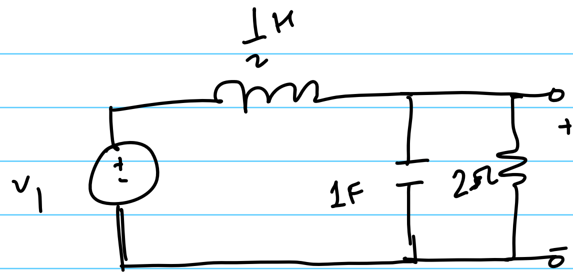
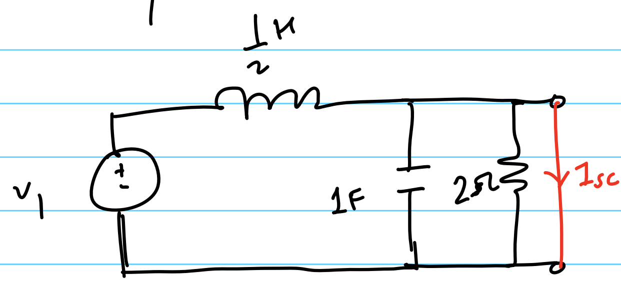
Ans 1.



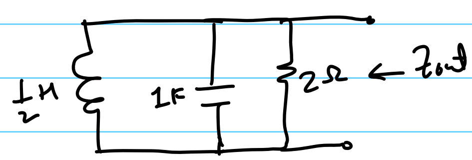
To find Norton's equivalent -

I_{sc}



$$\boxed{i_{sc} = \frac{V_1}{j\omega L} \Rightarrow \frac{2V_1}{j\omega} \Rightarrow \frac{-2jV_1}{\omega}}$$

To find R_{out},



$R_{out} \Rightarrow 2\Omega \,||\, \frac{1}{j\omega} \,||\, \frac{j\omega}{2}$

$$\frac{1}{Z_{out}} \Rightarrow \frac{1}{2} + j\omega + \frac{2}{j\omega}$$

$$\frac{1}{Z_{out}} \Rightarrow \frac{j\omega - 2\omega^2 + 4}{2j\omega}$$

$$\boxed{Z_{out} = \frac{2j\omega}{j\omega - 2\omega^2 + 4}}$$

a) $\underline{\underline{V_1 = 2\cos t}}$

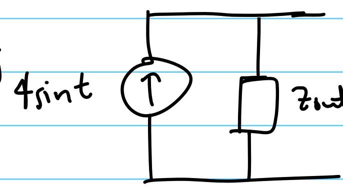
$\omega = 1$

$$i_{sc} = \frac{-2j \times 2}{1} \Rightarrow -4j$$

$$i_{sc} = Re\{-4j e^{jt}\} \Rightarrow Re\{-4j(\cos t + j\sin t)\}$$

$$\Rightarrow \underline{4\sin t}$$

$$Z_{out} \Rightarrow \frac{2j}{j+2} = \underline{\underline{0.4+0.8j}}$$



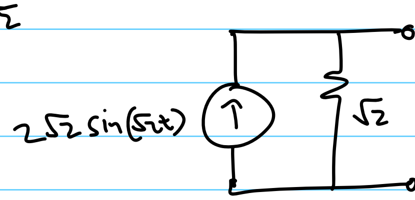
b) $v_1 = 2\cos(\sqrt{2}t)$

$\omega = \sqrt{2}$

$$i_{sc} \Rightarrow \frac{-2j}{\sqrt{2}} \times 2 \Rightarrow \frac{-4j}{\sqrt{2}} \Rightarrow -2\sqrt{2}j$$

$$i_{sc}(t) \Rightarrow Re\{e^{j\sqrt{2}t} \times -2\sqrt{2}j\} \Rightarrow 2\sqrt{2}\sin(\sqrt{2}t)$$

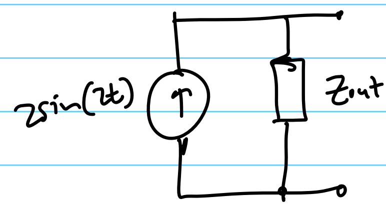
$$Z_{out} \Rightarrow \frac{2\sqrt{2}j}{j\sqrt{2}} \Rightarrow \sqrt{2}$$



c) $V_1 = 2\cos(2t)$

$i_{sc} \Rightarrow \frac{-2j \times 2}{2} \Rightarrow -2j$

$i_{sc}(t) \Rightarrow 2\sin(2t)$



$Z_{out} \Rightarrow \frac{4j}{2j-4} \Rightarrow \frac{2j}{j-2} = 0.4 - 0.8j$

Ans.2

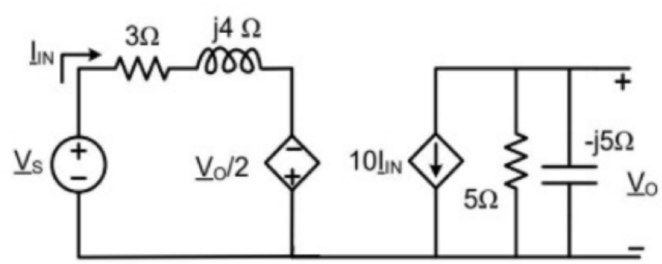


Figure 2

To find V_{th},

$$I_{IN} = \frac{V_s + V_o/2}{3+4j} \quad -①$$

$$\frac{-5 \times 5j}{5-j5} \Rightarrow \frac{-5j}{(1-j)} \Rightarrow \frac{5}{j+1}$$

$$V_o = -10 I_{IN} \times (5 \| -j5)$$

$$V_o = -10 I_{IN} \times \frac{5}{j+1} \quad -②$$

Substituting ① in ②

$$V_o = -10\,(V_s + V_o/2) \times \frac{5}{(j+1)(3+4j)}$$

$$V_o(j+1)(3+4j) = -50\left(V_s + \frac{V_o}{2}\right)$$

$$V_o\left[3j - 4 + 3 + 4j\right] = -50\left(V_s + \frac{V_o}{2}\right)$$

$$V_o\left[7j - 1 + 25\right] = -50\,V_s$$

$$\boxed{V_o \Rightarrow \frac{-50\,V_s}{7j + 24}} \Rightarrow (-1.92 + 0.56j)\,V_s$$

To find R_{TH},

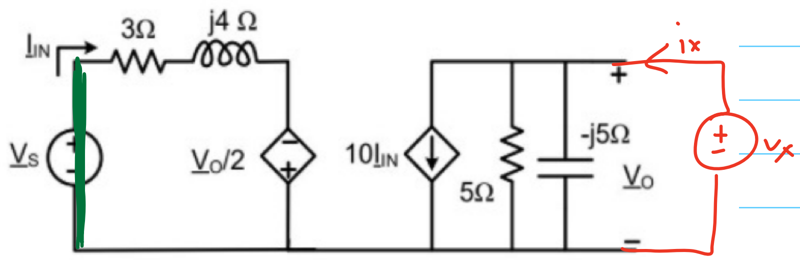


Figure 2

$$\frac{V_x}{i_x} = R_{TH}$$

$$\underline{\underline{V_o = V_x}}$$

$$I_{IN} \Rightarrow \frac{\frac{V_o}{2}}{3+4j} \Rightarrow \frac{V_o}{6+8j} = \frac{V_x}{6+8j}$$

$$i_x \Rightarrow 10I_{IN} + \frac{V_x}{5} + \frac{V_x}{-5j}$$

$$i_x \Rightarrow \frac{10V_x}{6+8j} + \frac{V_x}{5} + \frac{V_x}{-5j}$$

$$i_x = \frac{10 v_x}{6+8j} + \frac{v_x}{5} + \frac{j v_x}{5}$$

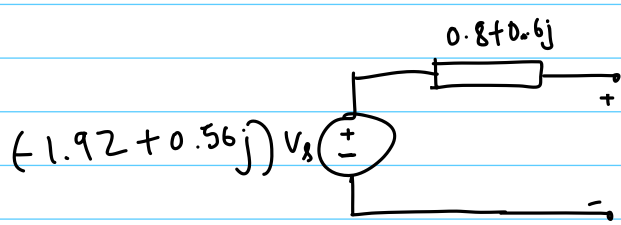
$$i_x \Rightarrow \frac{10 v_x}{6+8j} + \frac{(j+1) v_x}{5}$$

$$i_x \Rightarrow \frac{5 v_x}{3+4j} + \frac{(j+1) v_x}{5}$$

$$i_x = \frac{25 v_x + (j+1)(3+4j) v_x}{5(3+4j)} \Rightarrow \frac{25 v_x + [3j - 4 + 3 + 4j] v_x}{15+20j}$$

$$i_x \Rightarrow \frac{25 v_x + [7j - 1] v_x}{15+20j} \Rightarrow \frac{24 v_x + 7j\, v_x}{15+20j}$$

$$\boxed{Z_{eff} \Rightarrow \frac{v_x}{i_x} \Rightarrow \frac{15+20j}{24+7j}} \Rightarrow \underline{\underline{0.8 + 0.6j}}$$



Ans. 3

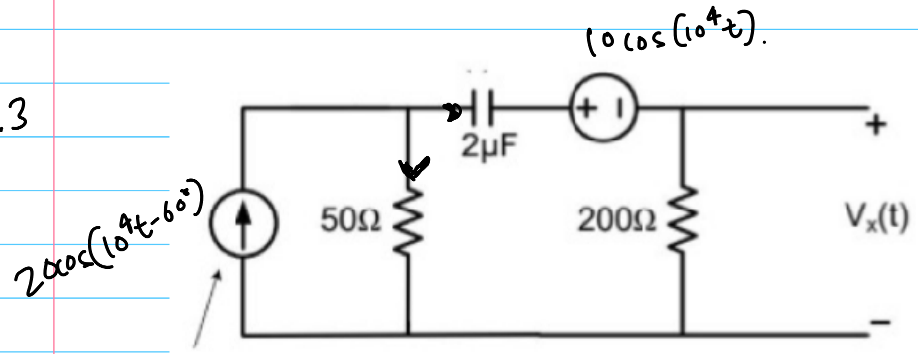
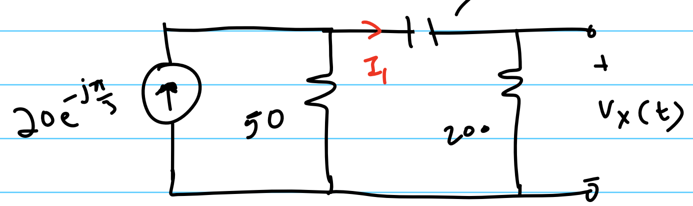


Figure 3

a) <u>Due to current source only,</u>

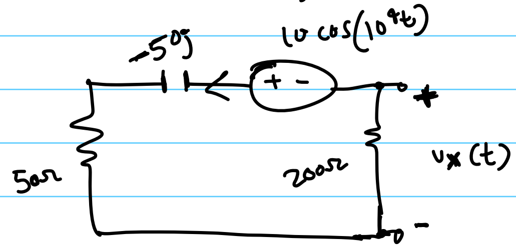
$$\frac{1}{j\times10^4\times2\times10^{-6}} \Rightarrow -50j$$



$$I_1 \Rightarrow 20e^{-j\pi/3}\times\frac{50}{200-50j+50} \Rightarrow 20e^{-j\pi/3}\times\frac{1}{5-j}$$

$$V_x\Big|_{\text{due to C.S}} = I_1\times200 \Rightarrow \frac{4000}{5-j}e^{-j\pi/3}$$

<u>Due to voltage source only,</u>



$$V_x \Rightarrow \frac{-200}{250-50j}\times10$$

$$V_x\Big|_{\text{voltage}} \Rightarrow -\frac{4}{5-j}\times10 \Rightarrow \frac{-40}{5-j}$$

$$\Rightarrow V_x\big|_{total} \Rightarrow \frac{4000}{5-j} e^{-j\pi/3} + \frac{-40}{5-j}$$

$$V_x\big|_{total} \Rightarrow (517.85 - 589.25i) + (-7.69 - 1.538i)$$

$$\Rightarrow 510.16 - 590.788j = 780.57\angle -49.188$$

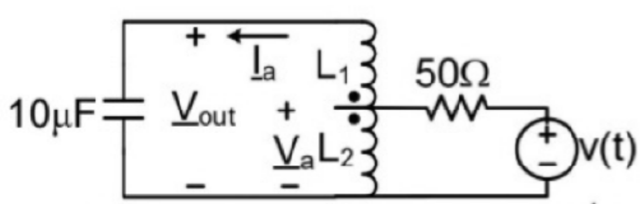
$$\boxed{V_x(t) = 780.57\cos(10^4 t - 49.188)}$$

b) $V_x\big|_{total} \Rightarrow Re\left\{\frac{4000}{5-j} e^{-j\pi/3} e^{j10^4 t}\right\} + Re\left\{\frac{-40}{5-j10} e^{j10^3 t}\right\}$

due to current source. due to voltage source

$$\boxed{784.46\cos(10^4 t - 49.188) + 3.577\cos(10^3 t - 116.56)}$$

Ans.4



$L_2 = L$, $L_1 = 9L$ $v(t) = 2\sin(10^4 t)$ Volts

$L = 1mH$

Figure 4

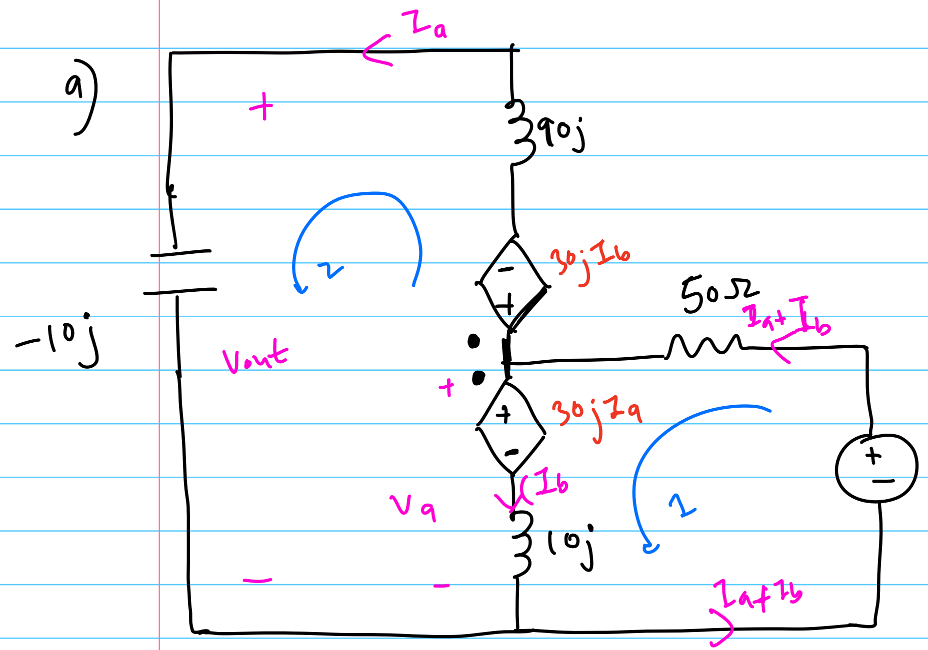
$j\omega L_1 \Rightarrow j \times 10^4 \times 1\times10^{-3} \times 9$

$\Rightarrow \underline{90j}$

$j\omega L_2 \Rightarrow \underline{10j}$

$10\mu F \Rightarrow \frac{1}{j\times 10^4 \times 10\times10^{-6}} \Rightarrow \underline{-10j}$

a)



$M = k\sqrt{L_1 L_2}$

$M = 1\sqrt{9L^2} \Rightarrow 3L = 3\times10^{-3} H$

$j\omega M \Rightarrow 3\times10^{-3} \times j \times 10^{4} \Rightarrow \underline{\underline{30j}}$

$v(t) = 2\sin(10^4 t) = 2e^{-\pi/2 j}$

$= \underline{-2j}$

b) <u>KVL in loop 1</u>

$-2j - 50(I_a + I_b) - 30jI_a - 10jI_b = 0$

$I_a(50+30j) + I_b(50+10j) = -2j \quad — (1)$

<u>KVL in loop 2</u>

$-30jI_b - 90jI_a + 10jI_a + 10jI_b + 30jI_a = 0$

$-20jI_b - 50jI_a = 0$

$2I_b + 5I_a = 0$

$I_b = -\frac{5}{2} I_a \quad — (2)$

Substituting ② in ①

$$I_a(50+30j) - \frac{5}{2}(50+10j)I_a = -2j$$

$$I_a(50+30j) - (125+25j)I_a = -2j$$

$$I_a(-75+5j) = -2j$$

$$I_a = \frac{-2j}{-75+5j} \quad , \quad I_b \Rightarrow \frac{5j}{-75+5j}$$

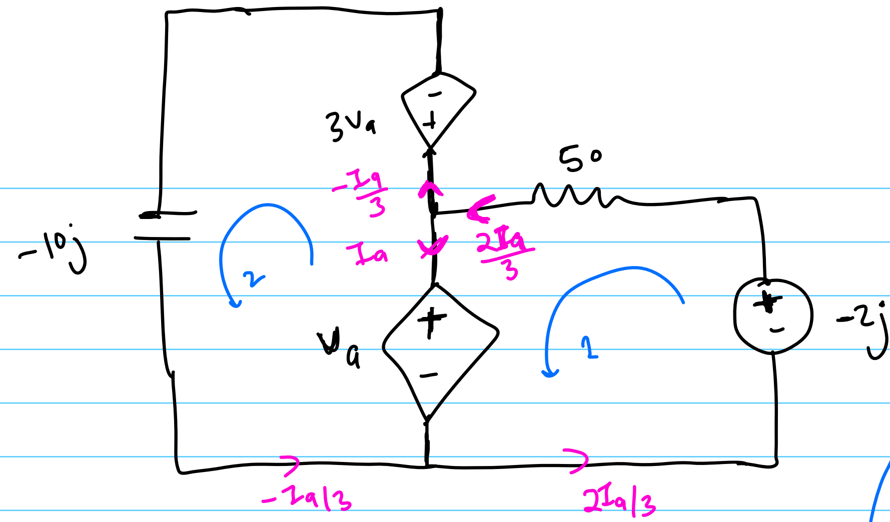
$$V_a \Rightarrow 30j\,I_a + 10j\,I_b$$

$$V_a \Rightarrow \frac{30j(-2j)}{-75+5j} + 10j \times \frac{5j}{-75+5j} \Rightarrow \frac{10}{-75+5j} \Rightarrow \frac{2}{-15+j}$$

$$\boxed{V_a = \frac{-15}{113} - \frac{j}{113} \Rightarrow 0.133\angle -176.185}$$

c) $$\frac{L_2}{L_1} = \frac{N_2^2}{N_1^2} \Rightarrow \frac{1}{9}$$

$$\frac{N_2}{N_1} = \frac{1}{3} \Rightarrow \underline{\underline{N_1 = 3N_2}}$$



KVL in loop ①,

$$-2j - \frac{2I_a}{3} \times 50 - V_a = 0$$

$$-2j - \frac{2}{3} \times \overset{10}{\cancel{50}} \times \frac{3}{5} j V_a - V_a = 0$$

$$-2j - 20j V_a - V_a = 0$$

$$V_a = \frac{-2j}{1+20j}$$

$$\Rightarrow -\frac{40}{401} - \frac{2}{401} j$$

substitute

KVL in loop ②,

$$-3V_a - \frac{I_a}{3} \times 10j + V_a = 0$$

$$2V_a + \frac{I_a}{3} \times 10j = 0 \Rightarrow \boxed{I_a = -\frac{6V_a}{10j} \Rightarrow +\frac{3}{5} j V_a}$$

Ans.5

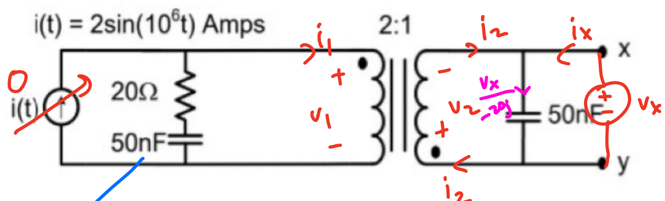


Figure 5

$$\frac{1}{j \times 10^6 \times 50 \times 10^{-9}} \Rightarrow -20j$$

$$\frac{V_x}{i_x} \Rightarrow Z$$

$$V_x = -v_2$$

$$v_1 = 2v_2$$

$$i_1 = -\frac{1}{2} i_2$$

$$v_1 = -i_1 \times (20 - 20j)$$

$$v_2 = \frac{-i_1 \times (20-20j)}{2} \Rightarrow -i_1 (10 - 10j)$$

$$v_2 = i_2 (5 - 5j) = -V_x$$

$$i_x = \frac{v_x}{-20j} + \frac{v_x}{5-5j}$$

$$i_x \Rightarrow \frac{j v_x}{20} + \frac{v_x}{5-5j} \Rightarrow \frac{j v_x}{20} + \frac{v_x}{5-5j}$$

$$i_x \Rightarrow \frac{v_x}{5}\left(\frac{j}{4} + \frac{1}{1-j}\right) \Rightarrow \frac{v_x}{5}\left(\frac{j+1+4}{4(1-j)}\right)$$

$$Z_{th} \Rightarrow \boxed{\frac{v_x}{i_x} \Rightarrow \frac{20(1-j)}{5+j} \Rightarrow 3.076-4.615j}$$

Ans.6

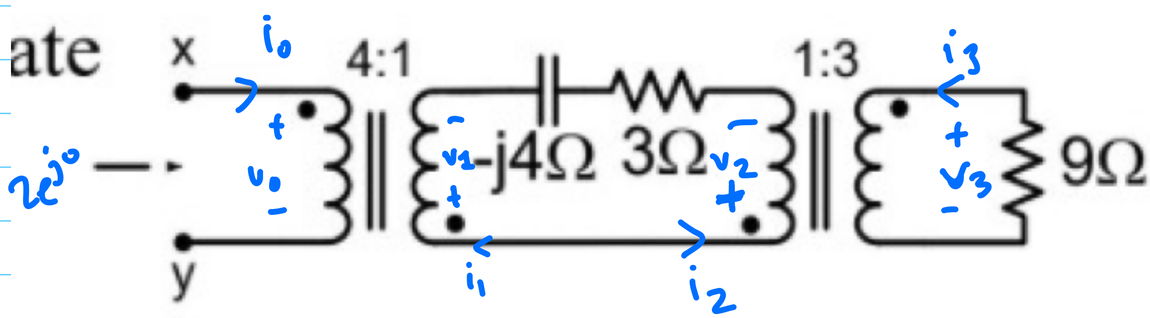


Figure 6

$$v_1 = \frac{v_0}{4}$$

$$i_1 = -4 i_0 = -i_2$$

$$v_3 = -9 i_3 = 3 v_2$$

$$i_3 = \frac{-i_2}{3}$$

Using above relations.

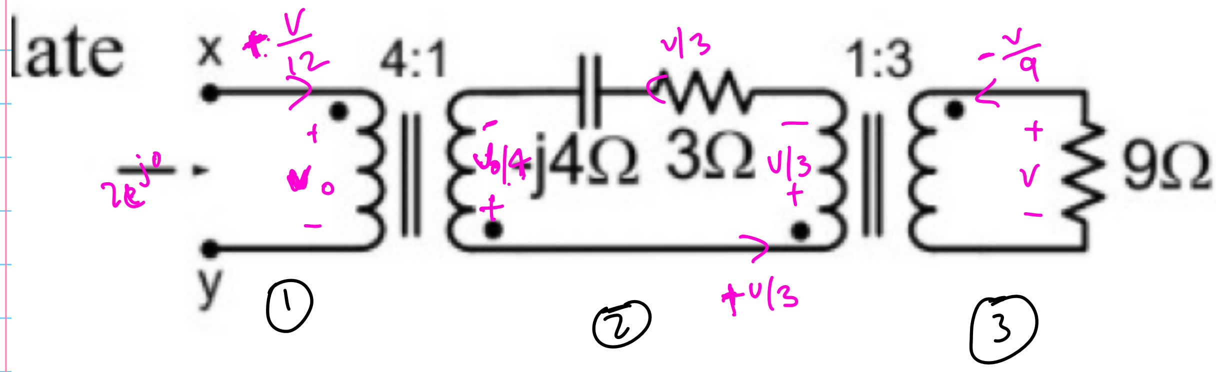


Figure 6

Applying KVL in secⁿ ②

$$-V_0/4 + \frac{v}{3}(-4j+3) + \frac{v}{3} = 0$$

$$\frac{V_0}{4} = \frac{v}{3}(-4j+4)$$

$$V_0 = \frac{4}{3}(-4j+4)\,v$$

$V_0 = 2e^{j0}$

$$2 = \frac{4}{3}(-4j+4)\,v \Rightarrow v \Rightarrow \frac{3}{2(-4j+4)}$$

$$\Rightarrow \boxed{0.1875 + 0.1875i}$$