Mid Sem Solution

Q:- 1)

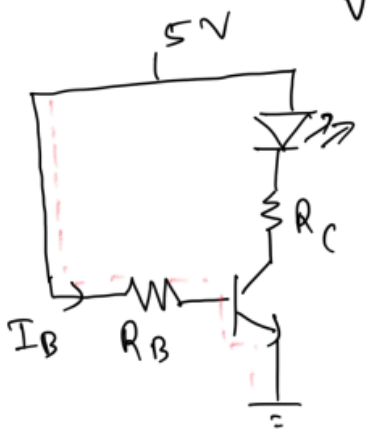
To operate the transistor in saturation:-

$$V_{BC} > 400mV$$

$$V_B - V_C > 400mV$$

$$V_{BE} - V_{CE} > 400mV$$

$$V_{BE} > 700mV \quad (\text{Given } V_{CE} = 300mV)$$



Apply K.V.L in the input loop

$$5 - I_B R_B - V_{BE} = 0$$

$$V_{BE} = 5 - I_B R_B$$

$$5 - I_B R_B > 700mV$$

$$4.3V > I_B R_B$$

$$\frac{4.3}{\frac{I_C}{\beta}} > R_B$$

$$R_B < 1.745M\Omega$$

$$\left[I_e = I_S e^{\frac{V_{BE}}{V_T}} \right]$$

$$I_e = 2.46 \times 10^{-4} A$$

Q:- 2) Voltage across resister R_2 be V_{R2}

Since $I_b \simeq 0$

$$V_{R2} - V_Z - V_{BE(Q2)} = 0$$

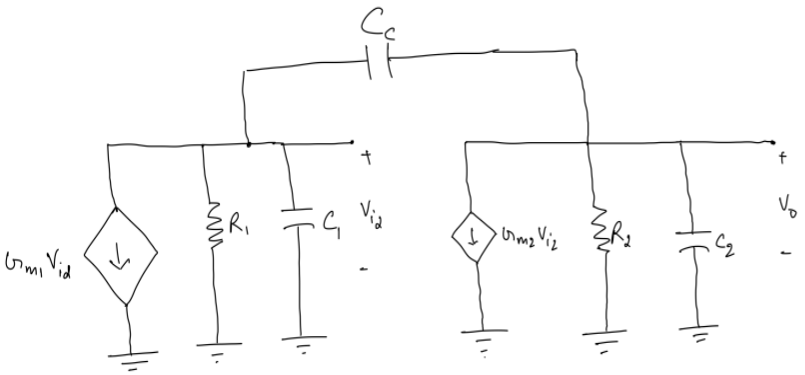
$$V_{R2} = 5.7$$

$$V_{R2} = \frac{R_2}{1K + R_2} V_o \quad \text{[Voltage division rule]}$$

$$R_2 = 1.72\,K$$

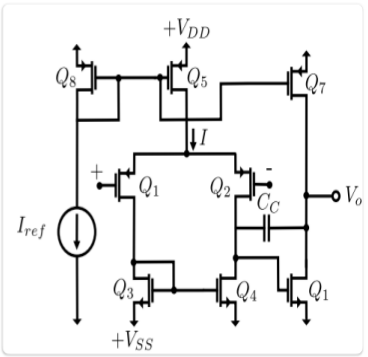
3. 0.38 mF

④



$R_1 = r_{o2} \,||\, r_{o4}$

$R_2 = r_{o1} \,||\, r_{o7}$



5. 1250 ohm and 30 kohm

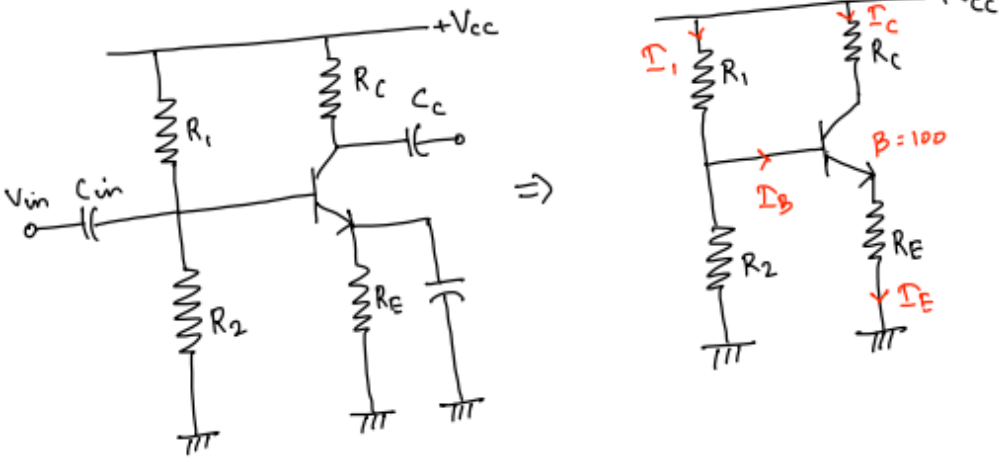
6) $R_1 = 10k\Omega$, $R_2 = 2.2k\Omega$, $R_C = 3.6k\Omega$, $R_E = 1.1k\Omega$, $V_{cc} = 10V$

$\beta = 100$, $I_B \simeq 0$ [Refer to fig. 8]

DC analysis of the npn transistor to be done :-

$C_{in}, C_C, C_E \rightarrow$ open.

$I_E = I_C$ ($\because I_B = 0$)



$\because I_B = 0$, I_1 will flow through R_1 & R_2

$I_1 = \dfrac{V_{cc}}{R_1 + R_2} = \left(\dfrac{10}{10+2.2}\right) mA = 0.82mA$

Voltage across $R_2 = (0.82 \times 2.2)V \simeq 1.8V$

$V_{BE} = 0.7V$.

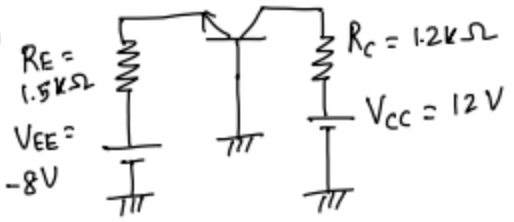
$\therefore V_E = (1.8 - 0.7)V = 1.1V$ $\Rightarrow I_E = \dfrac{V_E}{R_E} = \dfrac{1.1}{1.1} mA = 1mA = I_C$

$\therefore$ D.C. power drawn from the supply (V_{cc}) = $V_{cc} \times (I_C + I_1)$

$= [10 \times (1 + 0.82)] mW$

$= 18.2mW$ (Ans)

7)



$I_C = ?$, $V_{CB} = ?$

$V_{BE} = 0.7V$

$I_B = 0A$

$\Rightarrow V_B = 0 \quad \Rightarrow V_{BE} = 0.7V \quad \Rightarrow V_E = -0.7\ V.$

$$\Rightarrow I_E = \frac{V_{EE} - V_E}{R_E} = \left(\frac{-8+0.7}{1.5}\right) mA = -4.87mA = I_C \quad \text{(Ans)}$$

Apply KCL to the collector-side loop:—

$$\Rightarrow V_{CC} = I_C R_C + V_{CB}$$

$$\Rightarrow V_{CB} = V_{CC} - I_C R_C = 18 - (-4.87) \times 1.2$$

$$\Rightarrow V_{CB} = 23.14V \text{ (Ans)}$$

8.

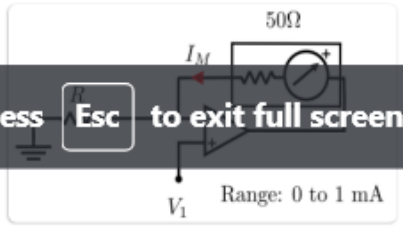
Centre-zero voltmeter

When $V_{i(-)} = 0$, $V_{i(-)} = 0$

meter is required to read mid-scale

↳ I_M should be equal to 0.5 mA

$$\therefore R_1 = \frac{0 - (-10)\ V}{0.5\ mA} = 20\ K\Omega$$



for full scale reading, $V_1 = +1\ V$ and $I_M = 1\ mA$

$$\frac{+1}{R} + \frac{+1 - (-10)}{20\ K\Omega} = 1\ mA \quad (\text{by KCL})$$

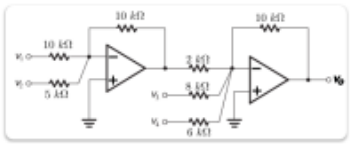
$$\Rightarrow \quad R = 2.22\ K\Omega$$

Now, for $V_1 = -1\ V$, I_M should be zero.

$$I_M = \frac{-1 - (-10)}{20\ K\Omega} + \frac{-1}{2.2\ K\Omega}$$

$$= 0.45 - 0.45 = 0\ A.$$

10. Weighted Summer

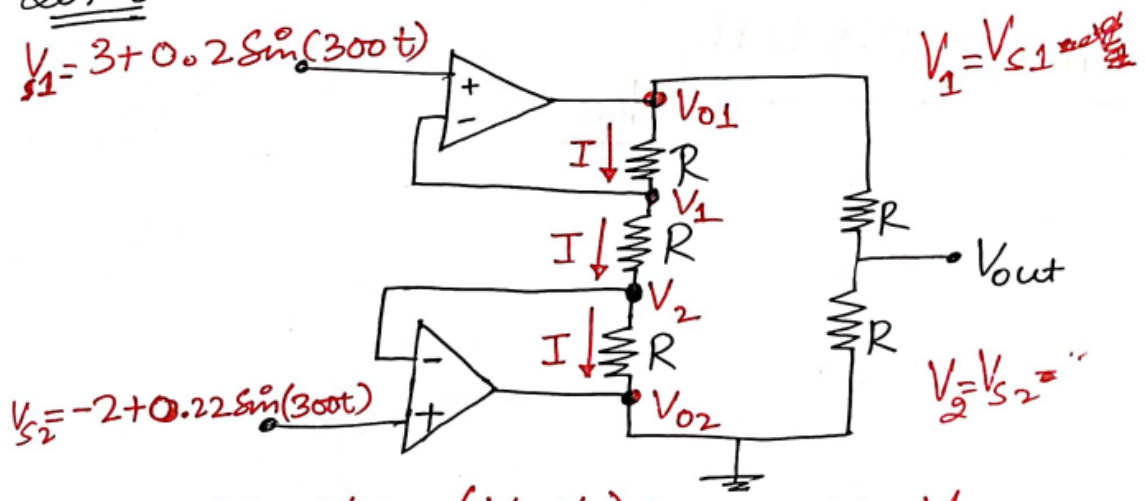


$$V_o = V_1\left(\frac{10\ K\Omega}{10\ K\Omega}\right)\left(\frac{10\ K\Omega}{2\ K\Omega}\right) + V_2\left(\frac{10\ K\Omega}{5\ K\Omega}\right)\left(\frac{10\ K\Omega}{2\ K\Omega}\right) - V_3\left(\frac{10\ K\Omega}{8\ K\Omega}\right) - V_4\left(\frac{10\ K\Omega}{6\ K\Omega}\right)$$

$$\boxed{V_o = 5V_1 + 10V_2 - 1.25V_3 - 1.67V_4}$$

9.

Solⁿ:



$$V_{o1} = IR + V_1 = \frac{(V_1 - V_2)}{R}R + V_1 = 2V_1 - V_2 \quad \text{——(1)}$$

$$V_{o2} = V_2 - IR = V_2 - \left(\frac{V_1 - V_2}{R}\right)\times R = 2V_2 - V_1 \quad \text{——(2)}$$

$$V_o = \frac{V_{o1}\times R}{R+R} + \frac{V_{o2}\times R}{R+R} = \frac{V_{o1} + V_{o2}}{2}$$

$$= \frac{2V_1 - V_2 + 2V_2 - V_1}{2} = \frac{V_1 + V_2}{2}$$

$$V_o = \frac{V_1 + V_2}{2} = \frac{3 + 0.2\sin(300t) - 2 + 0.22\sin(300t)}{2}$$

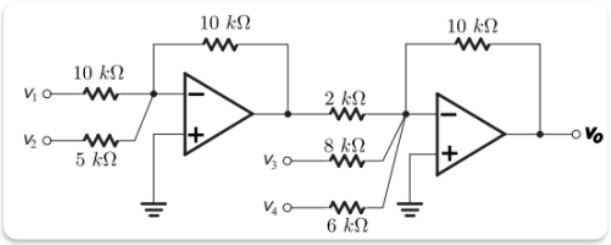
$$= \frac{1 + 0.42\sin(300t)}{2} = \frac{1}{2} + \frac{0.42}{2}\sin(300t)$$

$$= 0.5 + 0.21\sin(300t)$$

$$\boxed{V_{o(avg)} = 0.5 \text{ Volts}}$$

Ans

(10) weighted Summer



$$V_o = V_1\left(\frac{10\,k\Omega}{10\,k\Omega}\right)\left(\frac{10k\Omega}{2\,k\Omega}\right) + V_2\left(\frac{10k\Omega}{5\,k\Omega}\right)\left(\frac{10\,k\Omega}{2\,k\Omega}\right)$$

$$- V_3\left(\frac{10\,k\Omega}{8\,k\Omega}\right) - V_4\left(\frac{10\,k\Omega}{6\,k\Omega}\right)$$

$$\boxed{V_o = 5V_1 + 10V_2 - 1.25V_3 - 1.67V_4}$$