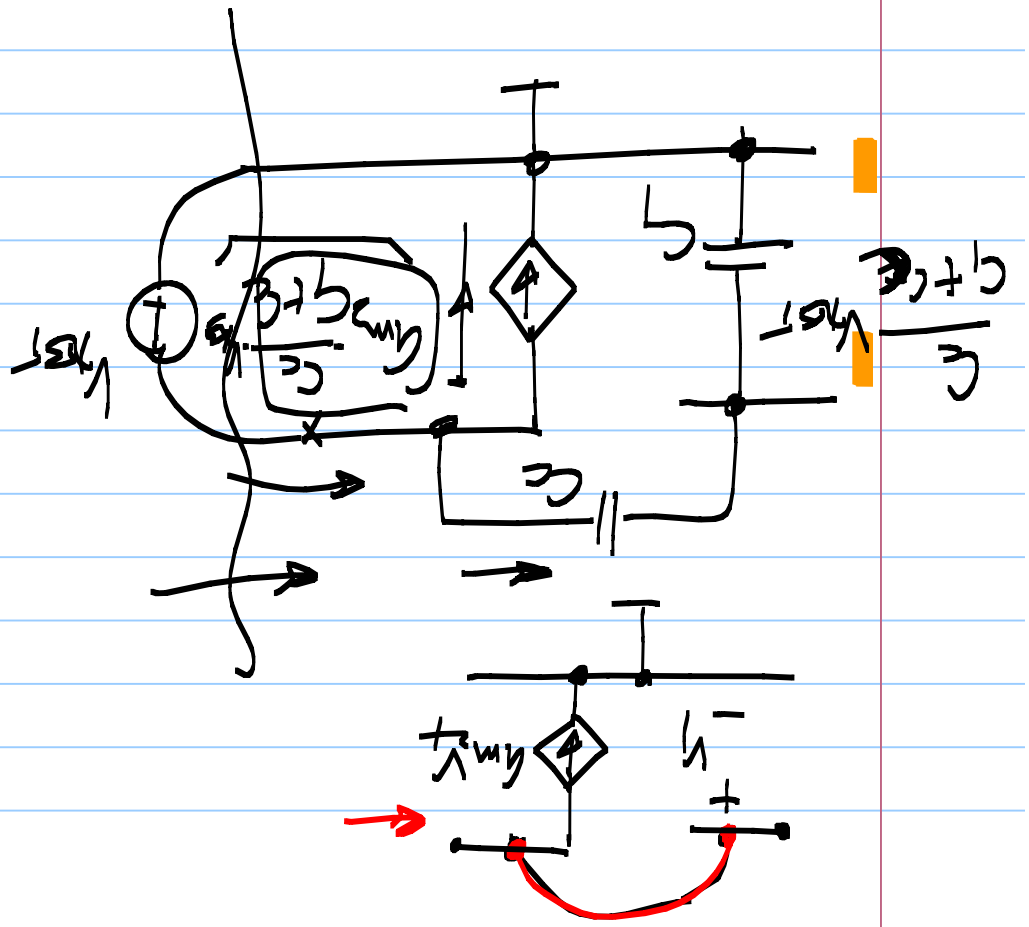
with C_c

$$s_1 = -\frac{G_{o1} G_{o2}}{G_{m_2} C_c + G_{o1}(C_2+C_c) + G_{o2}(C_1+C_c)}$$

$$\simeq -\frac{G_{o1}}{C_1 + \left(\dfrac{G_{m_2}}{G_{o2}} + 1 + \dfrac{G_{o1}}{G_{o2}}\right) C_c + \left(\cancel{1} + \dfrac{G_{o1}}{G_{o2}}\right) C_2}$$

Miller multiplied C_c





$$\omega_{u,loop} < \overline{p_2 \left(= -s_2\right)} \simeq \frac{g_{m_2} \cdot \frac{C_c}{C_1 + C_c}}{C_2 + \frac{C_1 C_c}{C_1 + C_c}} \simeq \frac{g_{m_2}}{C_1 + C_2}$$

$C_c \gg C_1$

$$A_{dc,loop} \cdot |s_1| = \frac{1}{k} \cdot \frac{g_{m_1} g_{m_2}}{g_{o_1} g_{o_2}} \cdot \frac{g_{o_1} g_{o_2}}{g_{m_2} C_c + g_{o_1}(C_2 + C_c) + g_{o_2}(C_1 + C_c)}$$

$$\simeq \left(\frac{1}{k}\right)\left[\frac{g_{m_1}}{C_c}\right]$$

$\omega_{u,opA}$

$\omega_{u,comp}$

$$L(s) = \frac{A_0}{k} \frac{\left[1 - s/z_1\right]}{\left(1 + s/p_1\right)\left(1 + s/p_2\right)}$$

2.5 Mrad/s

227 Mrad/s

$$\angle L\Big|_{s = j\omega_{u,loop}} = -\frac{\pi}{2} - \tan^{-1}\left(\frac{1}{k}\cdot\frac{G_{m1}}{G_{m2}}\right) - \tan^{-1}\left(\frac{\omega_{u,loop}}{p_2}\right) - \tan^{-1}\left(\frac{\omega_{u,loop}}{z_1}\right) = -104^\circ$$

$$z_1 = \frac{G_{m2}}{C_c}$$

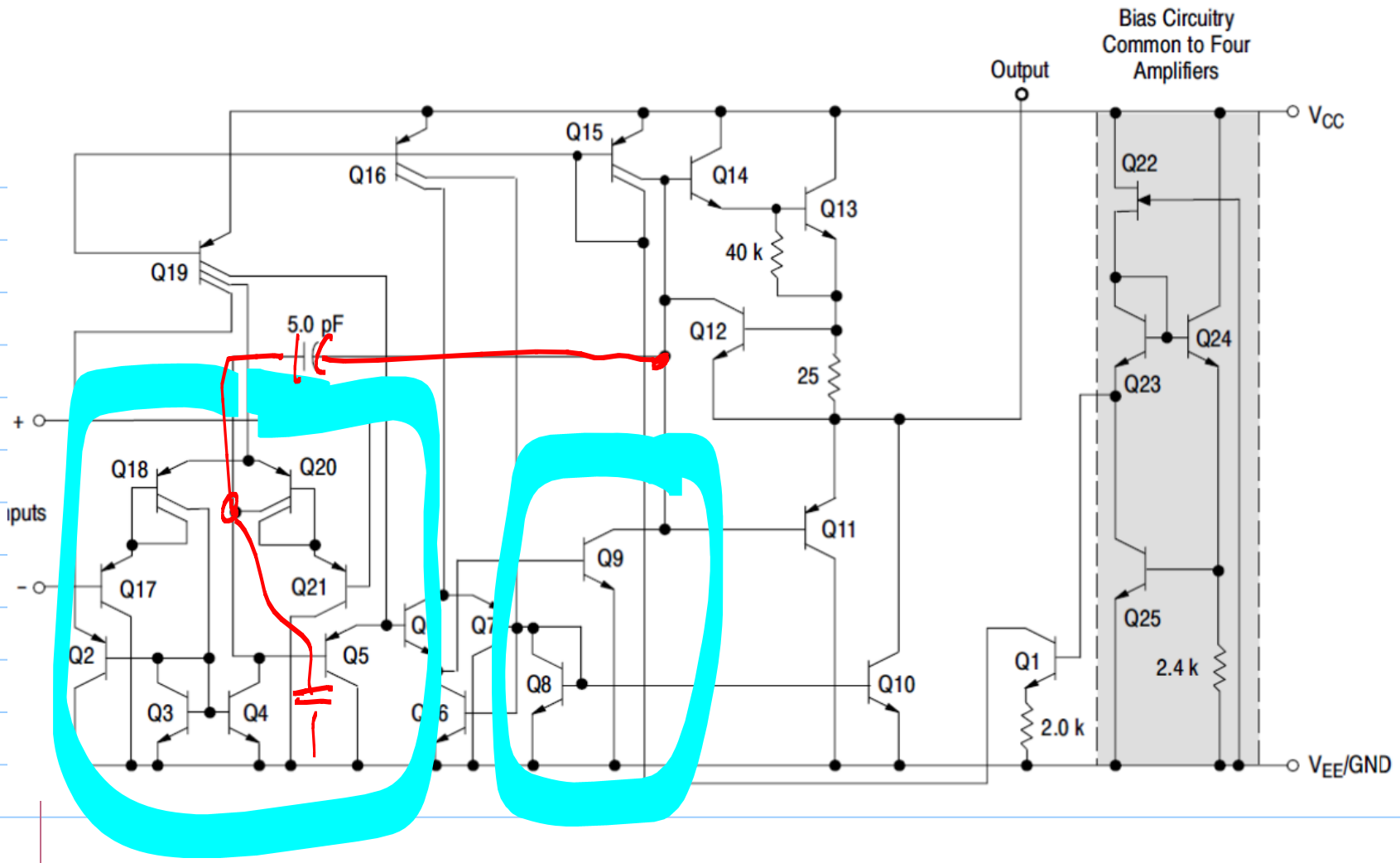
$$\omega_{u,loop} = \frac{1}{k}\cdot\frac{G_{m1}}{C_c}$$

$$C_c = \frac{1}{100}\cdot 11\text{pF}\cdot 4 = 0.44\text{pF}$$

$$\tan^{-1}\left(\frac{1}{k}\cdot\frac{G_{m1}}{C_c}\cdot\frac{C_1 + C_2}{G_{m2}}\right) = 14^\circ$$

$$p_2 \simeq \left[\frac{G_{m2}}{C_1 + C_2}\right] \left\{C_c \gg C_1\right\}$$

$$\frac{1}{Z} \quad \frac{1}{k}\cdot\frac{G_{m1}}{C_c}$$


Bias Circuitry
Common to Four
Amplifiers
Output
V_{CC}
V_{EE}/GND
Q15
Q16
Q14
Q13
40 k
Q19
5.0 pF
Q12
25
Q22
Q24
Q23
+
Inputs
−
Q18
Q20
Q11
Q9
Q17
Q21
Q7
Q2
Q5
Q8
Q10
Q1
Q25
2.4 k
Q3
Q4
2.0 k