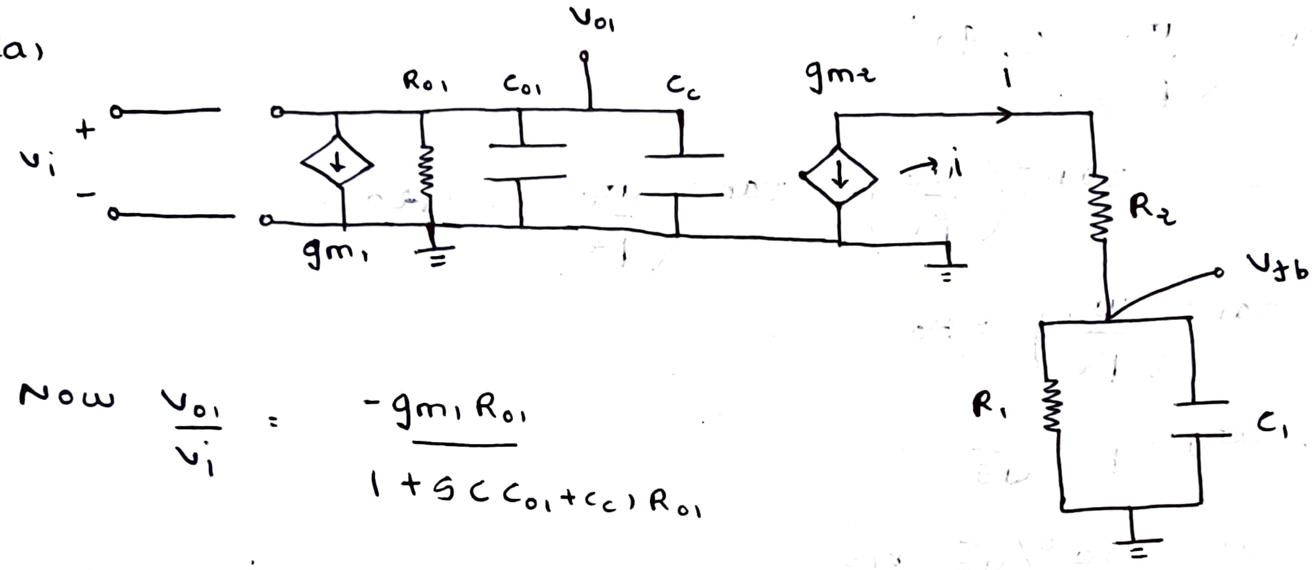
Endsem: 2020

(1) we have; for loop gain

(a)



Now $\dfrac{V_{01}}{V_i} = \dfrac{-g_{m1} R_{01}}{1 + s(C_{01} + C_c) R_{01}}$

Now; $\dfrac{i}{V_i} = \dfrac{g_{m1} g_{m2} R_{01}}{1 + s(C_{01} + C_c) R_{01}}$

$Z = \dfrac{\frac{R_1}{sC_1}}{R_1 + \frac{1}{sC_1}} = \dfrac{R_1}{1 + sC_1R_1}$

$\therefore V_{fb} = iZ$

$\therefore \dfrac{V_{fb}}{V_i} = \dfrac{g_{m1} g_{m2} R_{01}}{(1 + s(C_{01} + C_c) R_{01})} \times \dfrac{R_1}{(1 + sC_1R_1)}$

$\therefore LG(s) = \dfrac{g_{m1} g_{m2} R_{01} R_1}{(1 + s(C_{01} + C_c) R_{01})(1 + sC_1R_1)}$

$= \dfrac{10^5}{(1 + \frac{s}{10^6})(1 + s(10pF + C_c)10^5)}$

$=$

(b) Now for Pm of 60°;

$\angle LG = -120°$

$\therefore$ Now by dominant pole compⁿ ; $p_1 << p_2$

$\therefore \tan^{-1}\left(\frac{\omega_u}{p_1}\right) \simeq 90°$

$\therefore$ Now; $-\tan^{-1}\left(\frac{\omega_u}{p_1}\right) - \tan^{-1}\left(\frac{\omega_u}{p_2}\right) = -120°$

$\therefore \tan^{-1}\left(\frac{\omega_u}{p_2}\right) = 30°$

$\therefore \omega_u = p_2/\sqrt{3}$

$\therefore \omega_u = 10^6/\sqrt{3}$ r/s

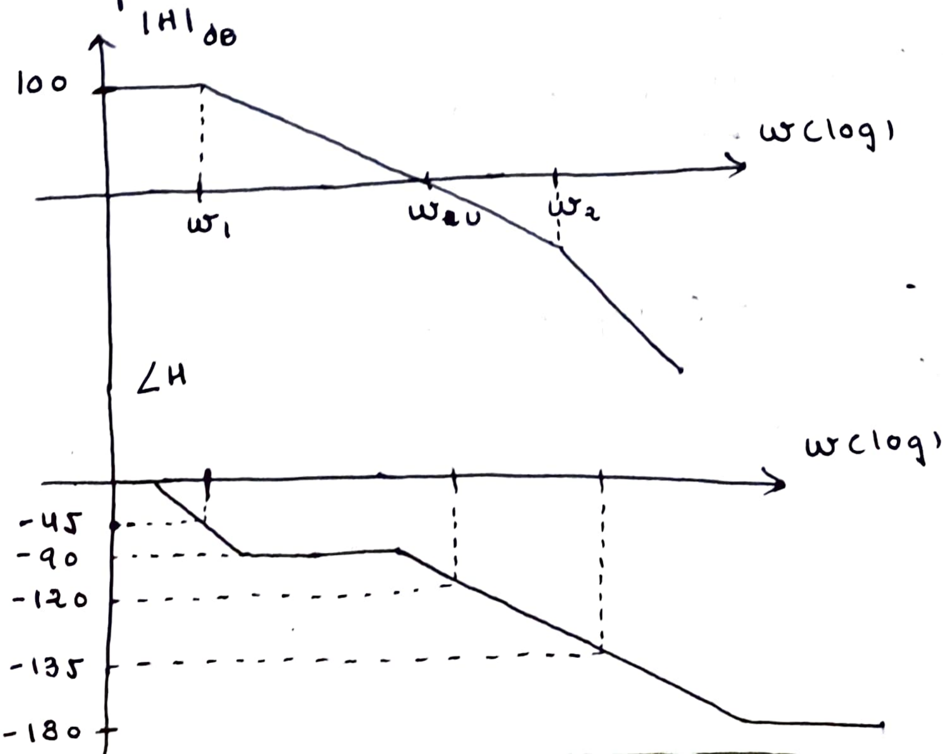
$= 577.35$ Kr/s

$\therefore$ Now; $\omega_u = \frac{10^5}{10^5(10pF + C_c)}$

$\therefore 10pF + C_c = 1.732\ \mu F$

$\therefore C_c = 1.732\ \mu F$

(c) Bode plots are:



$H \equiv LG$

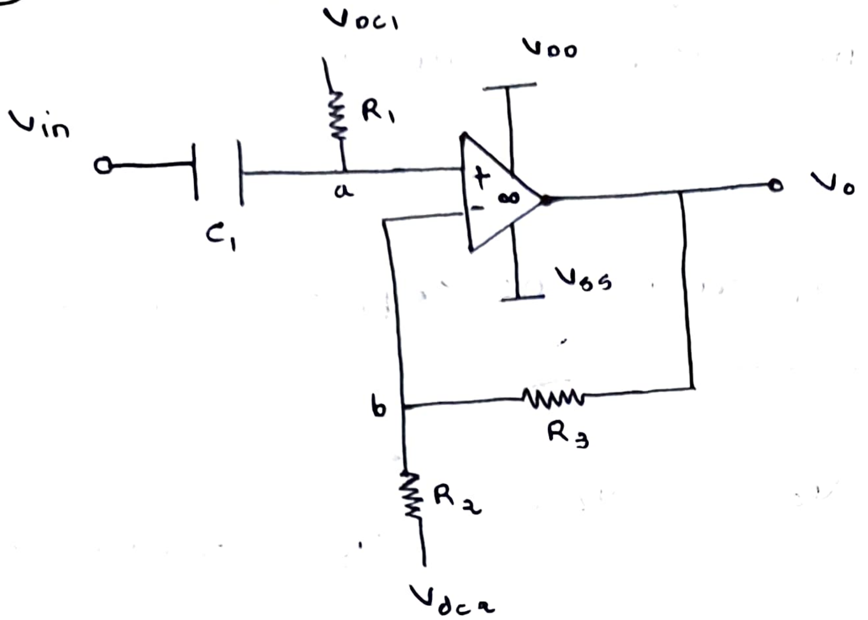
$\omega_1 = 5.774$ r/s

$\omega_u = 577.35$ Kr/s

$\omega_2 = 10^6$ r/s

//

(2) We have

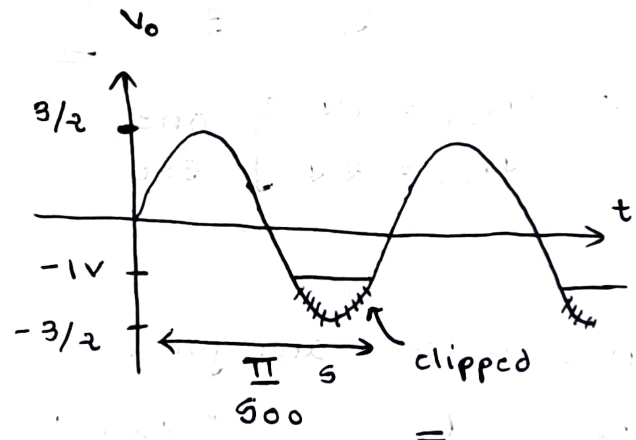


(a) Now; $V_{in} = \sin(1000t)\,V$

$C_1 \longrightarrow \infty$

$\therefore \dfrac{1}{j\omega C_1} \longrightarrow 0 \quad (S.C.)$

$V_{dc1} = V_{dc2} = 0V$



Now in ac analysis;

$$V_o = V_{in}\left(1 + \frac{R_3}{R_2}\right) \quad \text{or;}$$

$$V_o\left(\frac{2}{3}\right) = V_{in}$$

$$\therefore V_o = \frac{3V_{in}}{2} = \frac{3}{2}\sin(1000t)\,V$$

(idtally) but..

due to $V_{SS} = -1V$

$\frac{V_{dc2}(2)}{3}$

$\frac{V_{dc2}}{3}$

~~(b)~~ Now for proper functioning of device;

$(V_o)_{dc} = 0V$

In dc case

$$V_b = +V_{dc2}\left(\frac{2}{3}\right) = V_{dc1}$$

$$V_{dc2} = 3V_{dc1}$$

$$\therefore 3V_{dc1} + 2V_{dc2} = 0V \quad \times$$

One set $\begin{cases} V_{dc1} = 1V \\ V_{dc2} = 3V \end{cases}$ //

(c) But to avoid C_1 from charging;

$V_{dc1} = V_{dc2} = \underline{\underline{0V}}$ is most usable (WRONG!!)

~~(c) Now; we can~~ But;

for proper functioning of circuit; no crippling as in (a);

($V_{o}|_{dc} = \cancel{1}\,V$ (for (a) case)
0.5

Now; $\left(\dfrac{V_{dc2} - \cancel{2}^{\,0.5}}{3}\right)2 + V_{dc2} = V_{dc1}$

$V_o = 0.5 + 1.5 \sin(1000t)\,V$

$\dfrac{V_{dc2}}{3} + \dfrac{\cancel{2}^{\,1}}{3} = V_{dc1}$

no crippling

$\therefore \left.\begin{aligned} V_{dc1} &= 1V \\ V_{dc2} &= 2V \end{aligned}\right\}$ one set

(c) Now; In, AC analysis;

$\bar{V}_a = \dfrac{R_1}{R_1 + sC_1^{-1}\cancel{R_1}} (V_{in})$

$= \left(\dfrac{R_1}{R_1 + \dfrac{1}{sC_1}}\right)\bar{V}_{in}$

$s = j\omega$

$= \left(\dfrac{j\omega C_1 R_1}{\underbrace{j\omega C_1 R_1 + 1}_{z}}\right)\bar{V}_{in}$

$\therefore$ At; $\omega = 1000\,r/s$; $|z| \simeq 1$

$\therefore \omega C_1 R_1 >> 1$

$\therefore C_1 >> \dfrac{1}{\omega R_1}$ $(= 100nF)$

$\therefore \underline{\underline{C_1 >> 100nF}}$

One value; $\underline{\underline{C_1 = 1\mu F}}$

(b) For proper functioning; no cripping

$\therefore$ ~~CVoldc~~ $\times$ ~~Ain~~ 3A

$$\therefore \quad -\frac{3A_{in}}{2} + CV_{oldc} = -1V$$

$$\therefore \quad CV_{oldc} = \frac{3A_{in}}{2} - 1V.$$

$$\therefore \quad V_b = V_{dc2} - \left(\frac{V_{dc2} - V_o}{3}\right)2$$

$$= \frac{V_{dc2} + 2V_o}{3}$$

$$= \frac{V_{dc2} + 3A_{in} - 2}{3}$$

(d) Now for max A_{in} for proper working;

$$3A_{in}^{m} - 1 = 4$$

$$A_{in}^{max} = 5/3\ V$$

$$\therefore \quad V_{dc1} = \frac{V_{dc2} + 3A_{in} - 2}{3}$$

$$\therefore \quad 3V_{dc1} = V_{dc2} + 3A_{in} - 2$$

Any set would work depending on A_{in}

(3) Now; $z_1 = \frac{1}{Gm^2 z}$

$$= \frac{1}{2}$$

$$\therefore \quad z = 10 + \frac{5/2}{5s + \frac{2}{s}}$$

$$= 10 + 2.5s / 5s^2 + 2$$

$$\therefore \quad Z_1 = \frac{5s^2 + 2}{50s^2 + 2.5s + 20}$$

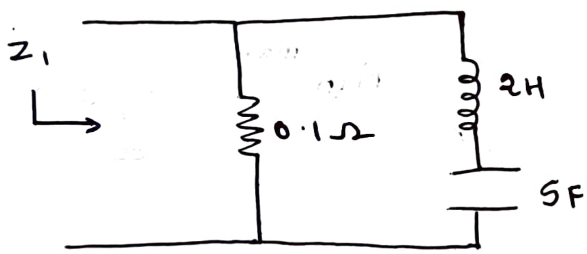
$$\therefore \quad \frac{1}{Z_1} = Z$$

$$Z = \frac{50s^2 + 2.5s + 20}{5s^2 + 2}$$

$$\therefore \frac{1}{Z_1} = 10 + \frac{(5s)(1/2s)}{5s + 1/2s}$$

$$= \left(\frac{1}{10}\right)^{-1} + \frac{1}{\left(\frac{1}{2s} + 5s\right)^{-1}}$$

$$= \left(\frac{1}{10}\right)^{-1} + \frac{1}{2s + \frac{1}{5s}}$$



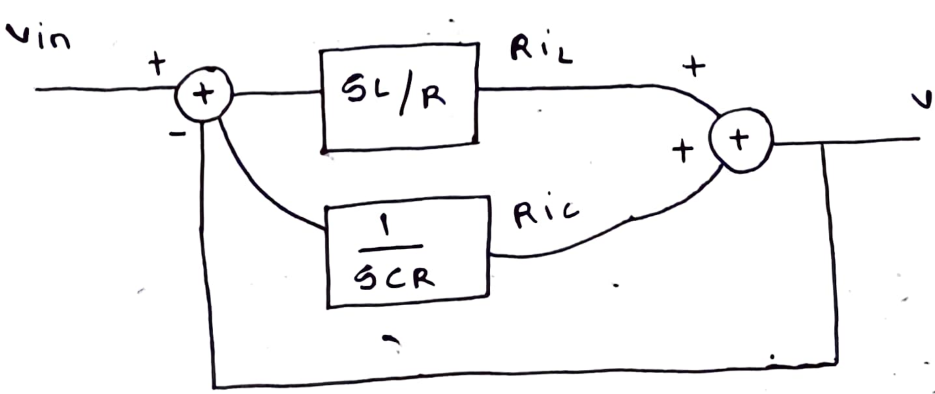
=

(4) Now; we have

$$i_L = \frac{V_{in} - V_o}{SL} \qquad i_c = (V_{in} - V_o)\, SC$$

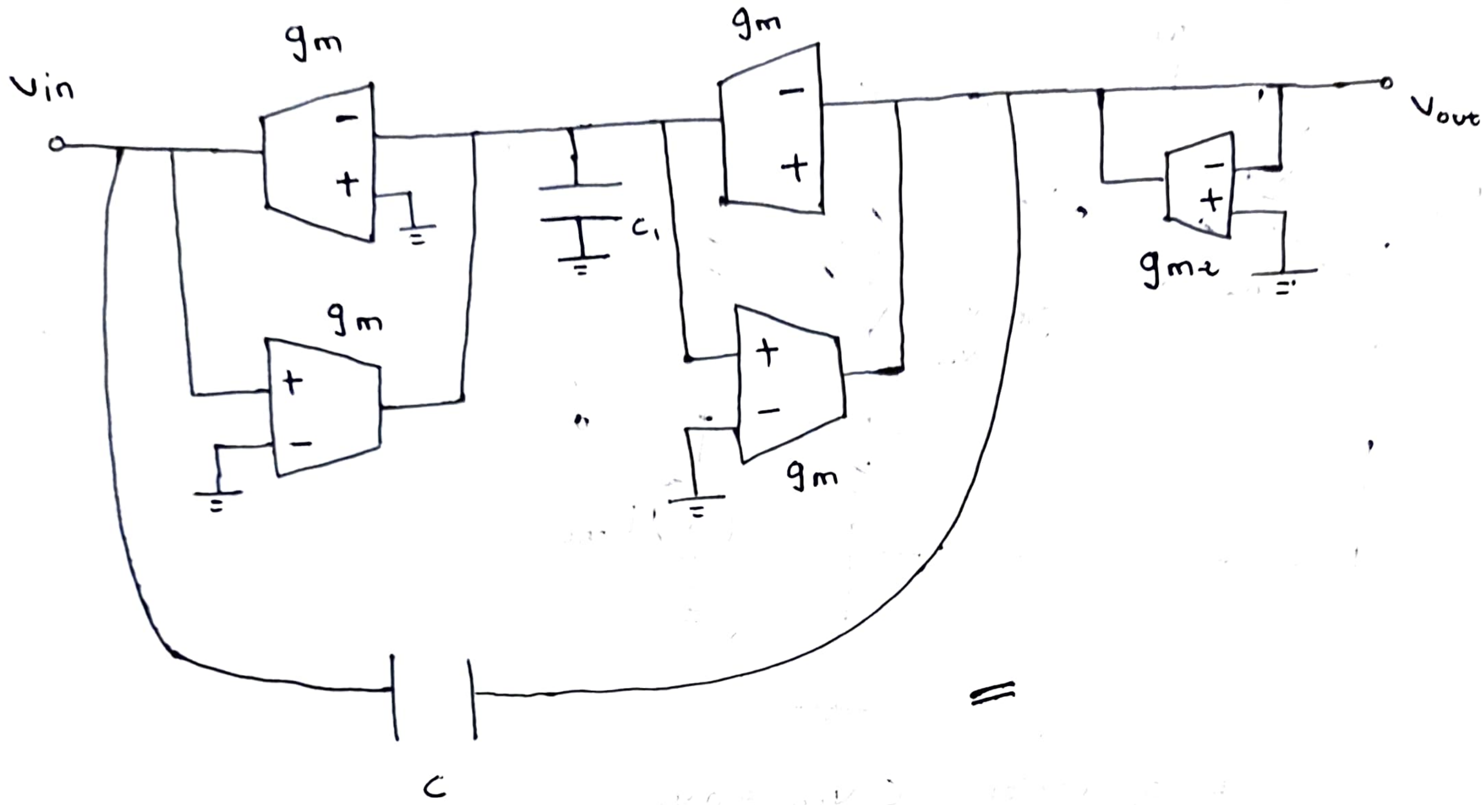
$$V_c = V_{in} - V_o$$

$$Ri_L = \frac{V_{in} - V_o}{SL/R}$$



Block diagram

∴ Now;



∴ Now; $\frac{C_1}{g_m^2} = 1\,\mu H \rightarrow$ 1 set $\left\{ \begin{array}{l} g_m = 15\ A/V \\ C_1 = 1\,\mu F \end{array} \right.$

$C = 1\,\mu F$

$g_{m2} = 0.025\ A/V$

(6) Now; $V_{in} = 0.775\ V$

(a) $b_2 = 1$

$b_1 = 1$

$b_0 = 0$

Output = 110

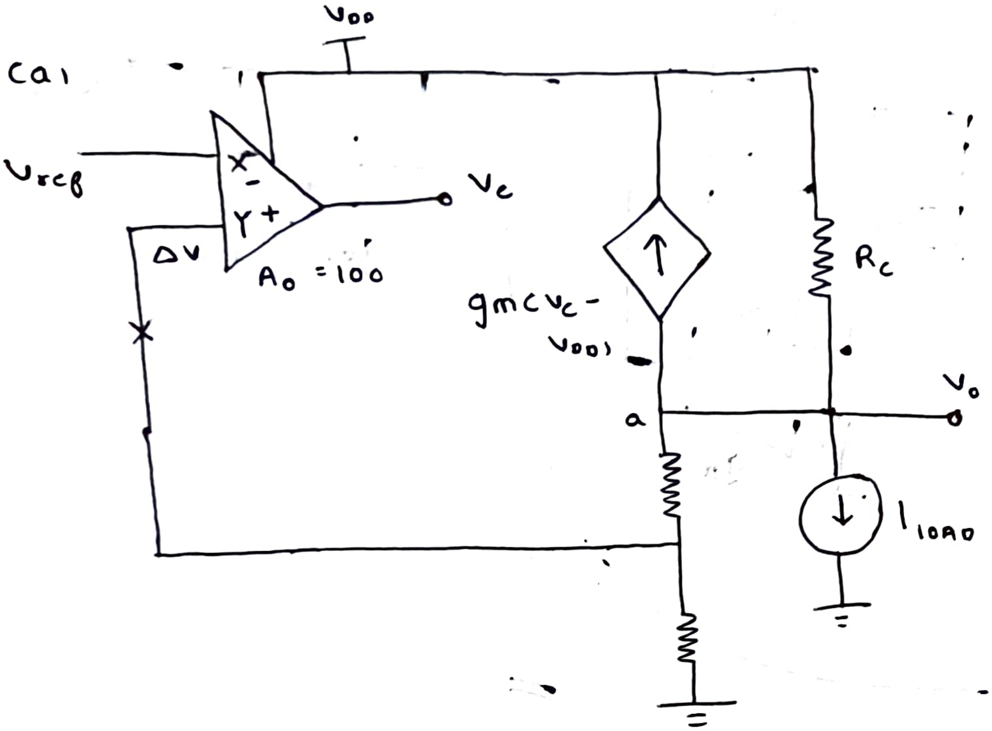
(b) Now for (a) case;

$V_{th2} = 0.76\ V$

$V_{th3} = 0.857\ V$

(5) We now have;

(a)



For −ve f.b. operation; $(V_{DD} \equiv 0V)$

∴ Now KCL @ a; $(I_{LOAD} \equiv 0A)$

$$g_m(V_c) + \frac{V_o}{R_c} + \frac{V_o}{R_1 + R_2} = 0$$

$$\therefore V_c = AV_e$$

$$\therefore V_o\left[\frac{1}{R_c} + \frac{1}{R_1 + R_2}\right] = -g_m A \Delta V$$

$$\therefore V_o < 0$$

$$\therefore V_o\left(\frac{R_2}{R_1 + R_2}\right) < 0$$

∴ Signs flipped; assumption is correct

X	−
Y	+

=

(b) We have;

KCL @ a;

$$1m_5(V_c - 2.5) + \cancel{2mA}^{-0.5mA} + 1mA + 0.1mA = 0$$

$$V_c = \cancel{-0.6V}\ 1.9V$$

Now; $100(V_y - V_x) = \cancel{-0.6}\ 1.9$

$$V_y - V_x = \cancel{-6mV}\ 19mV$$

$$1V - V_x = \cancel{-6mV}\ 19mV$$

$$V_x = \cancel{1.006}^{0.981}\ V \quad (= V_{ref})$$

(c) Now Keeping V_{ref} constant;

$\therefore (V_o)_{ideal} = \cancel{2.012V}\ 1.962V$

$\therefore$ Abs error $= \cancel{12mV}\ 38mV$

(d) Now, For Z_o;

$V_{ref} = 0V$; $V_{DD} = 2.5V$

Now; $V_c = 100V_t$

$\therefore$ KCL @ a;

$$\frac{(V_t - 2.5)}{1K} + 1m_5(100V_t - 2.5) + \frac{V_t}{20K} + \frac{V_t}{2K} = i_t$$

(wrong!)

Now; $V_{ref} = V_{DD} = 0V$

$V_c = 0V$

$$\therefore \frac{V_t}{1K} + \frac{V_t}{20K} + \frac{V_t}{2K} = i_t$$

$$\therefore Z_t = 645.161\Omega$$