y. E.

P1) $\beta_{F_1} = g_{m1} \cdot r_{ac_1} = 10mS \cdot 10k = \underline{\underline{100}}$

$r_{ai_1} = 100 \cdot \left(\frac{1}{g_{m1}} + r_{e0}\right) = 20k$

$V_{a1} = V_k \frac{20k // 10k}{20k // 10k + 5k} = 0,57 \cdot V_k$

$\frac{V_{b1}}{V_{a1}} = - \frac{g_{m1} \cdot (100k // 2k // r_{ai2})}{1 + g_{m1} \cdot (0,1k)}$ $\qquad r_{ai2} = \beta_{F2} \cdot \frac{1}{g_{m2}} = \underline{\underline{2k}}$

$\beta_{F2} = \underline{\underline{8}}$

$g_{m2} = \frac{20}{5k} = 4mS$

$\frac{V_{b1}}{V_{a1}} = - \frac{10m \cdot 0,99k}{1 + 10m \cdot 0,1k} = \underline{\underline{-4,95}}$

$V_{b1} = -2,82\ V_k = V_{ac2}$

$i_o = \frac{2,82 \cdot V_k \cdot 20}{10k} \rightarrow \frac{i_o}{V_k} = \underline{\underline{-564mS}}$

7. E.

2) $\beta_N = \beta_p = 100\mu \cdot 20 = 2\,mA/V^2$

$I_{DN} = \frac{\beta_N}{2} \cdot (V_{GS} - V_{TH})^2 \cdot \left(1 + \frac{V_{DS}}{V_A}\right)$ — V_{DS} omitted, 0

$1mA = 1mA \cdot (V_G - (-1,5) - 0,5)^2 \cdot \left(1 + \frac{V_o + 1,5}{40}\right)$

$1 = V_G + 1 \rightarrow \underline{V_G = 0V = V_{GGN}}$

$I_{DP} = \frac{\beta_P}{2} (V_{GS} - V_{TH})^2 \cdot \left(1 + \frac{V_{DS}}{V_A}\right)$ — V_{DS} omitted, 0

$1mA = 1mA \cdot (V_{GGP} - 5 - (-0,5))^2$

$1 = V_{GGP} - 4,5 \rightarrow \underline{V_{GGP} = 5,5V}$

b) $\underline{V_{i2} = 0}$

$\frac{V_o}{V_{i1}} = \frac{V_{dN}}{V_{SN}} = \left(g_{mN} + \frac{1}{r_{dsN}}\right) \cdot (r_{dsN} \,//\, r_{dsp})$

$g_{mN} = g_{mp} = \sqrt{2 \cdot \beta_N \cdot I_o} = 2\,mS$

$r_{dsN} = r_{dsp} = \frac{40V}{I_o} = 40k\Omega$

$\frac{V_o}{V_{i1}} = (2m + 0,025m) \cdot (20k\Omega) \cong 40$

$\underline{V_{i1} = 0}$

$\frac{V_o}{V_{i2}} = \frac{V_{dp}}{V_{gp}} = -g_{mp} \cdot (r_{dsN} \,//\, r_{dsp})$

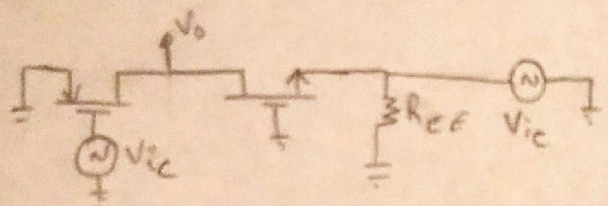
7.E

$\frac{V_o}{V_{in}} = -2M \cdot 20k = -40$

Superposition $\longrightarrow$ $V_o = 40 \cdot V_{i1} - 40 V_{i2}$

$$A_d = \frac{V_o}{V_{i1} - V_{i2}} = 40$$

c)



$R_{EE} = \frac{-1,5+5}{1\,mA} = 3,5\,k\Omega$

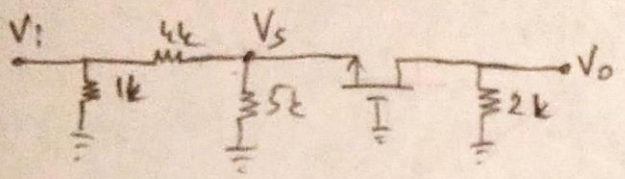
$V_o = 40\,v_{ic} - 40 v_{ic} = 0 \longrightarrow A_c = 0$

$CMRR = \left| \frac{A_d}{A_c} \right| = \infty$

N.C.

P3) $V_o = V_i$

a)



$V_S = 5 \cdot \frac{5}{9} - 5 = -2,22$ $\quad I_0 = \frac{-2,22 + 5}{5k} = 0,56\ mA$

$g_m = \sqrt{2 \cdot \beta \cdot I_0} = \sqrt{2 \cdot 4 \cdot 10^{-3} \cdot 10^{-3}} = 2,11\ mS$

$\frac{V_o}{V_i} = \frac{5}{9} \cdot g_m \cdot 2k = \underline{\underline{2,34}}$

b) $V_o < 5V \rightarrow$ Max $V_i \cong 2,13V$

c)

P4) $V_{o1} = 10V = V_{cc} \rightarrow V_p = 10 \cdot \frac{1}{5} = 2V$

$V_{o1} = -10V = -V_{cc} \rightarrow V_p = -2V$

$V_{in} > 2V \rightarrow V_{o1} = -10V$

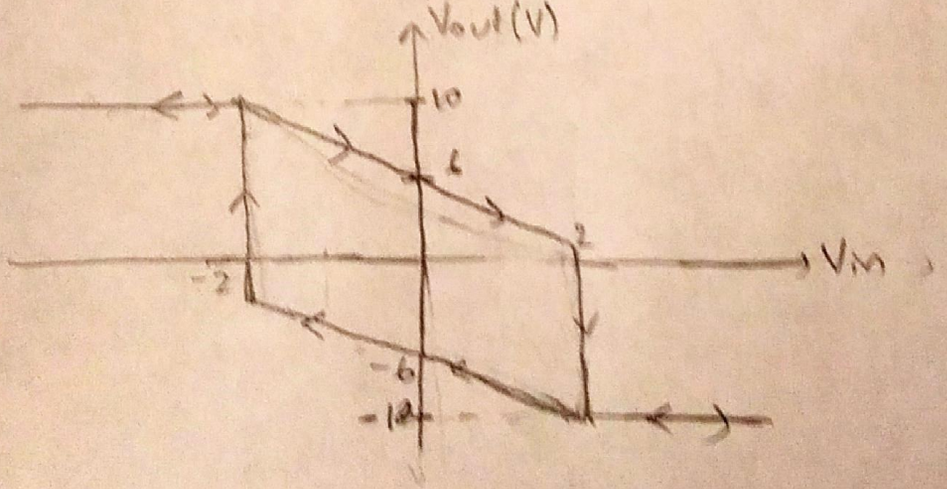
$V_p = -10 \cdot \frac{1}{5} = -2V \longrightarrow \frac{V_{in} + 2}{1k} = \frac{-2 - V_{out}}{2k}$

$2V_{in} + 4 = -2 - V_{out} \rightarrow \boxed{V_{out} = -2V_{in} - 6}$

$V_{in} < -2V \rightarrow V_{o1} = 10V$

$V_p = 2V \longrightarrow \frac{V_{in} - 2}{1k} = \frac{2 - V_{out}}{2k}$

$2V_{in} - 4 = 2 - V_{out} \longrightarrow \boxed{V_{out} = -2V_{in} + 6}$



Y.E.

P5) $V_{01} = 10V$ $\quad V_H^+ = 2V$ $\quad V_H^- = -2V$

$V_{out} > V_H^+ \rightarrow V_{01} = -10V$

$V_p = -10 \cdot \frac{1}{5} = -2V = V_N$

$\frac{V_{in} + 2}{1k} = \frac{-2 - V_{out}}{2k}$ $\quad V_{out} = -2V_{in} - 6$

$V_{out} < V_H^- \rightarrow V_{01} = 10V$

$V_p = 2V = V_N$

$\frac{V_{in} - 2}{1k} = \frac{2 - V_{out}}{2k}$ $\quad V_{out} = -2V_{in} + 6$