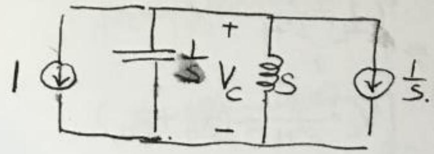
1. Method 1. the equivalent Laplace circuit is .



$$\Rightarrow \quad V_c = -\left(\frac{1}{s}+1\right) \cdot \frac{1}{s} \| s$$

$$= -\left(\frac{1}{s}+1\right) \cdot \frac{1}{\frac{1}{s}+s}$$

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

For $I_L = \frac{1}{s} + \frac{V_c}{s} = \frac{1}{s} - \frac{s+1}{(s^2+1)s}$

$$= \frac{s^2+1-s-1}{s(s^2+1)} = \frac{s-1}{s^2+1}.$$

$$\Rightarrow \quad V_c = \frac{-s}{s^2+1} - \frac{1}{s^2+1}$$

$\Downarrow$ $-\cos t$ $\quad$ $\Downarrow$ $-\sin t$ $\longrightarrow$ These inverse Laplace transform can be find in the table of the book !!!

$$I_L = \frac{s}{s^2+1} - \frac{1}{s^2+1}$$

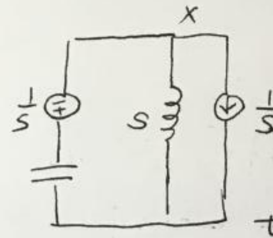
$\Downarrow$ $\cos t$ $\quad$ $\Downarrow$ $\sin t$.

$\Rightarrow V_c(t) = -(\cos t + \sin t)$

$i_L(t) = \cos t - \sin t$.

Method 2

1. Draw S-domain circuit and do node analysis @ x.



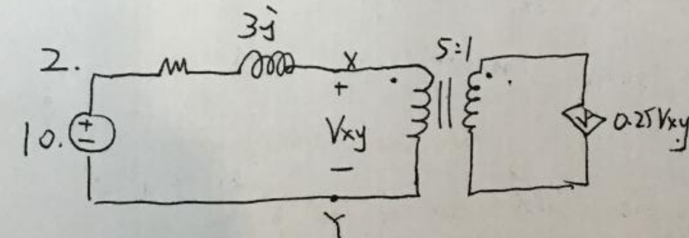
$$\begin{cases} I_L = \frac{V_c}{s} + \frac{1}{s} \\ V_c = -\left(\frac{1}{s} + I_L \cdot \frac{1}{s}\right) \end{cases} \Rightarrow \begin{cases} I_L = \frac{s-1}{s^2+1} = \frac{s}{s^2+1} - \frac{1}{s^2+1}. \\ V_c = \frac{-s-1}{s^2+1} = -\left(\frac{s}{s^2+1} + \frac{1}{s^2+1}\right) \end{cases}$$

take the inverse laplace transform of $I_L(s)$, $V_c(s)$

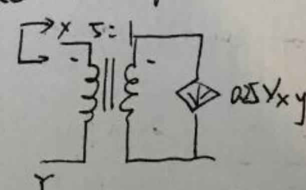
$$\Rightarrow i_L(t) = \cos t - \sin t$$

$$V_c(t) = -(\cos t + \sin t)$$

2.



. take Thevenin equivalent CKT at port X Y.

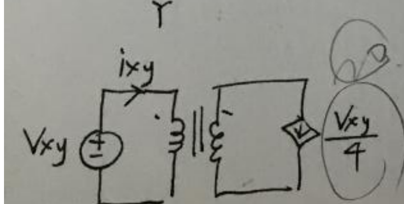


(1). V_{eq} $\because$ no independent source.

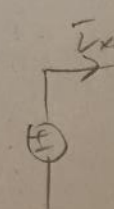
x y is open circuit.

$\Rightarrow V_{eq} = 0$

(2) $Z_{eq} = \frac{V_{xy}}{i_{xy}}$



$i_{xy} = \frac{V_{xy}}{4} / 5 = \frac{V_{xy}}{20}$

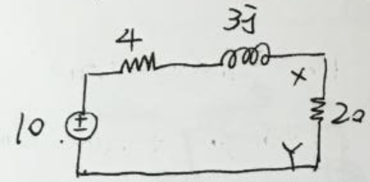


$\Rightarrow Z_{eq} = 20.$

$i_{xy} = \frac{V_{xy}}{20}$

port xy
$\Rightarrow$ the equivalent CKT of the right side is just a resistor.

$\therefore$ equivalent CKT is



$\Rightarrow I = \dfrac{10}{24+3j} = \dfrac{16}{39} - \dfrac{2}{39}j$

$V_{xy} = I \cdot 20 = 8.2 - 1.02j$

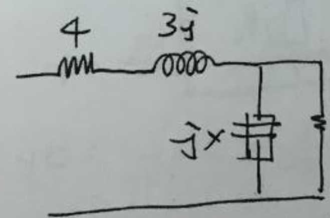
$\Rightarrow$ Complex power is $S = V_{xy} \cdot I^* = 3.42$ W.

$\because$ ideal transformer doesn't consume power

b. now since. ~~the load is x~~

therefore, the all the complex power at load XY will be the power consumed by load

b. Now, since. ~~the~~ load is fixed (at X,Y side just 2o resistor) We can do best is adding a ~~comp~~ component to cancel ~~the~~ ~~complex~~ imaginary part of source impedance.



$Z_L = \dfrac{jx \cdot 20}{jx + 20} = \dfrac{20xj(20-jx)}{20^2+x^2}$

$= \dfrac{400xj + 20x^2}{20^2 + X^2}$

$\therefore$ to cancel imajnary part

+5

rms phasor.

Problem 2: Refer to the circuit shown in Figure 2. The source is an rms phasor.

a. Determine the complex power delivered to the load.
b. What passive component should you connect between the terminals "x" and "y" such that maximum power is transferred to the load. What should be the value of this component?

One Res. Ind. Cap
Just one of them

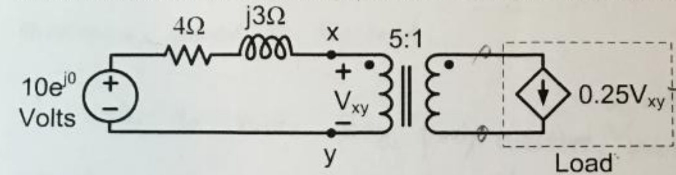
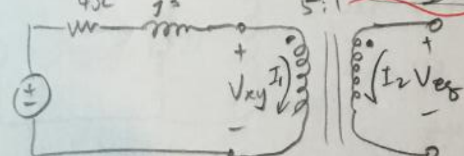


Figure 2.

(7 + 8 = 15 points)

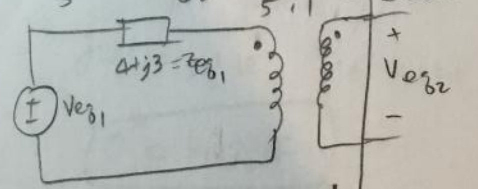
Solution:

$S = \frac{1}{2} V I^*$ → thevenin → V_{eq}



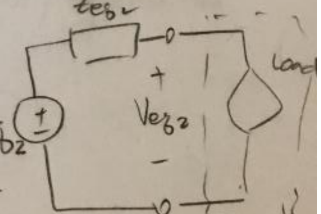
we need to find V_{eq_2}

$\frac{V_{xy}}{5} = V_{eq_2}$



$\Rightarrow V_{eq_2} = 2$

$0.2\angle 36.87°$



$V_{eq_2} = \frac{N_2}{N_1} V_{eq_1}$, $Z_{eq_2} = \left(\frac{N_2}{N_1}\right)^2 Z_{eq_1}$

$V_{eq_2} = \frac{1}{5} 10\angle 0° = 2$, $Z_{eq_2} = \frac{1}{25}(4+j3) = 0.2\angle 36.87°$,

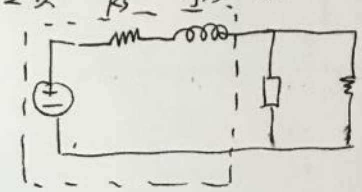
$Z_{eq_2}^* = 0.2\angle -36.87°$

$S = \underline{V}\,\underline{I}^* = \underline{V} \cdot \frac{\underline{V}^*}{Z^*} = \frac{1}{Z^*} \cdot |\underline{V}|^2 \Rightarrow \frac{1}{(0.2\angle -36.87°)} \cdot 4$

5

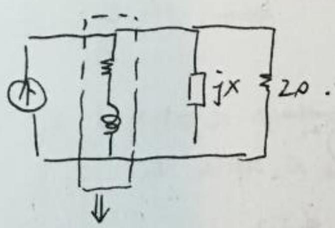
$\boxed{S = 20\angle 36.87°}$

In 2b $R_s = 4$ $jX_s = 3j$



The dashline part can be norton equivalent.

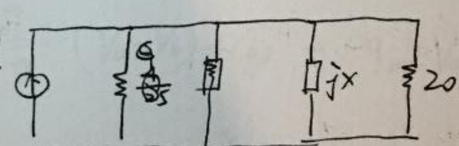
$\Rightarrow \dfrac{V_s}{R_s + jX_s}$



$\Downarrow$

$Z_{eq} = R_s + jX_s$ $\quad Y_{eq} = \dfrac{1}{R_s + jX_s} = G_{seq} + jB_{eq} = \dfrac{1}{4+3j} = \dfrac{4-3j}{25}$

$\Rightarrow \dfrac{\cancel{X}10}{4+3j}$



$G_{eq} = \frac{4}{25}$ $\quad \frac{-3j}{25}$

$\therefore jX = \frac{3}{25}j$ to cancel the imaginary part.

for real suspectance, only cap can achieve.

$jB = jWC = \frac{3}{25}j \quad \because W = 1 \Rightarrow C = \frac{3}{25}$

If choose $C = \frac{3}{25}$. the imaginary part canels each other.

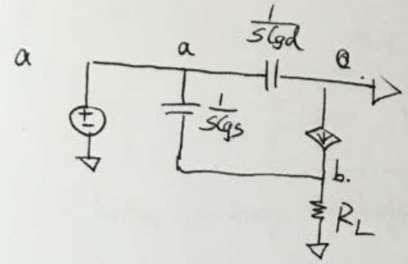
$$P_{av} = I_s^2 \frac{G_L}{(G_{eq} + G_L)^2}.$$

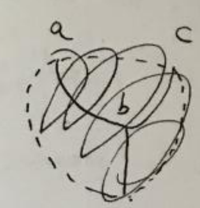
$$= \left|\frac{10}{4+3j}\right|^2 \frac{\frac{1}{20}}{\left(\frac{4}{25} + \frac{1}{20}\right)^2}.$$

$$= \frac{10^2}{25} \times \frac{1}{20} \times \left(\frac{100}{21}\right)^2 \doteq 4.53 \ W.$$

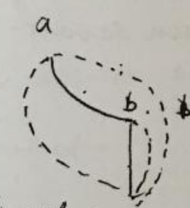
This is the optimum ~~ou~~ ~~por~~ transmitted power.

3





branch ~~8~~ 5 ~~tree~~.



node. 3 $3-1 \Rightarrow 2$ equation

a voltage is know only need 1

chord $5-2=3 \rightarrow 3$ equation for mesh analysis

$\Rightarrow$ node analysis is good.

$V_a = V_{in}$

$$\frac{V_b}{R_L} = (V_a - V_b) sC_{gs} + g_m (V_a - V_b)$$

~~$\Rightarrow V_b = \frac{1}{2}\left(1 + s/5\times10^{9}\right.$~~

$$V_b\left(\frac{1}{R_L} + sC_{gs} + g_m\right) = (g_m + sC_{gs}) V_a$$

$$\Rightarrow V_b = \left(\frac{g_m + sC_{gs}}{\frac{1}{R_L} + sC_{gs} + g_m}\right) V_a \quad ①$$

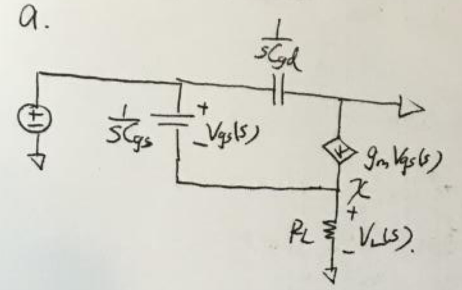
$$= \frac{1}{2}\left(\frac{1 + s/5\times10^{9}}{1 + s/10\times10^{9}}\right)\left(\frac{10^{10}}{s^2 + 10^{30}}\right)$$

From ①, we can see.

V_b is not related to C_{gd}.

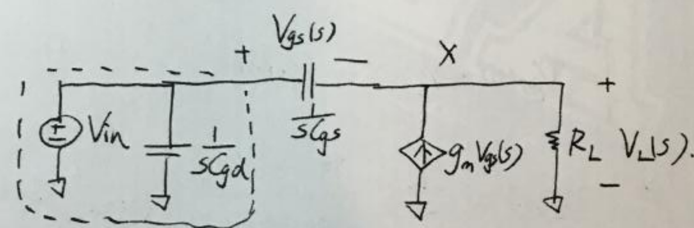
This can be shown as ~~follow~~ follows, which is a ~~sen~~ second method. ~~for this~~

3. a.



b. ~~the~~ circuit looks. complicated, we can simplify it.

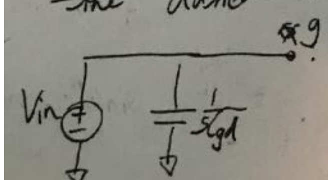
redraw the circuit, ~~we can find:~~ as



We only cares about $V_L(s)$.

In the ~~dot line~~ dash line circle. an impedance is in parallel with a Voltage source, ~~the~~ the dash line totally can be regarded as just a single Voltage source (based on EE10 knowledge).

We can also do the thevenin equivalent CKT for ~~the~~ the dashed line part.



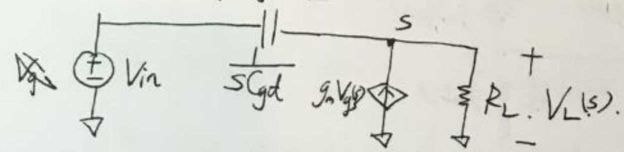
open the port g. we find $V_{eq} = V_{in}$

Then set $V_{in} = 0$ We try to find Z_{eq}.

$\because V_{in} = 0$ $\therefore$ is a short CKT $\Rightarrow Z_{eq} = 0$

above all ~~the~~ ~~gate~~ dash line part thevenin equivalent CKT is just a voltage source.

$+ V_{gs}(s) - = V_{in} - V_L(s)$.



Now the CKT is very simple.

do KCL at S:

$$\begin{cases} V_{gs}(s) \Big/ \frac{1}{sC_{gd}} + g_m V_{gs}(s) = \frac{V_L(s)}{R_L} & ① \\ V_{gs}(s) + V_L(s) = V_{in}(s) & ② \end{cases}$$

combine ①, ② $\Rightarrow$ $V_L(s) = \frac{1}{2}\left(\frac{1 + s/(5\times10^9)}{1 + s/(10\times10^9)}\right)\left(\frac{10^{10}}{s^2+10^{20}}\right)$

C. Now. doing the partial derevative of $V_L(s)$

$$\cancel{V_L(s) = \frac{K_1}{1+s/10\times10^9} + \frac{K_2}{s+10^{10}j} + \frac{K_2^*}{s-10^{10}j}}.$$

$$\cancel{K_1 = V_L(s) \cdot 1 + \frac{s}{10\times10^9}\Big|_{s=10\times10^9} =}$$

$$V_L(s) = 5\times10^9 \times \frac{2s+10^{10}}{(s+10^{10})(s^2+10^{20})} = 5\times10^9 \times \left(\frac{2}{s^2+10^{20}} - \frac{10^{10}}{(s^2+10^{20})(s+10^{10})}\right)$$

$$\Rightarrow \frac{10^{10}}{s^2+10^{20}} - \frac{1}{2}\frac{10^{20}}{(s^2+10^{20})(s+10^{10})} \xrightarrow{L^{-1}} \sin 10^{10}t - \left(\frac{e^{-10^{10}t}}{4} + \frac{\sin 10^{10}t - \cos 10^{10}t}{4}\right).$$