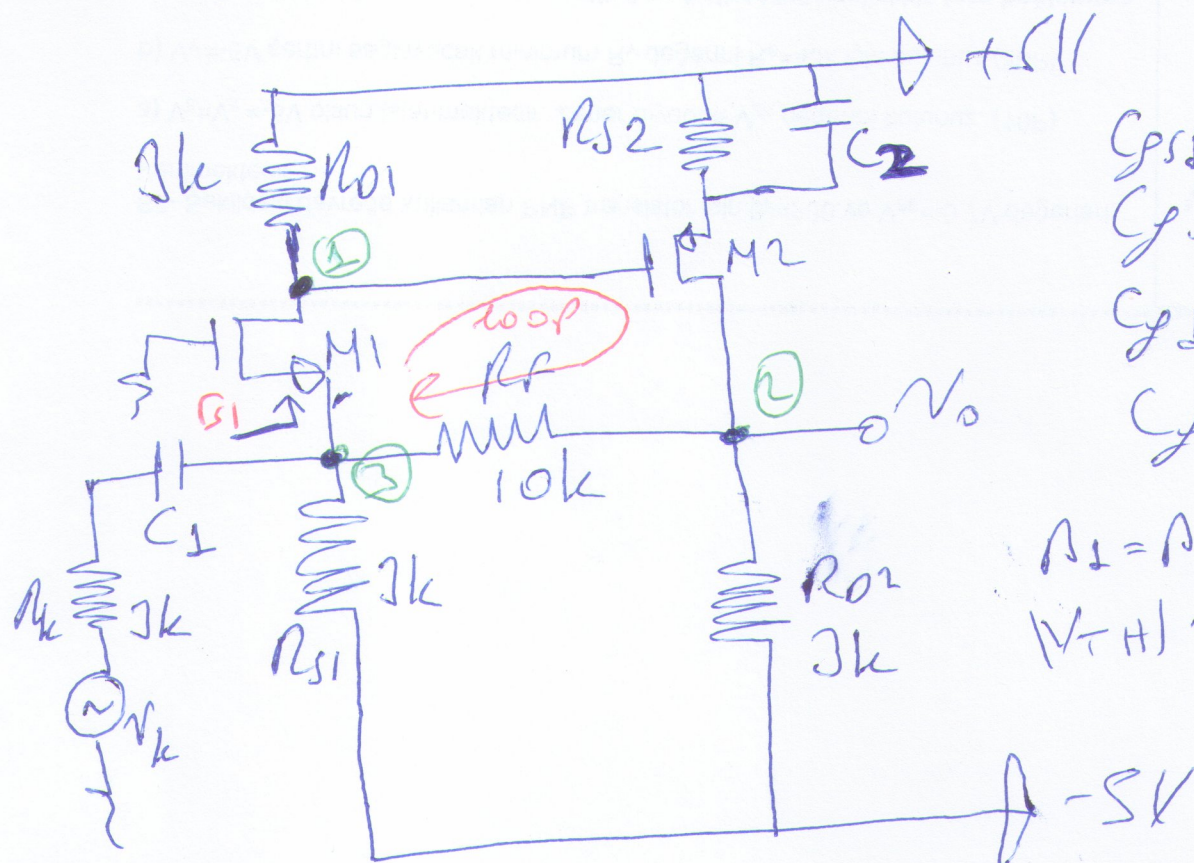


Analog — Summer 19 — MTL4

①



$$\begin{aligned} C_{gs1} &= 50 \text{ pF} \\ C_{gs2} &= 100 \text{ pF} \\ C_{d1} &= 10 \text{ pF} \\ C_{d2} &= 20 \text{ pF} \end{aligned}$$

$$\begin{aligned} I_{D1} &= I_{D2} = 2 \text{ mA} / \sqrt{2} \\ |V_{TH}| &= 1 \text{ V} \end{aligned}$$

$I_{D1} = I_{D2} = 2 \text{ mA}$ ($g_{m1} = g_{m2} = \sqrt{2 \mu I_D} = 2 \text{ mS}$)
 C_1 and C_2 are large capacitors.

a) LG? (loop gain) b) Phase Margin?

$$a) \quad LG = \frac{v_{d1}}{v_{s1}} \cdot \frac{v_{d2}}{v_{g2}} \cdot \frac{v_{s1}}{v_{d2}}$$

$$\frac{v_{d2}}{v_{g2}} = A_2$$

$$\left(\frac{v_{d1}}{v_{s1}} \right)_o = +g_{m1} \cdot R_{D1} = +2 \text{ mS} \cdot 3 \text{ k} = +6$$

$$\frac{v_{d2}}{v_{g2}} \approx -g_{m2} \cdot (R_{D2} \parallel R_f) \approx -4.6 \text{ k} \quad \left(\begin{array}{l} \frac{1}{g_{m1}} = 0.5 \\ R_{S1} \parallel R_{D1} \parallel R_k \\ \text{is ignored} \end{array} \right)$$

$$\frac{v_{s1}}{v_{d2}} = \frac{r_{S1} \parallel R_k \parallel R_{S1}}{r_{S1} \parallel R_k \parallel R_{S1} + R_f} = \frac{\frac{1}{2 \text{ mS}} \parallel 3 \text{ k} \parallel 3 \text{ k}}{\frac{1}{2 \text{ mS}} \parallel 3 \text{ k} \parallel 3 \text{ k} + 10 \text{ k}} \approx 0.036$$

$$(LG)_0 = (AA)_0 = 6 \cdot (-4,6) \cdot (0,036) \approx -1$$

!!!

Node ① $R_{eq1} \approx R_{o1} = 3k$

$$C_{eq1} = C_{gd1} + C_{gs2} + C_{gd2}(1 - A_2)$$

$$\downarrow$$

$$= 222pf$$

$$\omega_{k1} = \frac{1}{3k \cdot 222pf} \approx 1,5M$$

Node ② $R_{eq2} \approx R_{o2} \parallel R_L \approx 2,3k$

$$C_{eq2} = C_{gd2} \left(1 - \frac{1}{A_v}\right) \approx 24pf$$

$$\omega_{k2} = \frac{1}{2,3k \cdot 24pf} \approx 18M$$

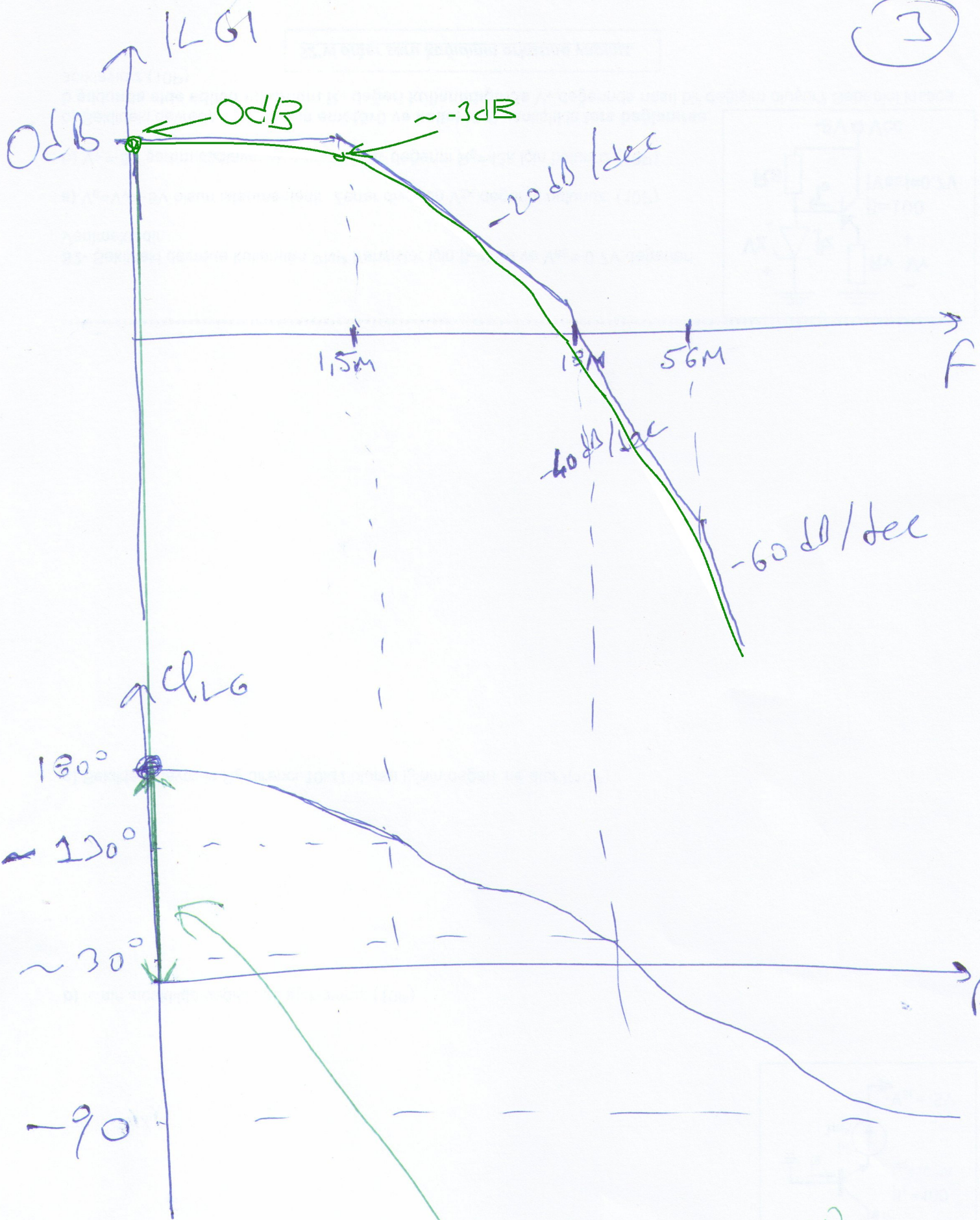
Node ③ $R_{eq3} = r_{s1} \parallel R_{u1} \parallel R_{s1} \parallel R_L \approx 0,36k$

$$C_{eq3} = C_{gs1} = 50pf$$

$$\omega_{k3} = \frac{1}{0,36k \cdot 50pf} \approx 56M$$

$$LG = (-2) \cdot \frac{1,5M}{s + 1,5M} \cdot \frac{18M}{s + 18M} \cdot \frac{56M}{s + 56M}$$

3



Phase margin = 180°

(You could understand the value after obtaining the midband value of the loop gain ($|L G|_0 = | -1 | = 0 \text{ dB}$))