ESC201A Quiz2 Set B

SAMYAK SINGHANIA

TOTAL POINTS

8 / 11

QUESTION 1

Q1 6 pts

1.1 Q1(a) 4 / 4

✓ **+ 4 pts** *Completely Correct*

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 1 pts VBB eq correct

+ 1 pts VBB calculation correct

+ 1 pts VCC eq correct

+ 1 pts VCC calculation correct

1.2 Q1(b) 1 / 2

+ 2 pts Completely Correct

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 1 pts Vs = +2V case analyzed correctly

✓ **+ 1 pts** *Vs = -2V case analyzed correctly*

QUESTION 2

2 Q2 3 / 5

+ 5 pts Correct

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 2 pts Small signal model of circuit drawn correctly

✓ **+ 1 pts** *Expressions for gm and r_pi correct*

+ 1 pts vo/is expression correct

+ 1 pts vo/is value correct

+ 2 *Point adjustment*

small signal model only partially correct, partial marks for correct approach

ESC201A: Introduction to Electronics, Quiz -2 (Set-B) **Date: 13.10.2022**

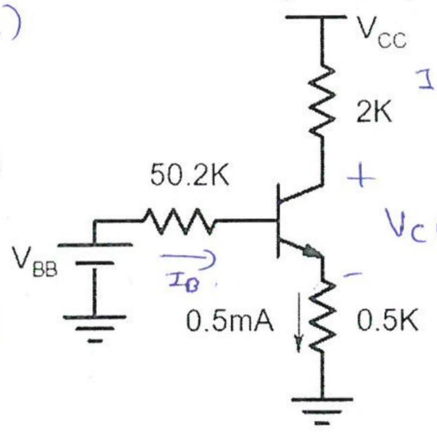
Name : SAMYAK SINGHANIA **Roll. No.** 210917 **Section:** W3

Q.1(a) Determine the value of voltage V_{BB} so that dc emitter current is 0.5mA. Determine also the minimum supply voltage V_{CC} necessary so that transistor operates in forward active mode. Assume that current gain $\beta_F = 200$. [4 Marks]

$I_E = I_B + I_C$ (in forward active mode)

$I_E = I_B + 200 I_B = 201 I_B$

$I_C = 200 I_B = \frac{200 I_E}{201}$



$\therefore V_{BB} = 50.2k(I_B) + 0.7 + 0.5k \times 0.5m$

$= 50.2 \times 10^3 \times \frac{0.5 \times 10^{-3}}{201} + 0.7 + 0.25$

$= 0.1248 + 0.7 + 0.25 = 1.07V$

$\therefore V_{BB} = 1.07V.$

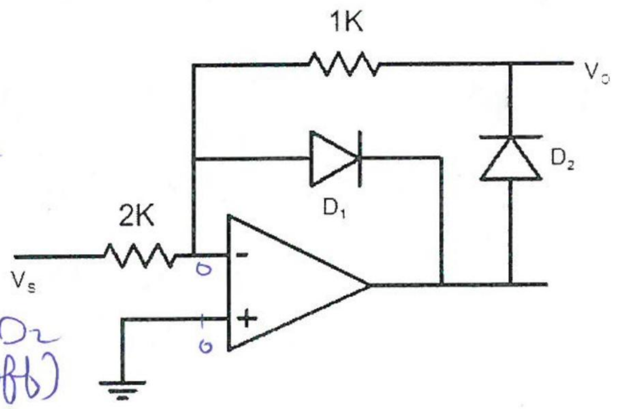
For forward active $V_{CE} > 0.2V$.

Now, $V_{CC} = (2k) I_C + V_{CE} + 0.5k \times 0.5m$

$V_{CE} = V_{CC} - 0.25 - 2 \times 10^3 \times \frac{200}{201} \times 0.5 \times 10^{-3} \Rightarrow (V_{CC} - 1.25) > 0.2V$

$\therefore \boxed{V_{CC} > 1.45}\ V$ $\therefore$ Minimum supply voltage V_{CC} should be greater than 1.45V

(b) Determine the output for the ideal opamp circuit shown below. Assume that diodes have cut-in voltage of 0.7V. Analyze the circuit for Vs = 2V and Vs = -2V. [2 Marks]



$V_+ = V_- = 0\ V.$

when $\boxed{V_S = -2.V}$

Current $=$ 1mA. in left

$\Rightarrow$ ~~0-Vo~~ $\frac{V_o - 0}{1K} = 1mA$

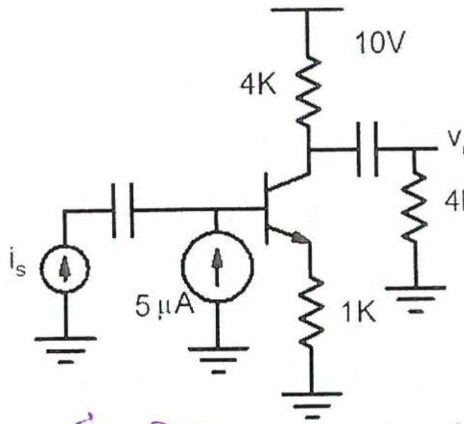
$\Rightarrow V_o = 1V.$ (D_1 & D_2 are off)

when $V_S = 2V$

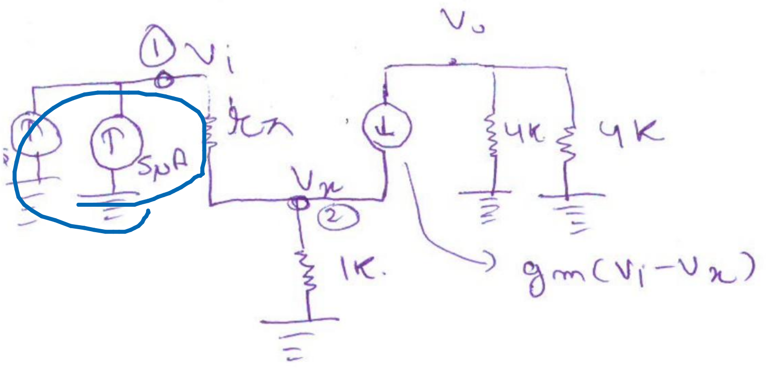
Current $= \frac{2-0}{2k} = 1mA$ in right.

$\Rightarrow \frac{0 - V_o}{1k} = 1\ mA \Rightarrow V_o = -1V.$ (D_1 & D_2 are off)

Q.2 For the circuit shown below, carry out ac analysis to determine the ratio $\frac{v_o}{i_s}$, where v_o is ac output voltage and i_s is ac sinusoidal current . Assume that transistor is biased in forward active mode and current gain $\beta_F = 200$. [5 Marks]



Ac analysis:



In DC analysis, clearly,
$I_B = 5\mu A$.
$\therefore I_C = 200\, I_B = 1mA$.

$g_m = \frac{I_C}{V_T} = \frac{1mA}{26mV} = 0.038.$

$r_\pi = \frac{\beta}{g_m} = \frac{200}{g_m}$

$v_o = -g_m(v_i - v_x) \times 2K.$

Applying KCL at Node ①, we get

$5\mu A + i_s = \frac{v_i - v_x}{r_\pi}$.

~~Also,~~ $\cancel{\frac{V_x}{1K} = I_E = 201\, I_B} \Rightarrow \cancel{V_x = 1 \times 10^3 \times 201 \times 5 \times 10^{-6} = 1005 \times 10^{-3}\, V}$.

Also, at node ②; $\frac{v_i - v_x}{r_\pi} + g_m(v_i - v_x) = \frac{V_x}{1K} \Rightarrow (v_i - v_x)\left(\frac{201\, g_m}{200}\right) = \frac{V_x}{1K}$

$\cancel{\Rightarrow 5\mu A + i_s + g_m(V_i - V_x) = 201 \times 5\mu A.}$

$\cancel{\Rightarrow g_m(V_i - V_x) = 200 \times 5\mu A - i_s} \quad - ①$

$\cancel{g_m(V_i - V_x)}$ & $\cancel{\frac{V_i - V_x}{r_\pi} = 5\mu A + i_s.}$

$\cancel{\Rightarrow 200\frac{(V_i - V_x)}{r_\pi} = 200 \times 5\mu A + 200\, i_s} \quad - ②$

$\cancel{\text{eq ②} - \text{eq ①} \Rightarrow (V_i - V_x)\left[\frac{200}{r_\pi} - g_m\right] = 201\, i_s.}$

$\Rightarrow (v_i - v_x)\left(\frac{201}{200} \times 0.038\right) = \cancel{201 \times 5\mu A}\ \frac{V_x}{1K}$. $\Rightarrow V_x = 38.19(v_i - v_x)$

$\Rightarrow 38.19\, v_i = 39.19\, V_x.$

$v_o = -g_m \frac{V_x}{38.19} \times 2K.$

$i_s = \frac{V_x\, g_m}{38.19 \times 200} - 5\mu A.$

$i_s = \frac{V_x}{201K} - 5\mu A$

$\frac{v_o}{i_s} = \frac{-g_m \frac{V_x}{38.19} \times 2k}{\frac{V_x}{201k} - 5\mu A}$