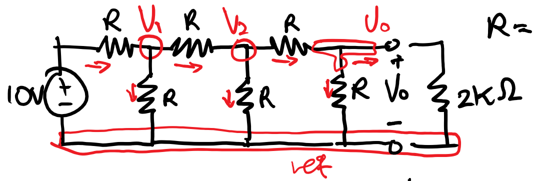
Problem Set 1

September 9, 2017 10:15 PM

Q1. Find Thevenin equivalence



$R = 1k\Omega$

$V_{th} = V_o$

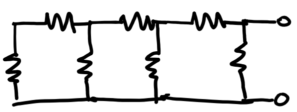
KCL1: $\frac{10 - V_1}{R} = \frac{V_1 - V_2}{R} + \frac{V_1}{R}$

KCL 2: $\frac{V_1 - V_2}{R} = \frac{V_2 - V_o}{R} + \frac{V_2}{R}$

KCL 3: $\frac{V_2 - V_o}{R} = \frac{V_o}{R}$

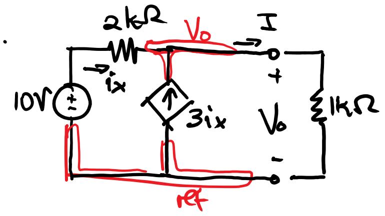
$\rightarrow V_o = 0.769\ V$

Kill the source for Rth



$R_{th} = 615.385\ \Omega$

Q2.



Find Thevenin, Norton

KCL: $\underbrace{\frac{10 - V_o}{2k}}_{ix} + 3ix = \frac{V_o}{1k}$

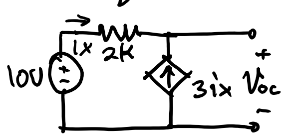
$4ix = \frac{V_o}{1k}$, $ix = \frac{10 - V_o}{2k}$

$\rightarrow V_o = 6.667\ V$

$ix = 1.667\ mA$

$I = \frac{6.667V}{1k\Omega} = 6.667\ mA$

* Taking off the load:

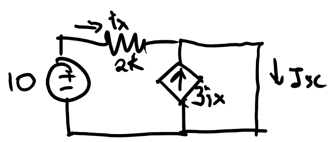


KCL: $\underbrace{\frac{10 - V_{oc}}{2k}}_{ix} + 3ix = 0$

$4ix = 0$

$\Rightarrow ix = 0$ (no current)

$\therefore V_{oc}$ (w/o load) = 10V

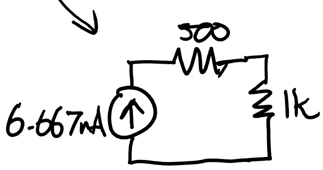


$I_{sc} = 4ix$,

$ix = \frac{10 - V_o}{2k}$ ← $V_o = 0$

$= 5mA$

$I_{sc} = 20mA$



$R_{th} = \frac{V_{oc}}{I_{sc}} = \frac{10V}{20mA} = 500\Omega$

Q3 Find magnitude & phase of impedence at 1kHz, 1MHz, 1GHz ..

Q3 Find magnitude & phase of impedence at 1kHz, 1MHz, 1GHz

$\downarrow$ 6283.185 rad/s $\quad \downarrow$ 6283.185 krad/s $\quad \rightarrow$ 6283.185 Mrad/s

a. 1nH inductor: $(Z_L = j\omega L)$

1kHz: $(6.283 \times 10^{-6}, \angle 90^\circ)\,\Omega$

1MHz: $(6.283 \times 10^{-3}, \angle 90^\circ)\,\Omega$

1GHz: $(6.283 \angle 90^\circ)\,\Omega$

b. 1mH inductor

1kHz: $(6.283 \angle 90^\circ)$

1MHz: $(6.283 \times 10^{3} \angle 90^\circ)$

1GHz: $(6.283 \times 10^{6} \angle 90^\circ)$

c. 1μH inductor

— same story —

d. 1nF capacitor $\left(Z_C = \frac{1}{j\omega C}\right)$

1kHz: $(159.2 \times 10^{3}, \angle -90^\circ)$

1MHz: $(159.2 \angle -90^\circ)$

1GHz: $(159.2 \times 10^{-3} \angle -90^\circ)$

e. 1pF capacitor

— same procedure —

f. 1μF capacitor

— same procedure —

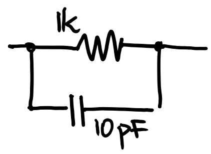
Q4. a.

$\omega = 2\pi(1 \times 10^{6})$ rad/s

$$Z = 1000 + \frac{1}{j\omega(10 \times 10^{-12})}$$

$$= (15.947 \angle -86.405^\circ)\,k\Omega$$

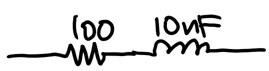
b.



$$Z = 1000 \,//\, \frac{1}{j\omega C}$$

$$= (998.032 \angle -3.595^\circ)\,\Omega$$

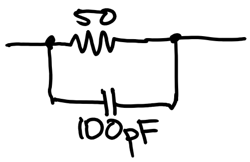
c.



$$Z = 100 + j\omega L$$

$$= (100\angle 0.036^\circ)\,\Omega$$

d.



$$Z = 50 \parallel \frac{1}{j\omega C}$$

$$= (49.975\angle -1.8^\circ)\,\Omega$$

Q5. $R_{internal} = \frac{V_{oc}}{I_{sc}} = \frac{10V}{1mA} = 10k\Omega$

Q6.

$$\frac{V_{th} - 1V}{R_{th}} = \frac{1}{100k\Omega}, \quad \frac{V_{th} - 0.5V}{R_{th}} = \frac{0.5V}{10k\Omega}$$

$$\boxed{\begin{aligned} V_{th} &= 1.125\,V \\ R_{th} &= 12.5k\Omega \end{aligned}}$$

$$I_N = \frac{V_{th}}{R_{th}} = \boxed{0.090\,mA}$$