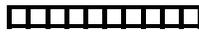
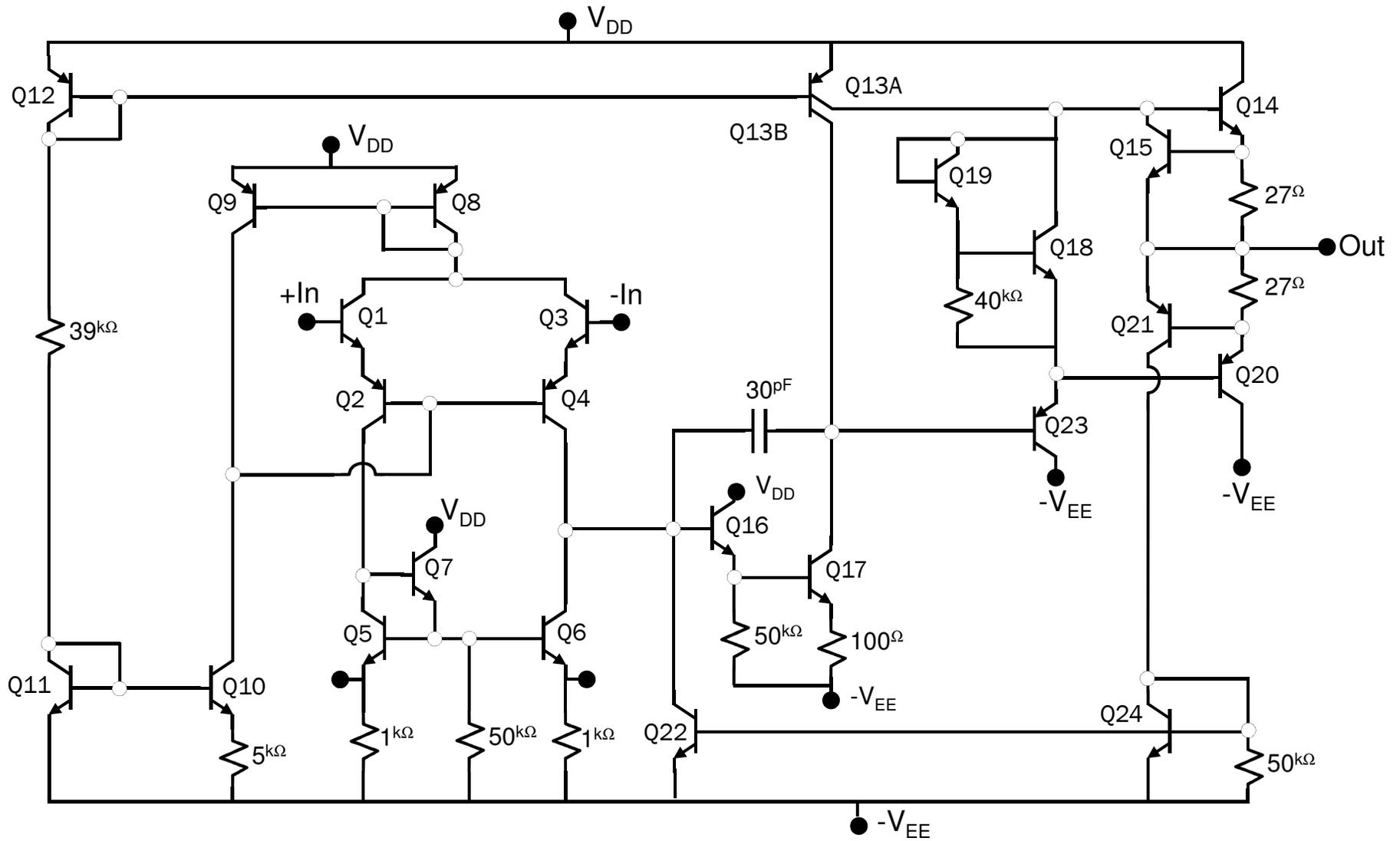


Session 0:  
Principles of Electronics

# OpAmp 741

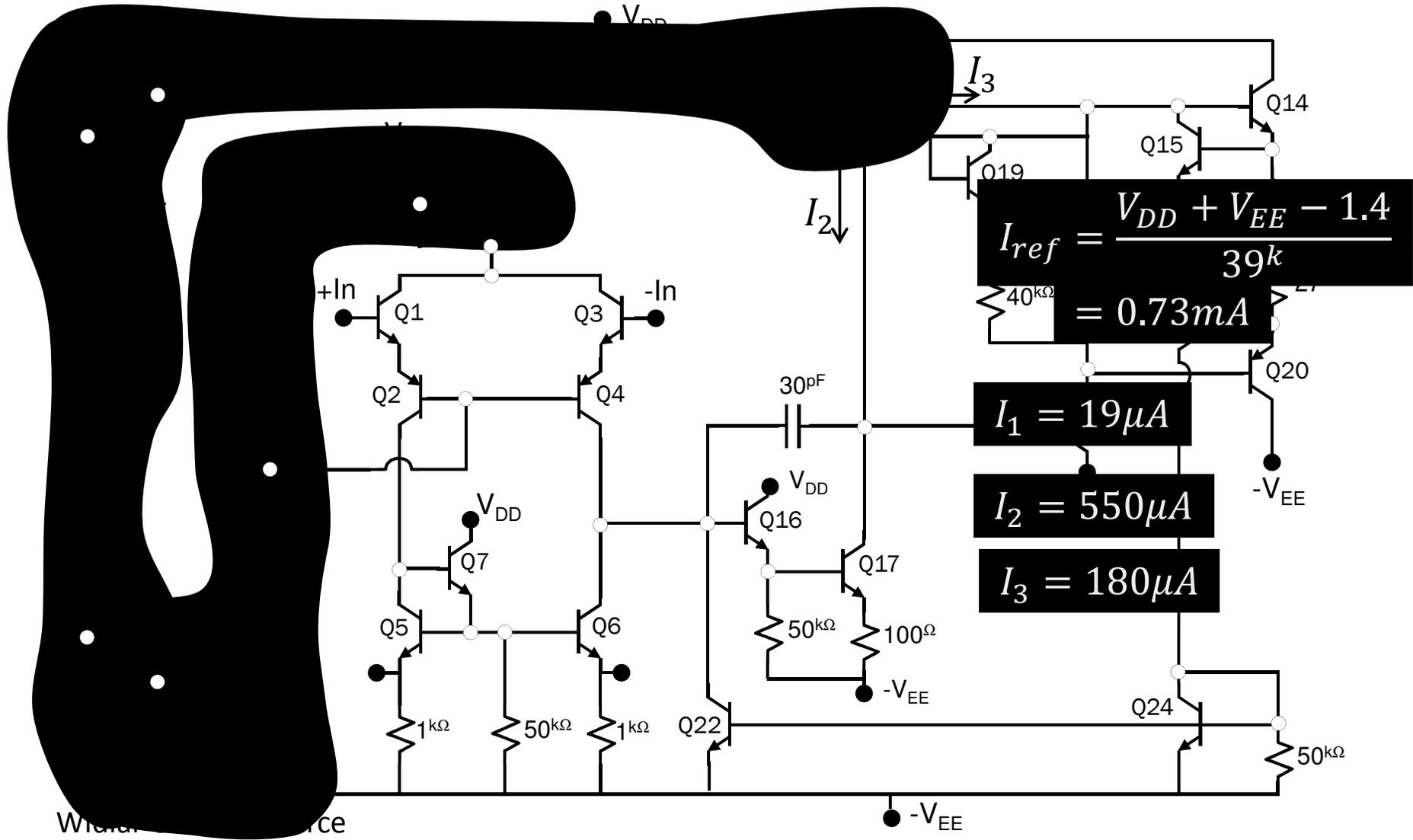
# OpAmp 741 Schematics

1. 
2. 
3. 
4. 
5. 



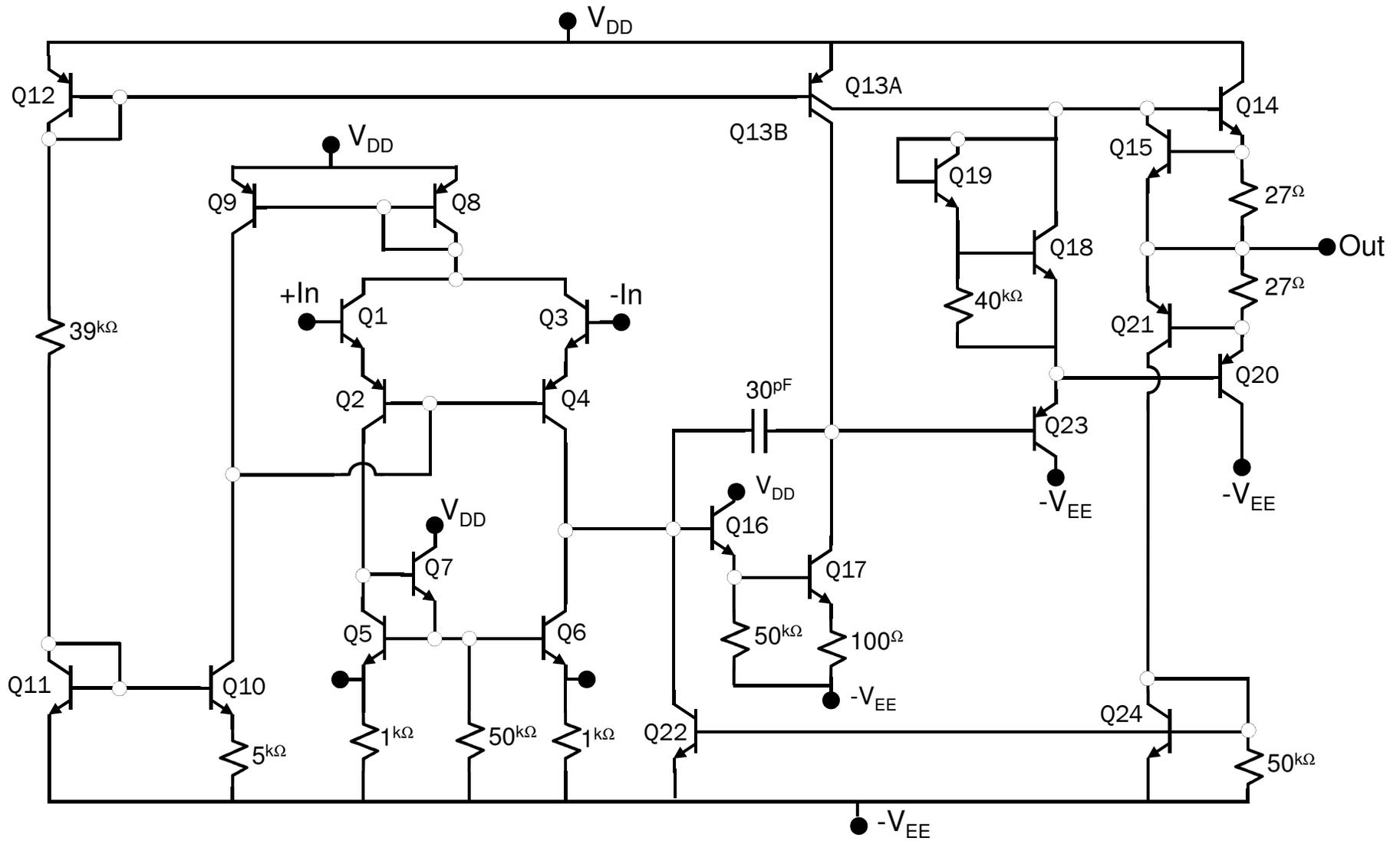
# 741, Bias

1.
2.
3.
4.
5.



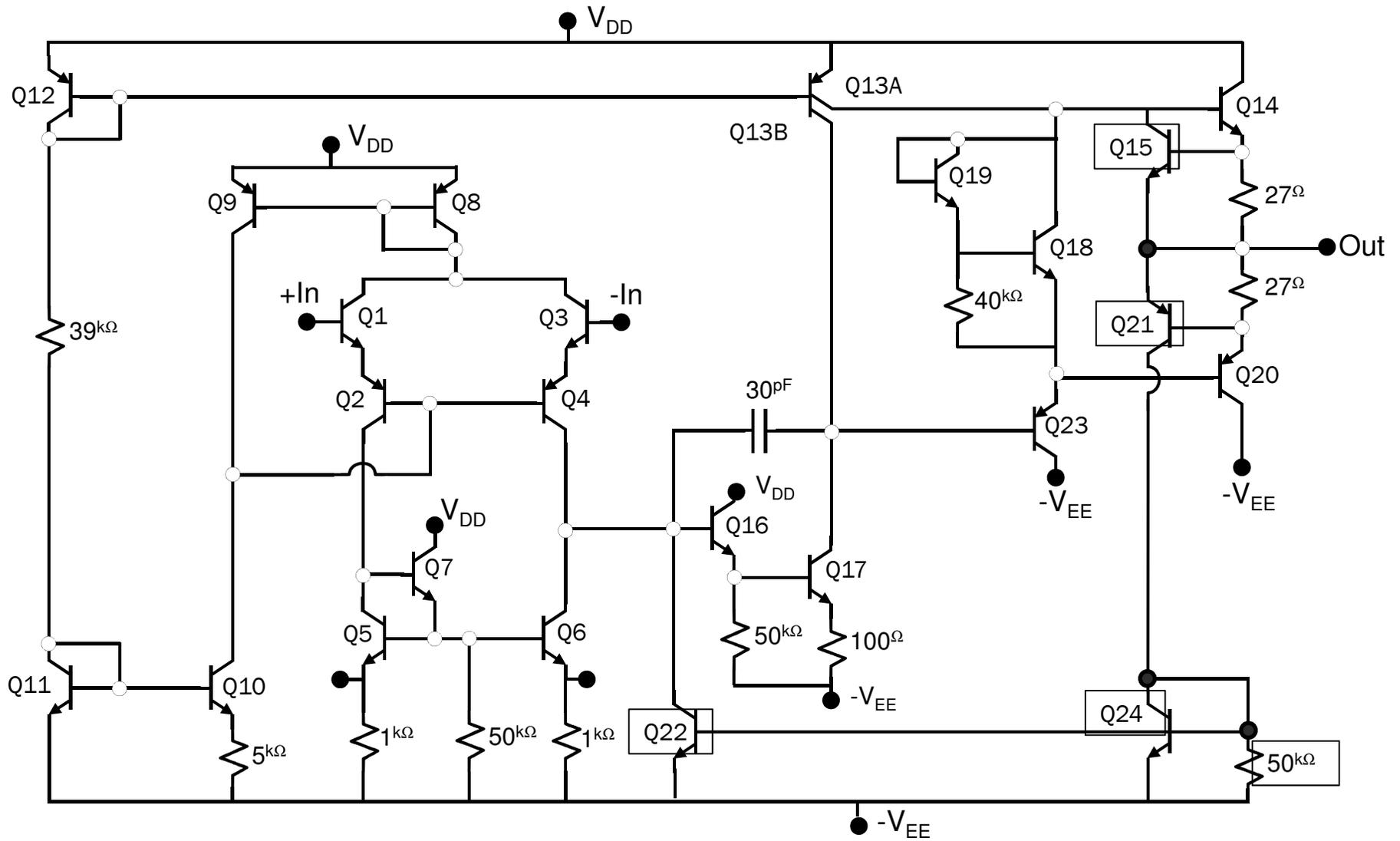
# Simplify!

1.
2.
3.
4.
5.



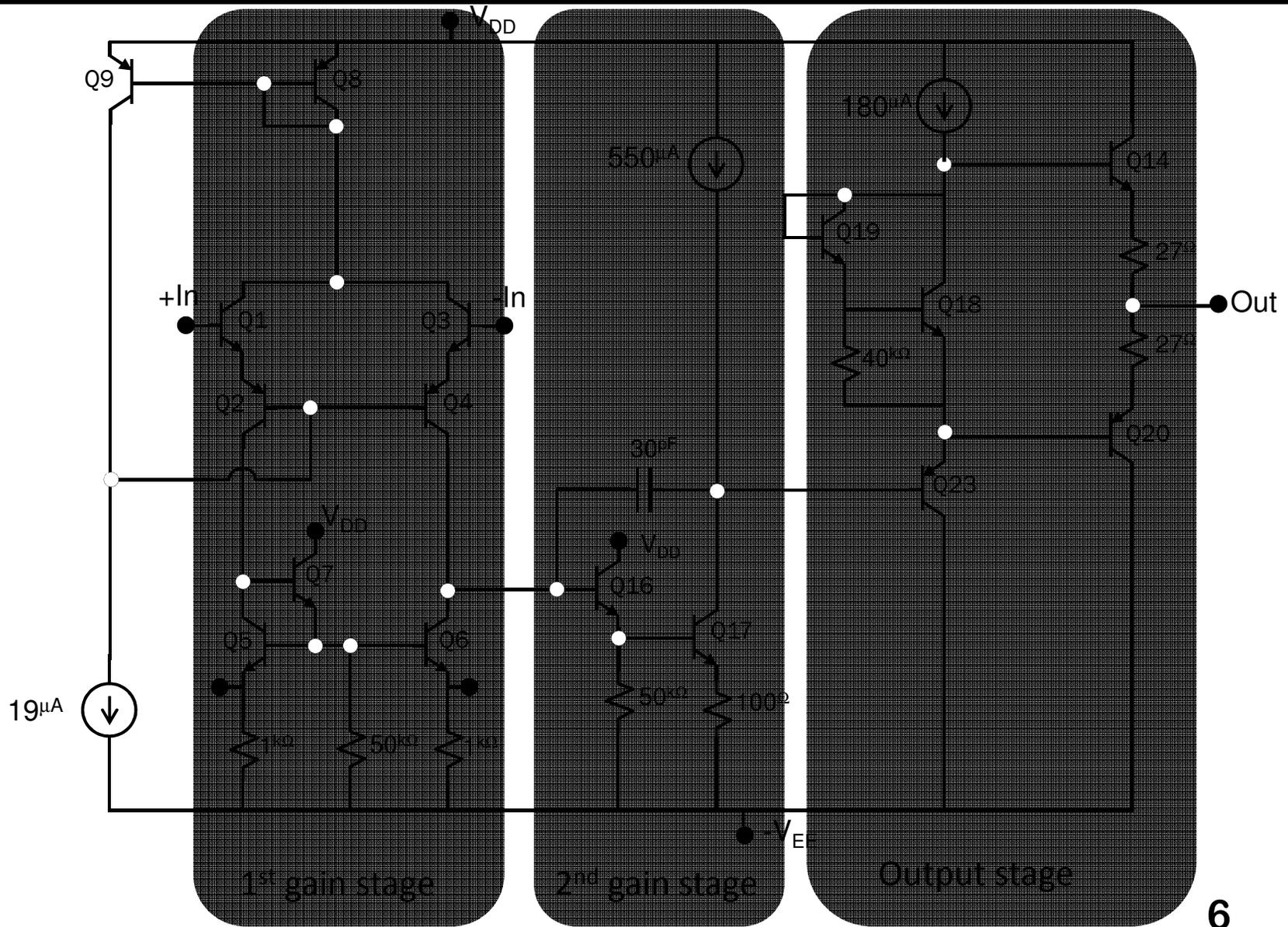
# Simplify!

1.
2.
3.
4.
5.



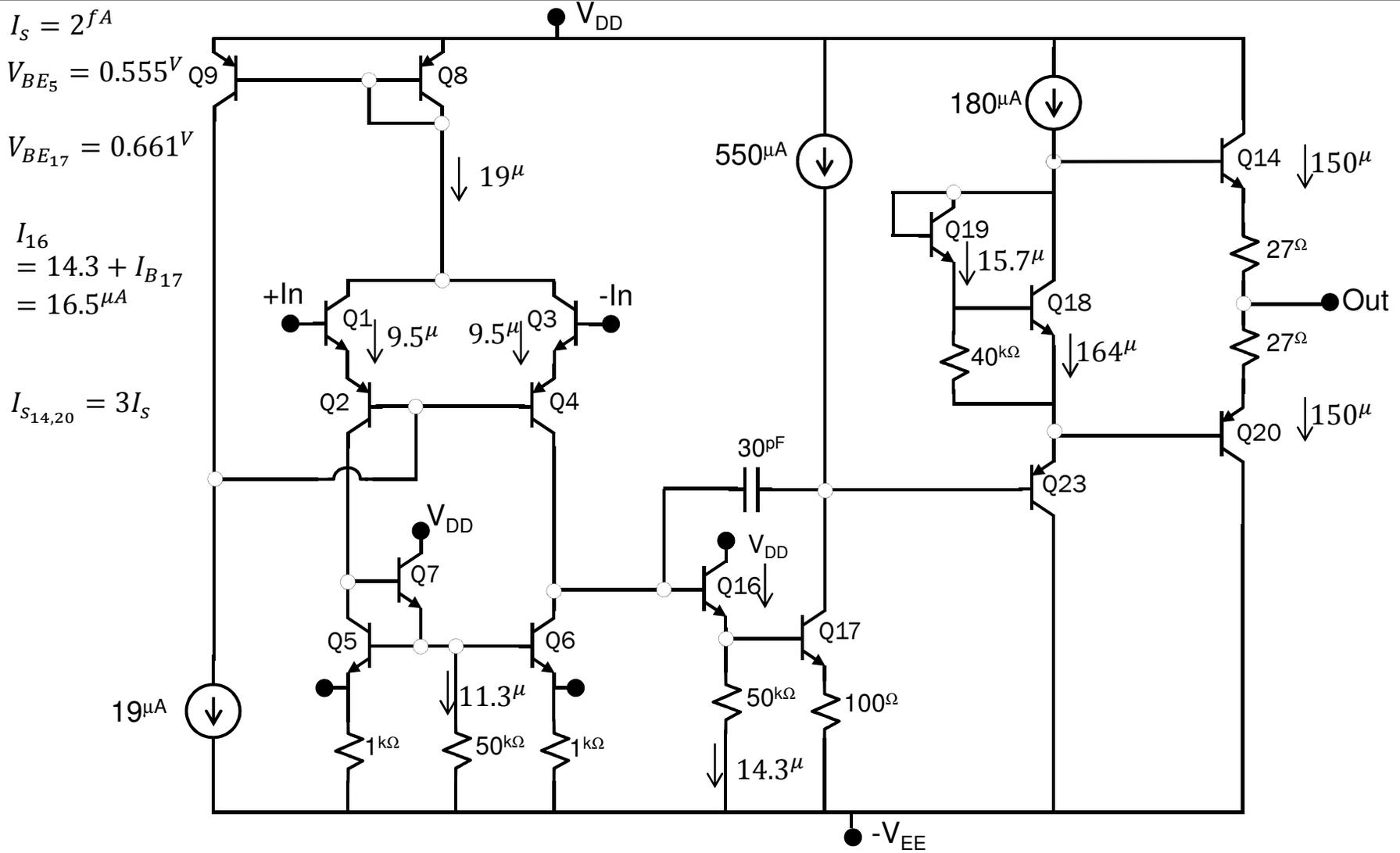
# Simplify!

1.
2.
3.
4.
5.



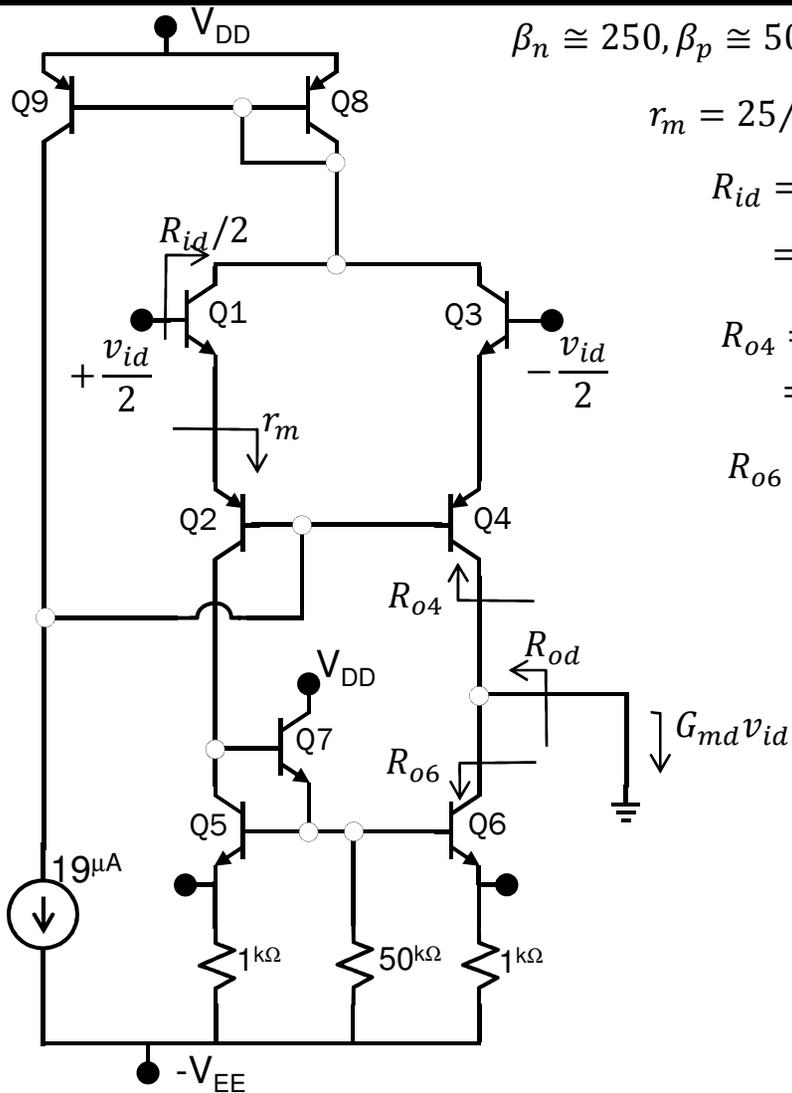
# Bias!

1.
2.
3.
4.
5.



# 1st gain stage

1.
2.
3.
4.
5.



$$\beta_n \cong 250, \beta_p \cong 50, V_{Ap} = 50V, V_{An} = 130V$$

$$r_m = 25/0.0095 = 2.6^k$$

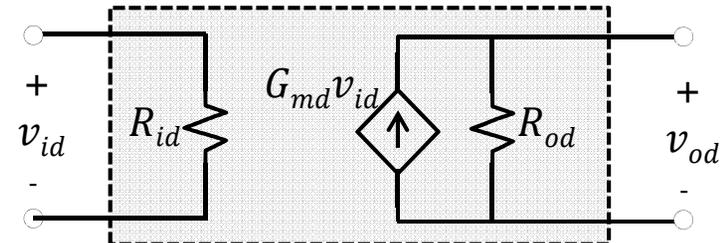
$$R_{id} = 2[r_{\pi_n} + \beta_n r_m] = 2.7^M$$

$$R_{o4} = r_{o4}(1 + g_{m4}r_{m3}) = 2r_{o4} = 10.5^M$$

$$R_{o6} = r_{o6}(1 + g_{m6}1^k) = 18.7^M$$

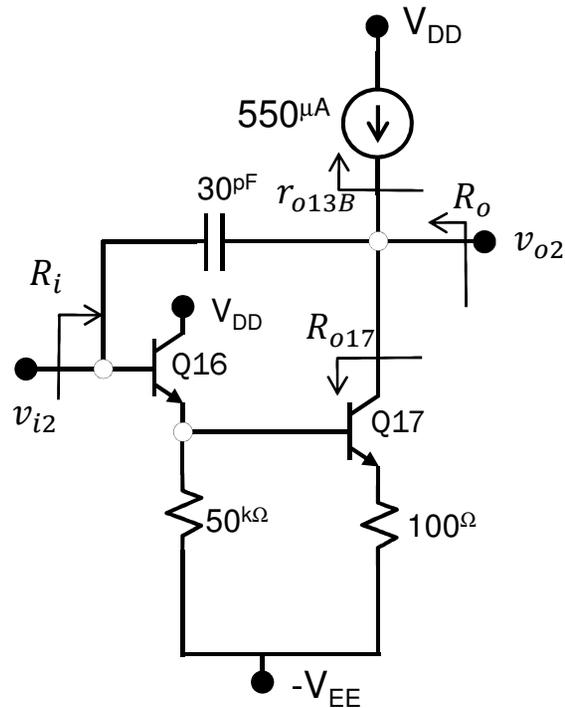
$$R_{od} = R_{o4} \parallel R_{o6} = 6.8^M$$

$$G_{md} = \frac{1}{2}g_m = 183\mu S$$



# 2nd gain stage

1.
2.
3.
4.
5.



$$R_i = r_{\pi 16} + \beta_n [50^k \parallel (r_{\pi 17} + \beta_n \times 0.1^k)]$$

$$= 5.7^M$$

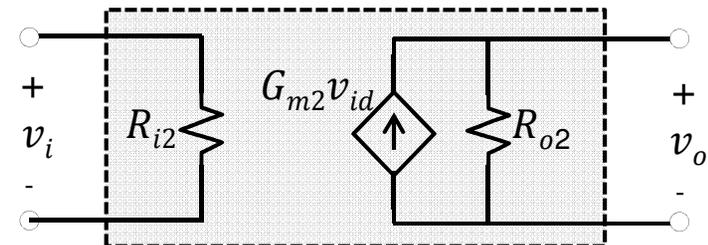
$$R_{o17} = r_{o17} (1 + g_{m17} \times 0.1^k)$$

$$= 732^K$$

$$R_o = 81^K$$

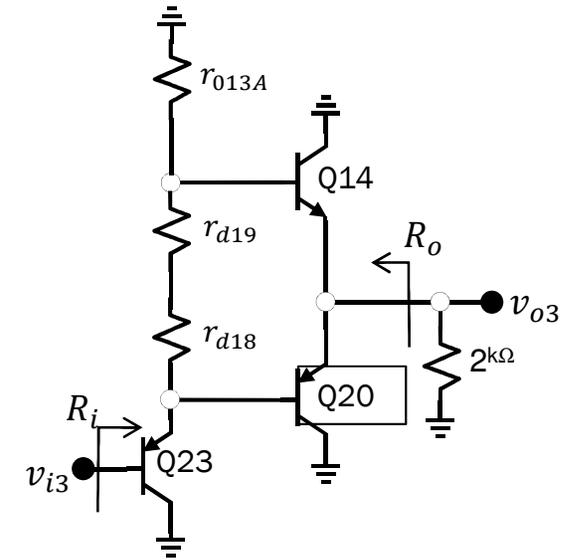
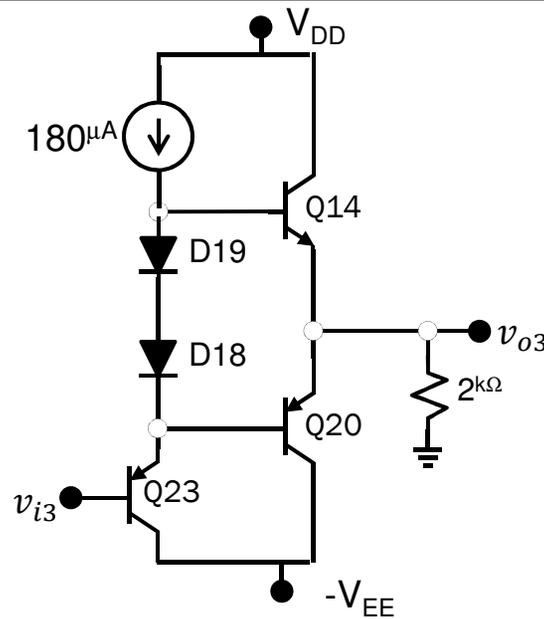
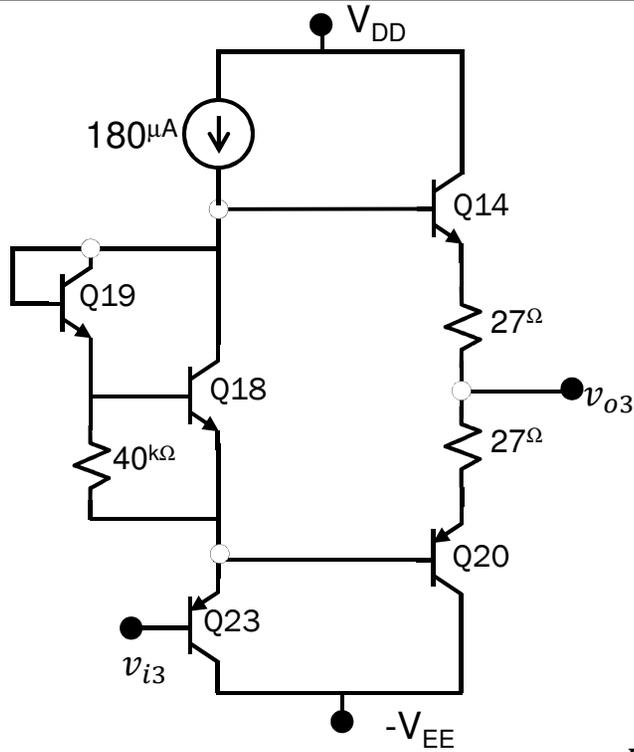
$$r_{o13B} = 91^K$$

$$G_m = \frac{g_{m17}}{1 + g_{m17} \times 0.1^k} = 6.8^{mS}$$



# Output stage

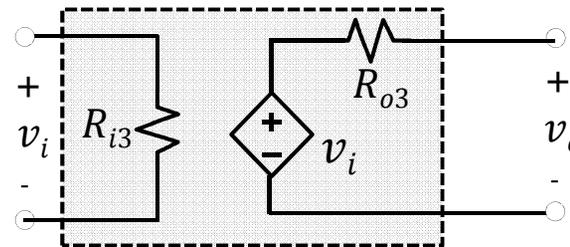
1.
2.
3.
4.
5.



$$R_i = r_{\pi 23} + \beta_p [r_{d18} + r_{d19} + r_{o13A} \parallel (r_{\pi 14} + \beta_n R_L)] = 9.1^M$$

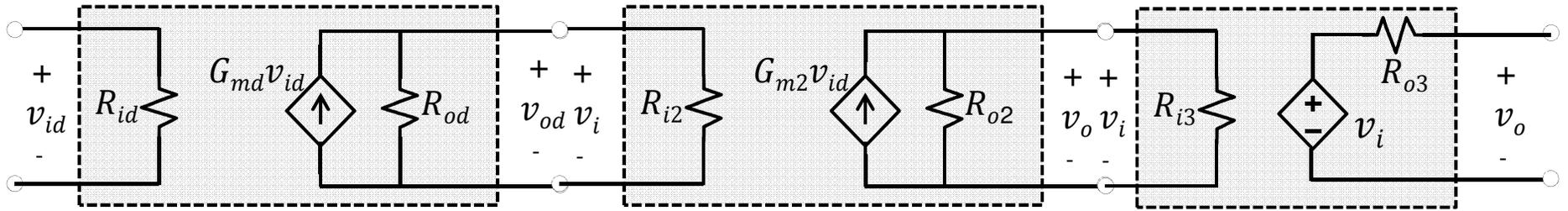
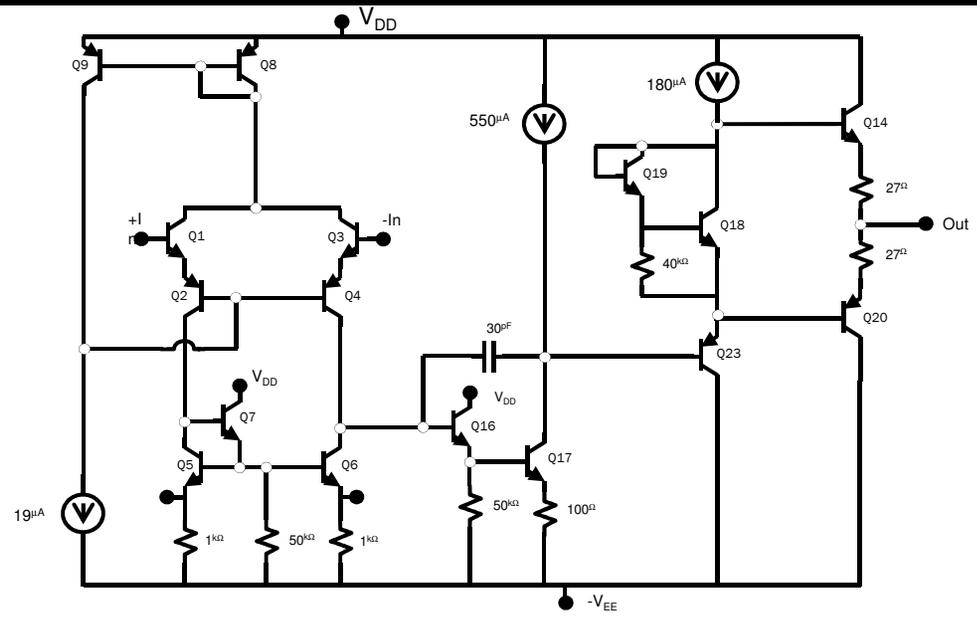
$$R_o = 27^{\Omega} + r_{m14} + \frac{1}{\beta_n} [r_{o13} \parallel (r_{d18} + r_{d19} + r_{m23} + R_{o2}/\beta_p)] = 48^{\Omega}$$

$$A_v \sim 1$$



# 741

1.
2.
3.
4.
5.



$$R_{id} = 2.7^M \quad R_{od} = 6.8^M \quad R_{i2} = 5.7^M \quad R_{o2} = 81^K \quad R_{i3} = 9.1^M \quad R_{o3} = 48^\Omega$$

$$G_{md} = 183^\mu S \quad G_{m2} = 6.8^m S$$

$$A_v = G_{md}(R_{od} \parallel R_{i2}) \times G_{m2}(R_{o2} \parallel R_{i3}) = 308000$$