ESC201A EndSem Part 2

SAMYAK SINGHANIA

TOTAL POINTS

9 / 19

QUESTION 1

Q1 9 pts

1.1 1(a) 1 / 3

+ **3 pts** Completely Correct
+ **0 pts** Completely Incorrect
+ **0 pts** Not Attempted
+ **0 pts** Copied

✓ **+ 1 pts** *DC Equivalent circuit correctly found*

+ **1 pts** Transistor currents correctly found
+ **1 pts** Collector voltage correctly found

1 IB=0

2 IC=0

1.2 1(b) 2 / 6

+ **6 pts** Completely Correct
+ **0 pts** Completely Incorrect
+ **0 pts** Not Attempted
+ **0 pts** Copied
+ **3 pts** Transistor currents correctly found
+ **1.5 pts** RE correctly calculated
+ **1.5 pts** R2 correctly calculated

+ 2 *Point adjustment*

QUESTION 2

Q2 10 pts

2.1 2(a) 6 / 6

✓ **+ 6 pts** *Completely Correct*

+ **0 pts** Completely Incorrect
+ **0 pts** Not Attempted
+ **0 pts** Copied
+ **2 pts** Desirable circuit schematic correctly drawn
+ **1 pts** Feedback resistance correctly found
+ **1.5 pts** Resistors corresponding to source v1 correctly found
+ **1.5 pts** Resistors corresponding to source v2 correctly found

2.2 2(b) 0 / 4

+ **4 pts** Completely Correct

✓ **+ 0 pts** *Completely Incorrect*

+ **0 pts** Not Attempted
+ **0 pts** Copied
+ **1 pts** Bias state of diodes correctly found
+ **1.5 pts** Vo1 correctly found
+ **1.5 pts** Vo2 correctly found

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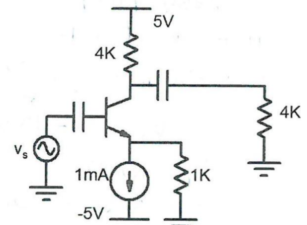
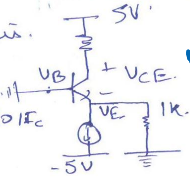
1 (a). Carry out dc analysis to determine collector voltage for the circuit shown below. Assume that current gain β_F =100. [3]



For DC analysis.



$\frac{I_C}{I_B} = 100$

$\therefore I_E = I_C + I_B = 101 I_C$

$1mA + \frac{V_E}{1K} = 101 I_C$

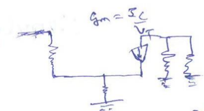
~~$V_E = 101 I_C \times 1K$.~~

Also, $5V = 4K I_C + V_{CE} + V_E$.

$\Rightarrow 5V = 4 I_C \times 10^3 + V_C - V_E + V_E$

Also, $1 + V_E = 101 I_C \times 10^3$.

$\therefore 5V = \frac{4 \times (1 + V_E)}{101} + V_C$



$1 + V_E = 101 I_C \times 10^3$

Also, we can saw that $V_{BE} + V_E = 0$.

$\Rightarrow V_B = 0$

$V_{BE} = 0.7$

$V_B = 0.7 + V_E$

$V_{BE} + V_E = 0$

$\because V_{BE} = 0.7 \quad \Rightarrow V_E = -0.7$.

1

$\therefore 5V = \frac{4}{101} \times 0.3 + V_C$

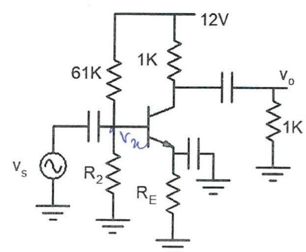
2

$\Rightarrow V_C = 4.988\ V$.

$V_{CE} = 5.688\ V$.

$\therefore V_{CE} > 0.2 \Rightarrow$ It is in Forward active.

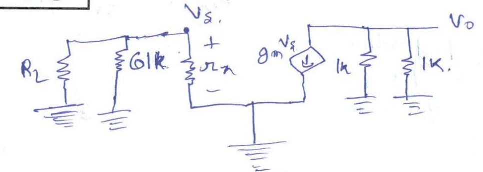
1 (b). Determine suitable values for resistances R_E and R_2 so as to obtain a voltage gain of -50V for the amplifier shown. Assume that dc value of base voltage is 5.9V , transistor is in forward active mode, thermal voltage V_T = 0.026V and β_F =100. [6]



$A_v = -50$

$\because V_T = 26mV$

$g_m = \frac{I_C}{V_T}$ $\qquad r_\pi = \frac{\beta}{g_m}$.



$V_o = -g_m V_s \left(\frac{1}{2} k\right)$.

$\Rightarrow A_v = \frac{V_o}{V_s} = -g_m \times 500 = -50$

$g_m = \frac{50}{500} = \frac{1}{10}$

$\therefore \frac{I_C}{V_T} = \frac{1}{10}$ $\quad I_C = \frac{V_T}{10} = 26 \times 10^{-4}\ A$.

Now, $r_\pi = \frac{\beta}{g_m} = \frac{100}{1/10} = 1000\ \Omega$.

Now $i_B = \frac{V_s}{r_\pi} = \frac{V_s g_m}{\beta}$.

DC analysis.

$12 = 10^3 I_C + V_{CE} + R_E I_E$.

$12 = 10^3 I_C + \frac{101}{100} I_C R_E + V_{CE}$.

$\therefore I_E = I_C + \frac{I_C}{100} = \frac{101 I_C}{100}$

$V_x = \frac{R_2 (12)}{61k + R_2} V$

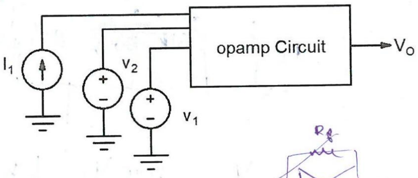
$\therefore V_x = 0.7V + I_E R_E$.

$\frac{12 R_2}{61k + R_2} = 0.7V + I_E R_E$.

~~$A_v = -g_m V_s$~~

~~$1 + (\beta + 1) R_E$~~

2(a). Design an opamp circuit that would produce the output voltage $V_O = -2 \times 10^3 I_1 - 2v_1 + v_2$, where I_1, v_1 and v_2 are input current and input voltages respectively as shown below. Assume ideal opamp characteristics and use only one opamp. [6]

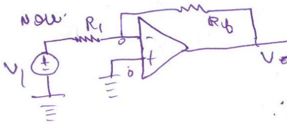


using principles of superposition we can separate the opamp into following components

$\therefore V_o = -R_f I_1$

Take $R_f = 2 \times 10^3 \Omega$.

Now



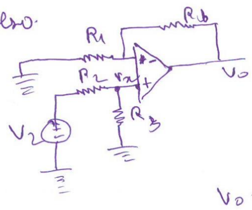
$\therefore \frac{V_1 - 0}{R_1} = \frac{0 - V_o}{R_f}$

$V_o = -V_1 \frac{R_f}{R_1}$

$\therefore \frac{R_f}{R_1} = 2 \Rightarrow R_1 = \frac{R_f}{2}$

$R_1 = 10^3 \Omega$

Also.



$V_x = \frac{R_3}{R_2 + R_3} V_2$

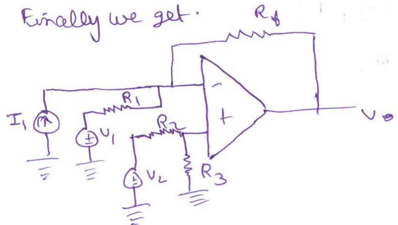
$\therefore \frac{V_x}{R_1} = \frac{V_o - V_x}{R_f}$

$V_o = V_x \left(1 + \frac{R_f}{R_1}\right) \Rightarrow V_o = 3V_x$

$V_o = 3 \times \frac{R_3}{R_2 + R_3} V_2 \Rightarrow \frac{3R_3}{R_2 + R_3} = 1 \Rightarrow R_3 = \frac{R_2}{2}$

Choose $R_2 = 2\Omega$, $R_3 = 1\Omega$.

Finally we get.



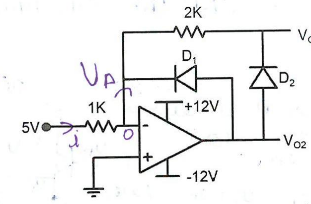
where $R_f = 2 \times 10^{+3} \Omega$.

$R_1 = 10^3 \Omega$.

$R_2 = 2\Omega$

$R_3 = 1\Omega$.

2(b). Assuming ideal opamp and ideal diodes, determine output voltage V_{O1} and V_{O2}. Note that opamp supply voltages are ±12V. [4]



$i = \frac{5 - 0}{1K} = 5mA$

$\because$ Ideal opamp, $V_- = V_+ = 0V$.

Now, $i = 5mA$.

$\therefore 5mA = \frac{0 - V_{O1}}{2K}$

$V_{O1} = -10V$.

$\because V_P = 0.V$

$\Rightarrow V_{O2} < 0.7V$

D_1 is always off.

~~Clearly $V_{O2} \neq V_{O1}$~~

~~$\Rightarrow V_{O2} = V_{O1} + 0.7V$.~~

~~$V_{O2} = -9.3V$.~~