+40

Problem One: Consider the circuit shown below. **(40 points)**

The source voltage $v_s(t) = 100\sin(5000t + 30^o)\,V$, find the following:

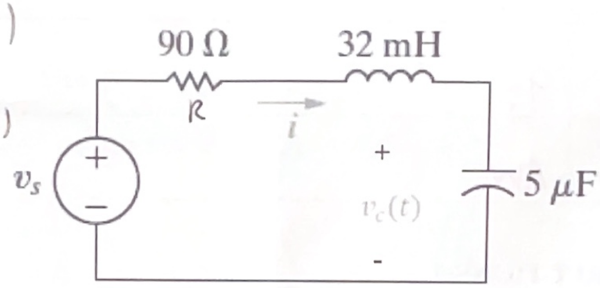
1- The current *i(t)*.
2- The voltage, $v_c(t)$, across the capacitor.
3- Draw the Phasor diagram to show the phasors of the current ***I*** *and the capacitor voltage* $\mathbf{V_C}$.

$w = 5000$

$V_s = 100\sin(5000t + 30)$

$= 100\cos(5000t - 60)$

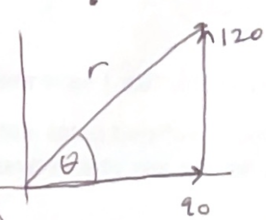
$= 100\angle{-60}\ V$



$X_L = jwL = j(32 \cdot 10^{-3})(5000) = j160\,\Omega$

$X_C = \frac{-j}{wC} = \frac{-j}{5000 \cdot (5 \cdot 10^{-6})} = -j40\,\Omega$

$Z_{Total} = R + \underbrace{X_L + X_C}_{= j120} = 90\,\Omega + j120\,\Omega$



$\therefore Z_{Total} = 150\angle{53.13^\circ}$

$r = 150\,\Omega$

$\theta = 53.13^\circ$

1. From Ohm's Law:

$I = \frac{V}{R} \rightarrow i(t) = \frac{V_s}{Z_{total}} = \frac{100\angle{-60}}{150\angle{53.13}}$

$i(t) = \frac{2}{3}\angle{-113.13} = \frac{2}{3}\cos(5000t - 113.13)\ A$

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2. In a series circuit, current is the same for all elements.

By Ohm's law: $V = IR \rightarrow V_c(t) = i(t) \cdot X_c$

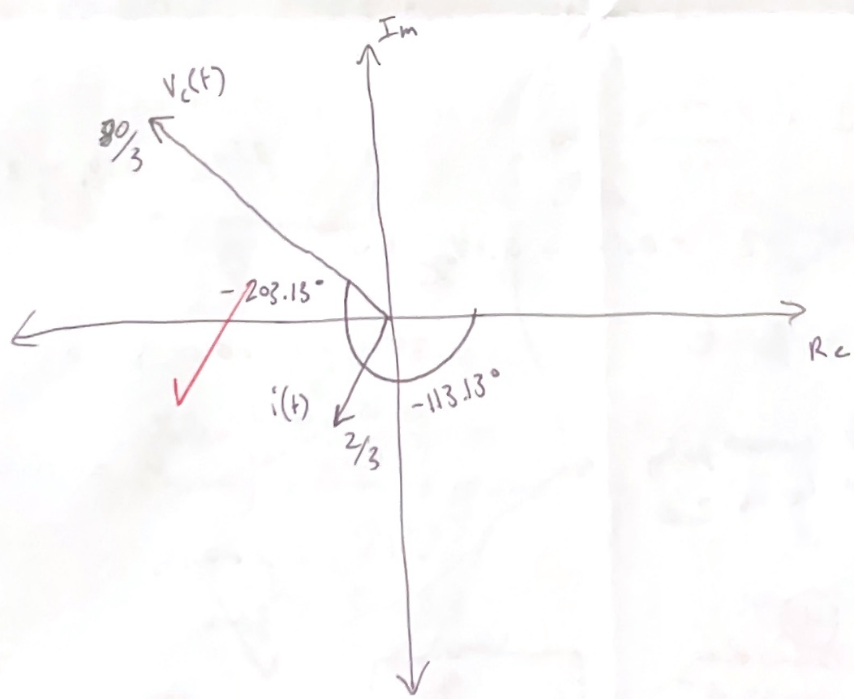
$= \frac{2}{3}\angle -113.13 \cdot \underbrace{-j40}_{40\angle -90}$

$V_c(t) = \frac{80}{3}\angle -203.13 \text{ V}$

$= \frac{80}{3}\cos(5000t - 203.13)$

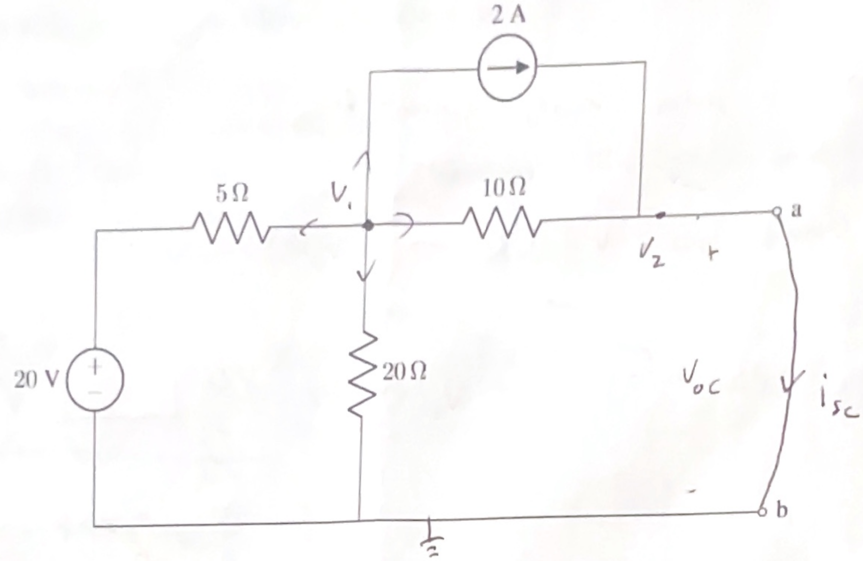
3.

Phasor diagram:



+19

Problem Two: Consider the circuit shown below. **(25 points)**



Obtain the Thevenin equivalent circuit across terminals a-b of the circuit shown.

I_{sc}: node voltage analysis @ node V_1:

@ V_2:

$$\frac{V_2 - V_1}{10} = 2$$

$$\frac{V_1 - 20}{5} + \frac{V_1}{20} + 2 + \frac{V_1 - V_2}{10} = 0$$

$0.1V_2 - 0.1V_1 = 2$ (2)

$0.2V_1 - 4 + 0.05V_1 + 2 + 0.1V_1 - 0.1V_2 = 0$

$0.35V_1 - 0.1V_2 = 2$ (1)

$0.35V_1 - (2 + 0.1V_1) = 2$

$0.35V_1 - 0.1V_1 = 4$

$0.25V_1 = 4$ $V_1 = 16V$

$V_{oc} = V_2$

∴ only current going to i_x is 2A

$0.1V_2 = 2 + 0.1V_1$

$= 36V$

→ $V_{oc} = 36V$

(-6)

$i_{sc} = \cancel{2A}$ setup another node-voltage for I_{sc} setup

36 (+ -) $\cancel{18}\Omega$ a b

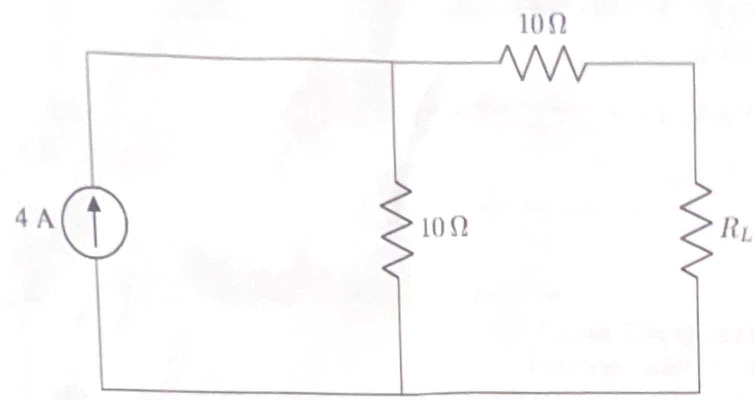
ok w/ errors

$R_{th} = \cancel{18}\ \Omega$

ok w/ errors

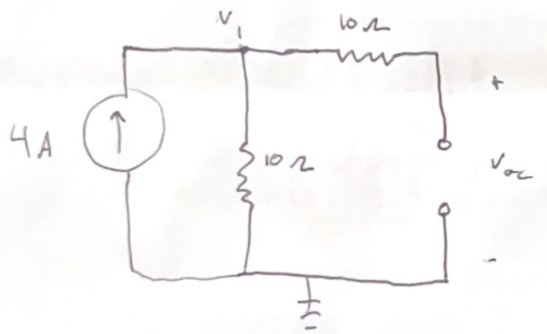
+20

Problem Three: Consider the circuit shown below: **(20 points)**



1- Find R_L for maximum power deliverable to R_L
2- Determine that maximum power.

To find R_L, need R_{Th}: redraw circuit w/ open circuit in place of R_L:



node voltage analysis @ V_1:

$$\frac{V_1 - V_{oc}}{10} + \frac{V_1}{10} = 4$$

@ V_{oc}: $$\frac{V_{oc} - V_1}{10} = 0$$

$$0.1 V_{oc} = 0.1 V_1$$

$$V_1 = V_{oc}$$

$$\frac{V_1}{10} = 4 \qquad V_1 = 40\,V$$

$$V_{oc} = 40\,V$$

current source splits evenly between 2 10Ω resistors:

$$I_{sc} = 2A$$

$$R_{Th} = 20\,\Omega$$

$$R_L = 20\,\Omega$$

$$P_{L_{max}} = \frac{(V_{oc})^2}{4R_L} = 20\,W$$

for max power, $R_L = R_{Th}$

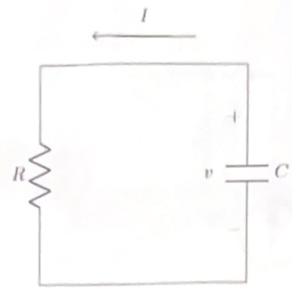
+12

Problem Four: Consider the circuit shown below. **(15 points)**

In the circuit shown, the following is observed.

$v(t) = 56e^{-200t}$ V, t > 0

$i(t) = 8e^{-200t}$ mA, t > 0



1- Find the values of R and C
2- Calculate the time constant τ
3- Determine the time required for the voltage to decay half its initial value at $t = 0$.

1. $R = \frac{V}{I} = \frac{56\cancel{e^{-200t}}}{8\cancel{e^{-200t}} \times 10^{-3}} = 7k\Omega$ (-1)

mA

$i(t) = C\frac{dv}{dt} \rightarrow C = \frac{dv}{dt} \cdot \frac{1}{i(t)}$ $\quad \frac{d}{dt}[v(t)] = \frac{d}{dt}[56e^{-200t}]$

$i = C\frac{dv}{dt}$

$C = i \cdot \frac{1}{\frac{dv}{dt}}$

(-2) $= -11200e^{-200t} \cdot \frac{1}{8e^{-200t}}$

$C = 14\cancel{00 F}$

2. $\tau = RC = 7 \cdot 1400 = 9800$

ok

3. at $t = 0$, $V = 56V$ ✓

$\rightarrow 28 = 56e^{-200t}$

$0.5 = e^{-200t}$

$\ln(0.5) = -200t \rightarrow \frac{\ln(0.5)}{-200} = t = 0.003\cancel{47}$ s ✓