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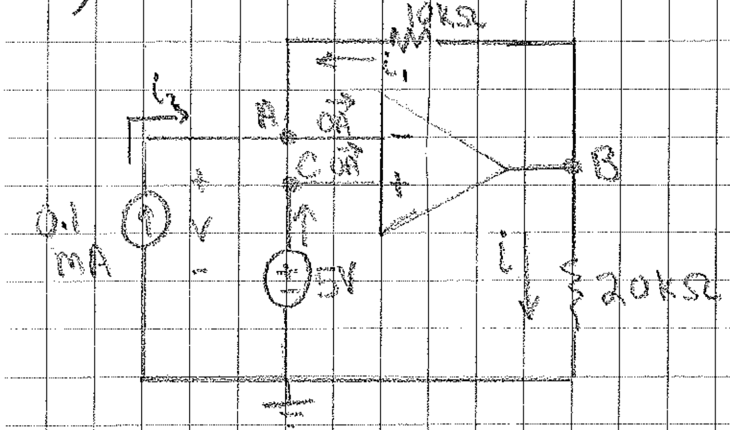
Engr. M20 HW #4

1) Find v and i in the circuit below.



KCL @ (-) opAmp:

Note: Principle of Short → $V_A = V_C$

Note: $V_C = 5V \Rightarrow \underline{V_A = 5V}$ (Eq 2)

$i_1 + i_2 = 0A$

$\frac{V_B - V_A}{10K} + 0.1mA = 0A$

$\frac{V_B}{10K} - \frac{V_A}{10K} + 0.1mA = 0$

$V_B - V_A + 1V = 0$ (Eq 1)

(Eq 1, Eq 2) → $V_B - 5 + 1 = 0$

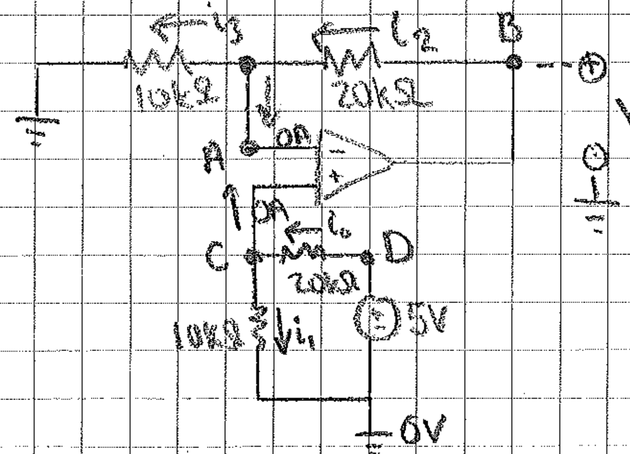
$V_B = 4V$ (Eq 3)

Note: $V = iR \Rightarrow 4 = i(20k)$

$\boxed{i = 200\mu A}$

Note: $V = V_A \Rightarrow \boxed{V = 5V}$

2) Find V_o and i_o in the CKT below:



KCL @ C:

$i_o = i_1 + 0A$

$\frac{V_D - V_C}{20K} = \frac{V_C - 0}{10K}$

$\frac{V_D}{\cancel{20K}} - \frac{V_C}{\cancel{20K}} = \frac{2V_C}{\cancel{20K}}$

Note: $V_D = 5V$

$5 - V_C = 2V_C$

$3V_C = 5$

$V_C = 5/3\,V$ (Eq 1)

Note: Principle of Short → $V_A = V_C$ ⇒ $V_A = 5/3\,V$ (Eq 2)

KCL @ A:

$i_2 = i_3 + 0A$

$\frac{V_B - V_A}{20k\Omega} = \frac{V_A - 0}{10k\Omega}$

$\frac{V_B}{\cancel{20K}} - \frac{V_A}{\cancel{20K}} = \frac{2V_A}{\cancel{20K}}$

$V_B = 3V_A = 3\left(\frac{5}{3}\right)$

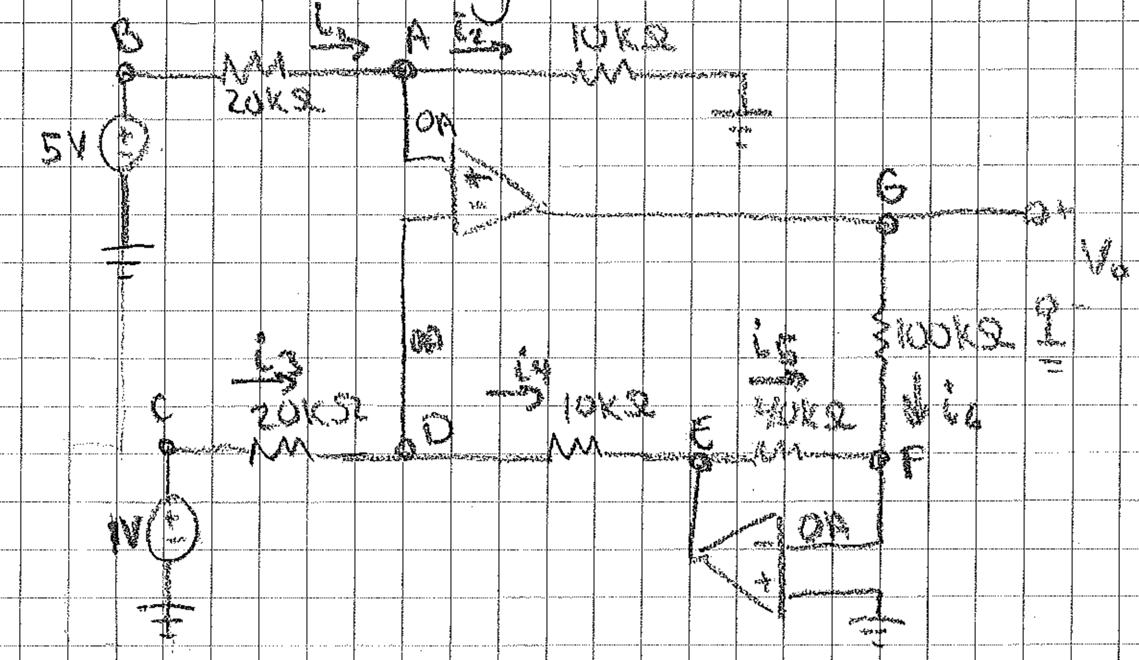
$\therefore V_B = 5V$ (Eq 3)

Note: $V_B = V_o$ → $\boxed{V_o = 5V}$

Note: $V = i_oR$ = $(V_D - V_C) = i_o(20K)$

$\frac{5 - 1.667}{20K} = i_o$ ⇒ $\boxed{i_o = 166.67\,uA}$

3) Find V_o in the following Circuits:



Note: $V_B = 5V$; $V_C = 1V$; $V_F = 0V$ (Principle of short)

KCL @ A:

$i_1 = i_2 + 0A$

$$\frac{V_B - V_A}{20K} = \frac{V_A - 0}{10K}$$

$$-\frac{V_A}{\cancel{20K}} + \frac{V_B}{\cancel{20K}} = \frac{2V_A}{\cancel{20K}}$$

$+V_B = 3V_A \Rightarrow V_A = 5/3 = 1.667V$ (Eq1)

$\therefore V_D = 1.667V$ (Principle of short)

KCL @ D

$i_3 = i_4 + 0A$

$$\frac{V_C - V_D}{20K} = \frac{V_D - V_E}{10K}$$

$$\frac{\cancel{V_C}^{1}}{\cancel{20K}} - \frac{V_D}{20K} = \frac{2V_D}{\cancel{20K}} - \frac{2V_E}{\cancel{20K}}$$

$3\cancel{V_D}^{5/3} = 1 + 2V_E$

$4 = 2V_E$

$V_E = 2V$ (Eq2)

KCL @ F

$i_5 + i_6 = 0A$

$$\frac{V_E - V_F}{40K} + \frac{V_G - V_F}{100K}$$

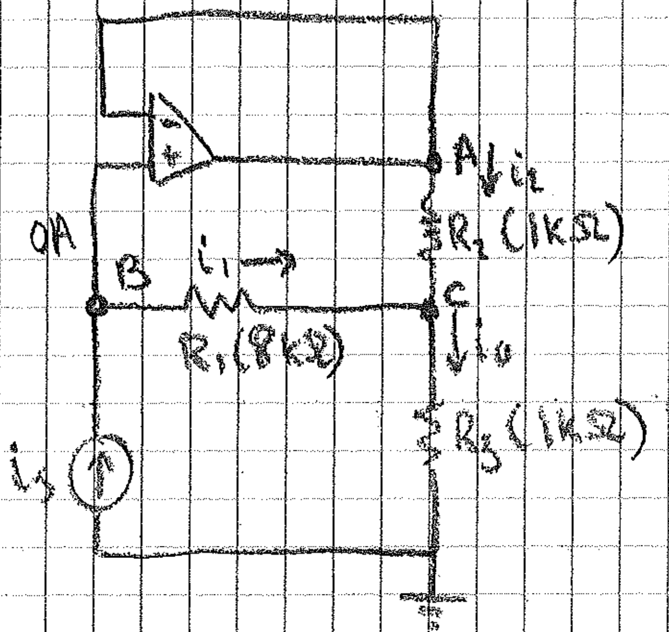
$$\Rightarrow \frac{5\cancel{V_E}^{2}}{\cancel{200K}} - \frac{5\cancel{V_F}^{0}}{\cancel{200K}} + \frac{2V_G}{\cancel{200K}} - \frac{2\cancel{V_F}^{0}}{\cancel{200K}} = 0$$

$10 = -2V_G$

$\therefore V_G = -5V$

Note: $V_G = V_o \Rightarrow \boxed{V_o = -5V}$

4) A non-inverting current amplifier in portrayed in CKT below. Calculate the gain i_o/i_s. Take $R_1 = 8k\Omega$, and $R_2 = R_3 = 1k\Omega$



<u>Note</u>: $V_A = V_B$ by principle of short.

KCL @ B

$i_s = i_1 + 0A$

$i_s = \frac{V_B - V_C}{8K}$

$i_s = \frac{V_B}{8K} - \frac{V_C}{8K}$ (1)

KCL @ C

$i_1 + i_2 = i_o$

$\frac{V_B - V_C}{8K} + \frac{V_A - V_C}{1K} = \frac{V_C - 0}{1K}$

$\frac{V_B}{8K} - \frac{V_C}{8K} + \frac{8V_A}{8K} - \frac{8V_C}{8K} = \frac{8V_C}{8K}$

$V_B - V_C + 8V_a - 8V_C = 8V_C$

$\cancel{V_B}^{V_a} + 8V_a = 17V_C$

$9V_a = 17V_C$

$\therefore V_B = V_a = 17/9\, V_C$ (2)

(1,2) → $i_s = \frac{17/9\, V_C}{8K} - \frac{V_C}{8K}$

$i_s = \frac{8/9\, V_C}{8K}$

$i_s = \frac{V_C}{9K}$ (3)

& $i_o = V_C/1K$

$\therefore V_C = i_o 1K$ (4)

(3,4) → $i_s = \frac{i_o 1K}{9K}$

$\boxed{\frac{i_o}{i_s} = 9}$