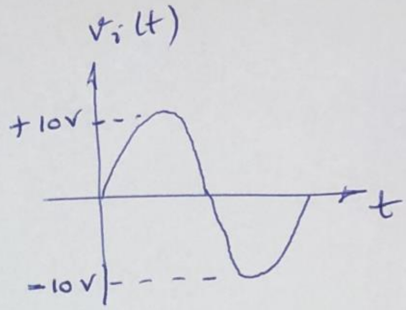
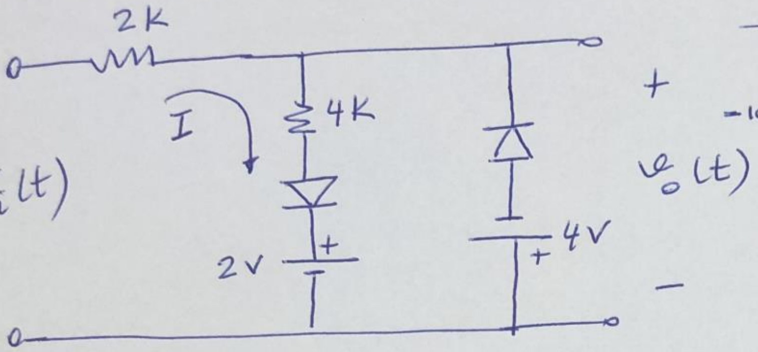
Q.#1.

Final





- For the positive half cycle, branch with 4V supply is OPEN circuit.

For $0 < v_i < 2V$ $\quad v_o = v_i$ (6p)

For $V_i \geq 2V$ (7p)

$$-V_i + (2K)I + (4K)I + 2 = 0$$

$$I = \frac{V_i - 2}{6K} \quad ; \text{ For } V_i = 10V \Rightarrow I = \frac{(10-2)V}{6K\Omega} = \frac{8}{6} mA = 1.33 mA.$$

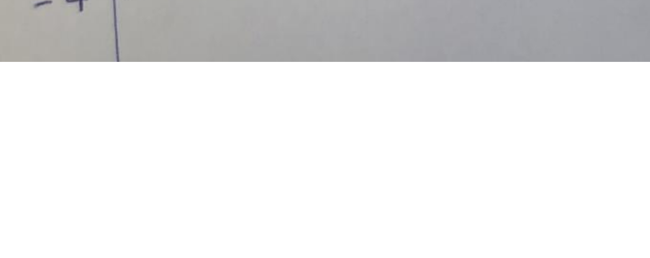
$$V_o = (4K)I + 2 \text{ Volts}$$

$$= (4K)(1.33mA) + 2 = 5.32 + 2 = 7.32V.$$

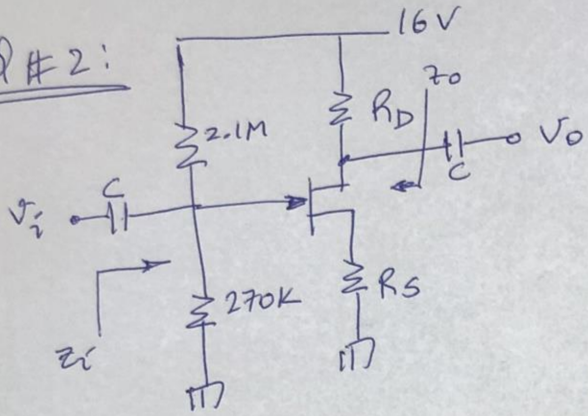
For the negative half cycle; Branch with 2V supply is OPEN circuit.

For $-4V < V_i < 0V$; $V_o = V_i$ (Branch with 4V supply is also OPEN) (6p)

For $-10V < V_i \leq -4V \Rightarrow V_o = -4V$ (6p)



Q#2:



$I_{DSS} = 5mA \quad V_p = -4V$

$V_D = 8V \quad V_S = 3.6V$

(3) $V_G = ?$ $I_{DQ} = ?$ (3)

(3) $R_D = ?$ $R_S = ?$ (3)

(3) $g_m = ?$ SS equiv. model (3)

(3) $A_V = \frac{V_o}{V_i}$? $Z_i = ?$ (2) $Z_o = ?$ (2)

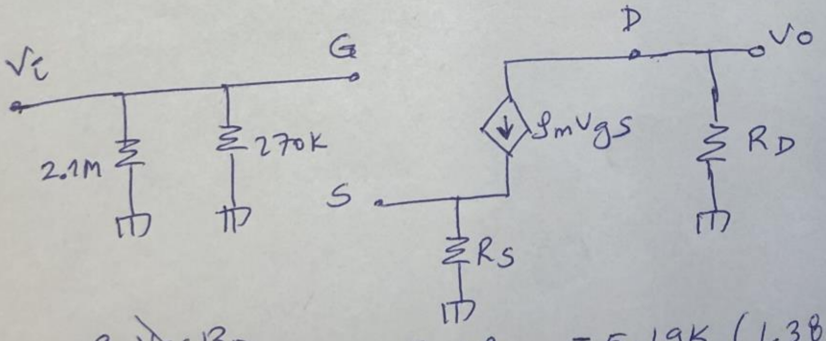
$$V_G = \frac{270K}{(2.1M + 270K)} \cdot 16V = (0.114)(16) = \boxed{1.82V}$$

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2 \qquad V_{GS} = V_G - V_S = 1.82 - 3.6 = \boxed{-1.78V}$$

$$= 5\left(1 - \frac{-1.78}{-4}\right)^2 = 5(1 - 0.445)^2 = \boxed{1.54mA}$$

$$R_S = \frac{V_S}{I_{DQ}} = \frac{3.6V}{1.54mA} = \boxed{2.33k\Omega} \qquad R_D = \frac{16-8}{1.54mA} = \boxed{5.19k\Omega}$$

$$g_m = \frac{\partial I_D}{\partial V_{gs}} = \frac{2 I_{DSS}}{|V_P|}\left(1 - \frac{V_{GS}}{V_P}\right) = \frac{2 * 5mA}{4V}\left(1 - \frac{-1.78}{-4}\right) = 2.5m(0.555) = \boxed{1.38 m℧}$$



$V_o = -g_m V_{gs} \cdot R_D$

$V_i = V_{gs} + g_m V_{gs} \cdot R_s$

$= V_{gs}(1 + g_m R_s)$

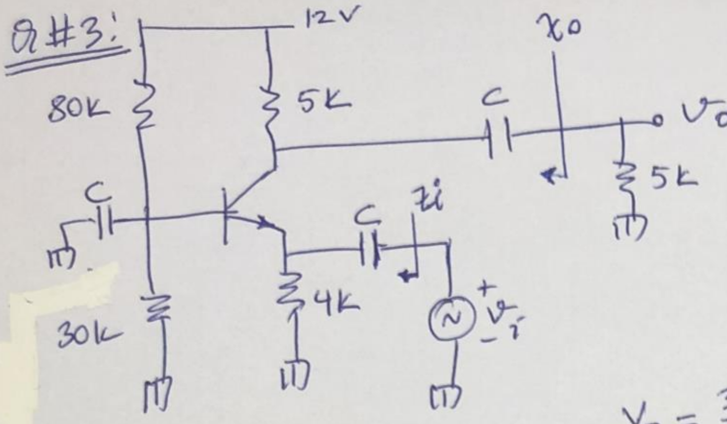
$$A_v = \frac{-g_m V_{gs} R_D}{V_{gs}(1 + g_m R_s)} = \frac{R_D \cdot -g_m}{(1 + g_m R_S)} = \frac{-5.19K\,(1.38 * 10^{-3})}{1 + (1.38m℧)(2.33k\Omega)} =$$

$$= \frac{-7.16}{1 + 3.22} = \boxed{-1.7}$$

$$Z_i = 270K \,//\, 2.1M = \boxed{239.2\,k\Omega}$$

$$Z_o = R_D = \boxed{5.19k\Omega}$$

Q#3:



$\beta = 100$

(2) $V_{BQ} = ?$ (2) $I_{EQ} = ?$ (2) $I_{CQ} = ?$

(2) $V_{CEQ} = ?$ s.s.e. r_e model? (3)

(2) $r_e = ?$ (3) $A_v = ?$ $A_I = ?$ (3)

(2) $z_i = ?$ $z_o = ?$ (2)

what type? (2)

$$V_B = \frac{30K}{30K+80K} \cdot 12V = \boxed{3.27V}$$

Test; $\beta R_E > (10)(30k)$

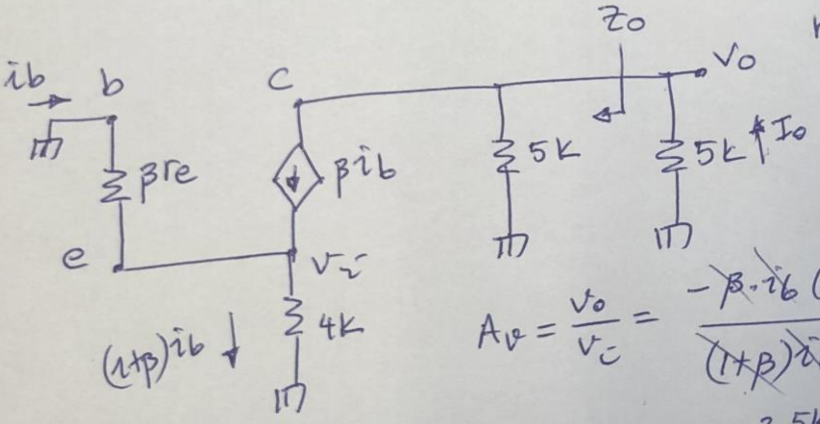
$(120)(4K) > 300K$ YES ✓

$$V_E = V_B - 0.7 = 3.27 - 0.7 = 2.57V.$$

$$I_{EQ} = \frac{V_{EQ}}{R_E} = \frac{2.57V}{4K\Omega} = \boxed{0.64mA}$$

$$V_{CEQ} = 12 - (0.64)(5+4) = \boxed{6.24V}$$

$$I_{CQ} \cong I_{EQ} = \boxed{0.64mA}$$



$$r_e = \frac{26mV}{I_{EQ}} = \frac{26mV}{0.64mA}$$

$$r_e = \boxed{40.62\Omega}$$

$$A_v = \frac{v_o}{v_i} = \frac{-\beta \cdot i_b (5K \| 5K)}{(1+\beta) i_b \cdot (4K \| r_e)}$$

$$= -\frac{2.5K}{40} = \boxed{-62.5}$$

$$I_o = \frac{\beta i_b}{2} \quad I_i \cong -\beta i_b$$

$$A_I \cong \boxed{0.5}$$

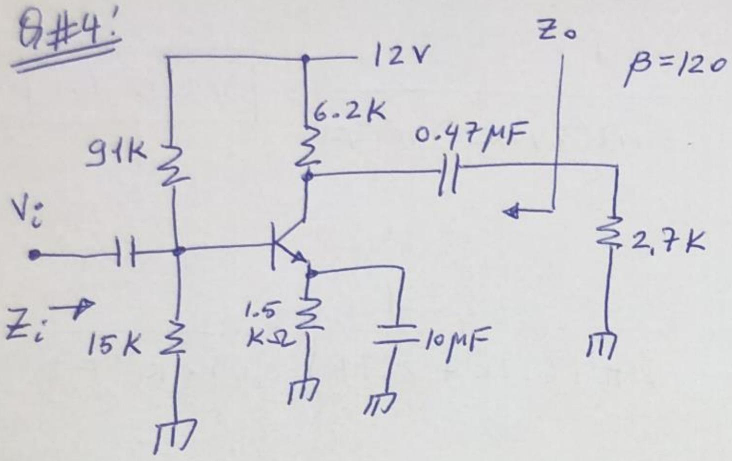
$$z_o = R_C = \boxed{5K\Omega}$$

$$z_i = R_E \| r_e$$

$$= (4K) \| (40.62\Omega)$$

$$= \boxed{40.21\Omega}$$

Q#4:



$\beta = 120$

V_{BQ} (2) I_{EQ} (2)

(2) I_{CQ} V_{CEQ} (2)

(3) sse r_e model

(2) A_v Z_i (2)

(2) Z_o f_{LS} (2)

f_{LC} (2) f_{LE} (2) f_c (2)

Test ; $\beta R_E > 10 \cdot (R_2)$

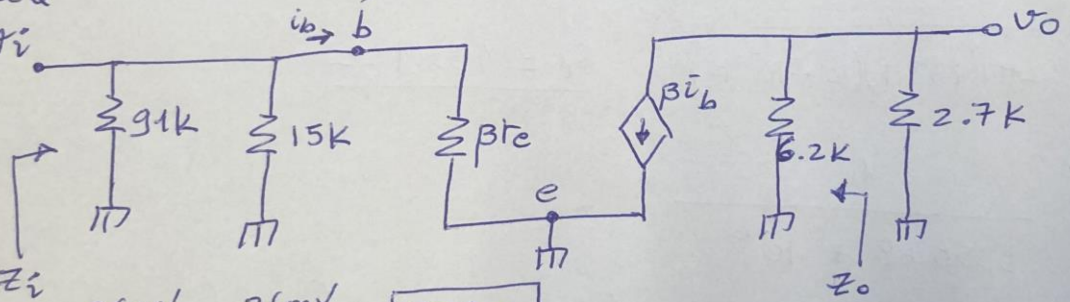
$(120)(1.5k) > 10(15k)$ YES ✓

$$V_{BQ} = \frac{15K}{15K + 91K} \cdot (12V) = \boxed{1.69V}$$

$$I_{EQ} = \frac{V_{BQ} - 0.7}{1.5K} = \frac{1V}{1.5K} = \boxed{0.67mA}$$

$$I_{CQ} \cong I_{EQ} = \boxed{0.67mA}$$

$$V_{CEQ} = V_{CC} - I_{CQ}(R_C + R_E) = 12 - 0{,}67mA(6.2K + 1.5K) = \boxed{6.84V}$$



$$r_e = \frac{26mV}{I_{EQ}} = \frac{26mV}{0{,}67mA} = \boxed{38.8\Omega}$$

$$v_o = -\beta \cdot i_b \{(6.2K) \| (2.7K)\}$$

$$v_i = \beta . r_e . i_b$$

$$A_v = \frac{v_o}{v_i} = \frac{-\beta i_b \cdot (6.2k)\|(2.7k)}{\beta . r_e . i_b} = \frac{-1.88K}{38.8\Omega} = \boxed{-48.45}$$

$$Z_i = (91k)\|(15k)\|[120(38.8)] = \boxed{3.42K\Omega}$$

$$\boxed{Z_o = 6.2k\Omega}$$