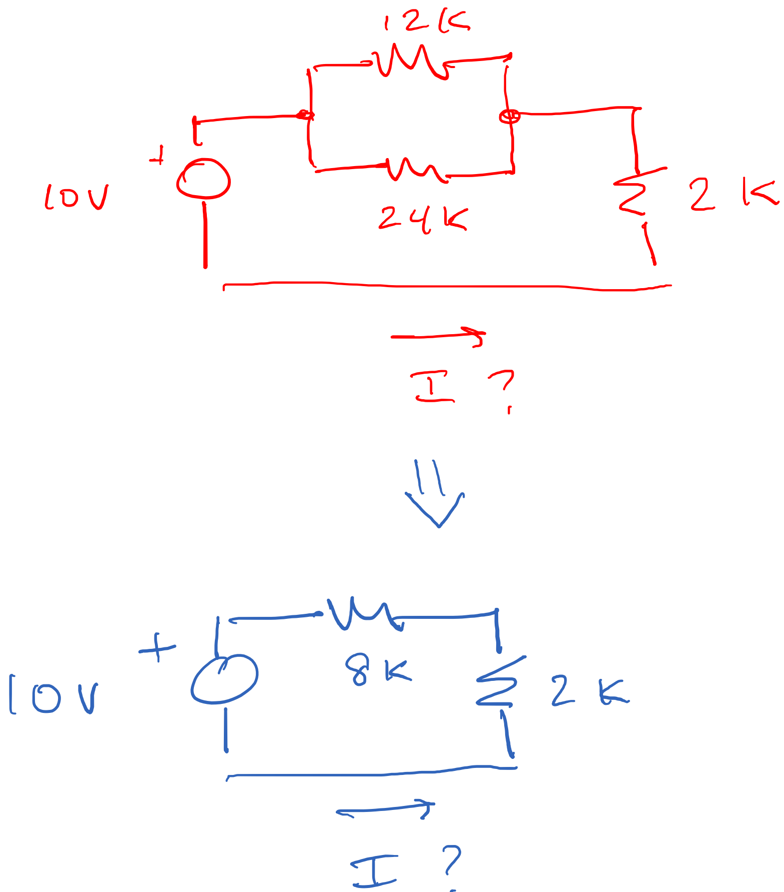
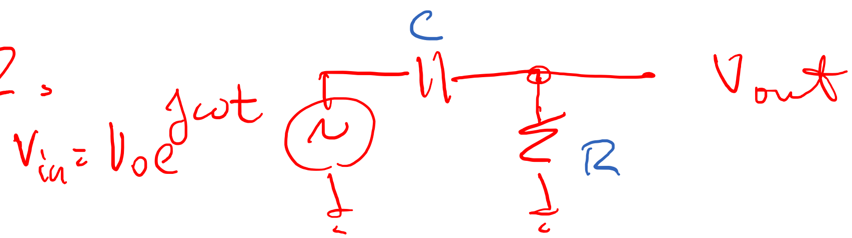
PS 1 SOLUTIONS

1.



$I = -1\,mA$

2.



$$V_{out} = \frac{R}{R - j\frac{1}{\omega C}} V_{in} \quad ; \quad \text{DEFINE } \tau \equiv RC$$

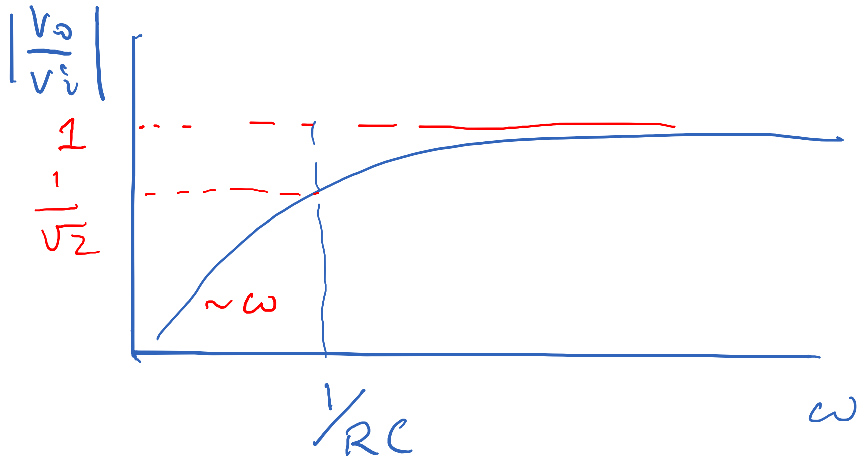
$$\frac{V_o}{V_i} = \frac{1}{1 - j\frac{1}{\omega\tau}} = \omega\tau \frac{\omega\tau + j}{1 + (\omega\tau)^2}$$

A. $$\left|\frac{V_o}{V_i}\right| = \frac{\omega\tau}{\left[1 + (\omega\tau)^2\right]^{1/2}}$$

B. $$\varphi = \tan^{-1}\left[1/\omega\tau\right]$$

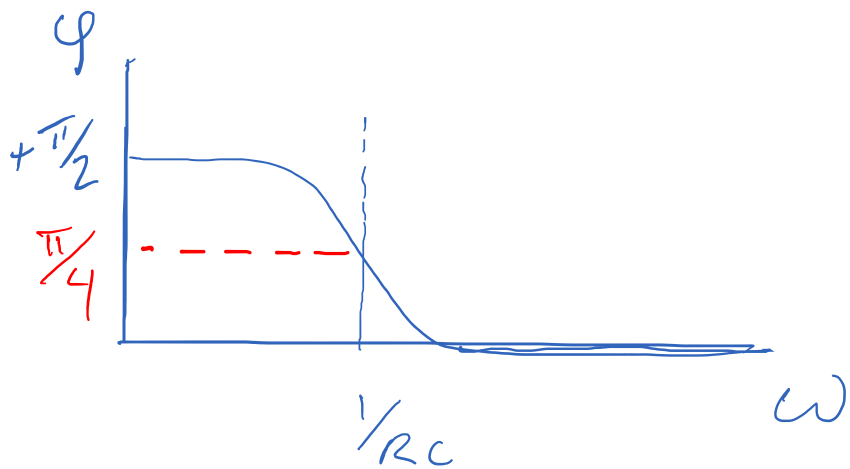
3.

A.



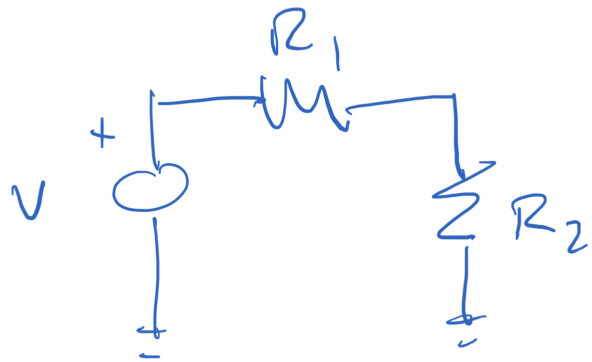
$\left|\frac{V_o}{V_i}\right|$
1
$\frac{1}{\sqrt{2}}$
$\sim \omega$
$1/RC$
ω

B.



φ
$+\pi/2$
$\pi/4$
$1/RC$
ω

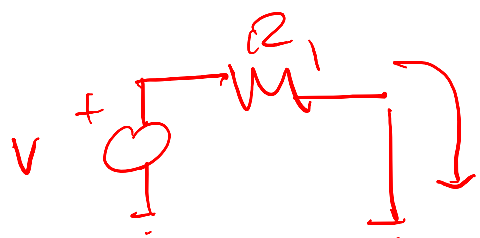
4.



$$V_T = V_{oc} = \frac{R_2}{R_1+R_2} V$$

$$R_T = V_{oc}/I_{sc}$$

I_{sc} ?



$$I_{sc} = \frac{V}{R_1}$$

$$\therefore R_T = \frac{\frac{R_2}{R_1+R_2} V}{\left(V/R_1\right)}$$

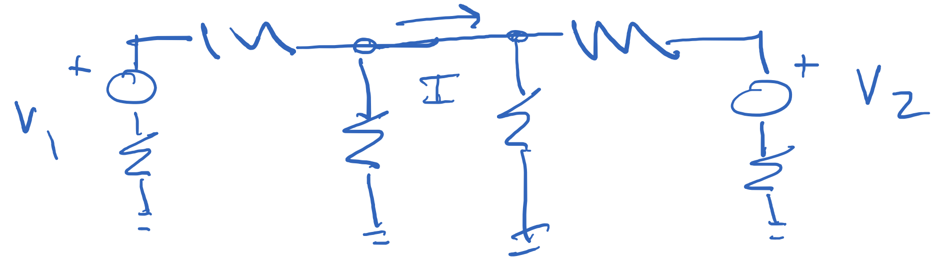
$$R_T = \frac{R_1 R_2}{R_1+R_2} = R_1 \| R_2$$

THEVENIN EQUIVALENT:

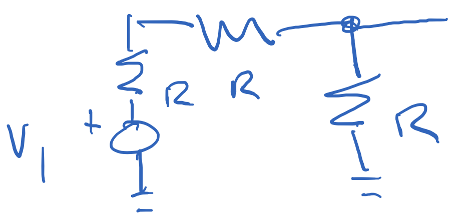
$$V_T = \frac{R_2}{R_1+R_2} V$$

$$R_T = \frac{R_1 R_2}{R_1+R_2}$$

5.



CONSIDER LEFT HALF



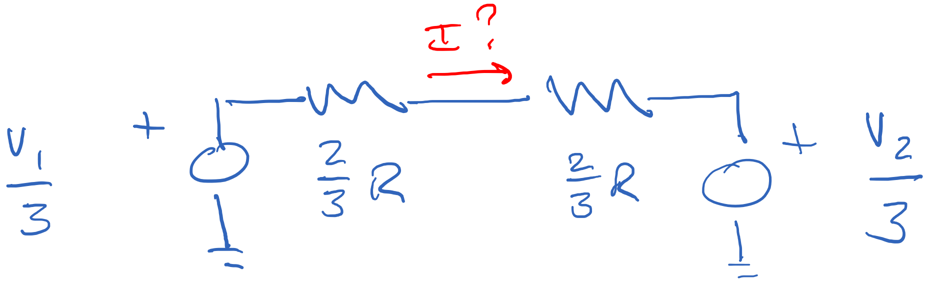
$$V_T = \frac{V_1}{3}$$

$$R_T = R \,||\, 2R = \frac{2}{3} R$$

AND SIMILARLY FOR RIGHT HALF

OVER

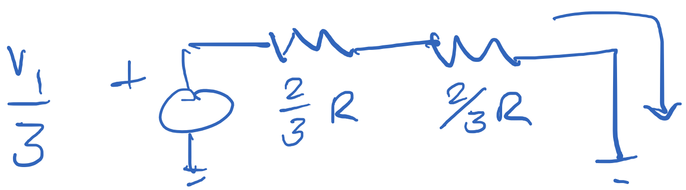
SO CIRCUIT BECOMES



NOW, USE SUPERPOSITION TO CALCULATE PARTIAL CURRENTS

I_1 & I_2 ; $I = I_1 + I_2$

e.g., PARTIAL CIRCUIT #1 ;

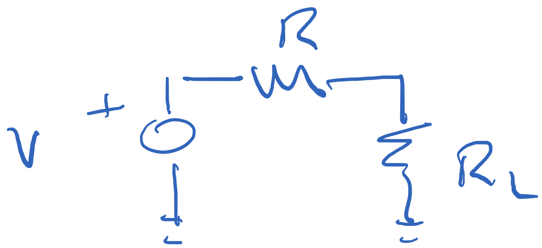


$I_1 = V_1/4R$

SIMILARLY, $I_2 = -V_2/4R$

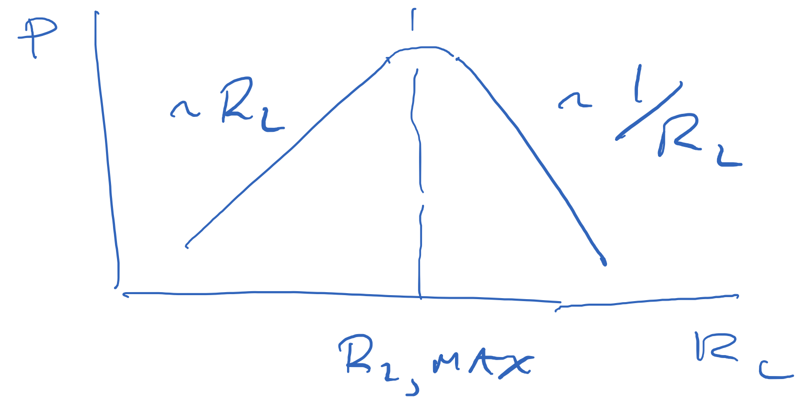
$$\boxed{\therefore\ I = I_1 + I_2 = \frac{1}{4R}\left[V_1 - V_2\right]}$$

6.



$$P = \frac{V_L^2}{R_L} = \frac{1}{R_L}\left[\frac{R_L}{R+R_L}\right]^2 V^2$$

NEED TO MAXIMIZE $\frac{R_L}{(R+R_L)^2}$



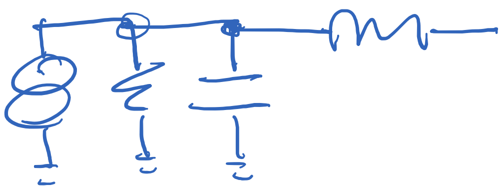
SOLVE

$$\frac{dP}{dR_L} = 0$$

$$\frac{1}{(R+R_L)^2} - \frac{2R_L}{(R+R_L)^3} = 0 \Rightarrow \boxed{R = R_L}$$

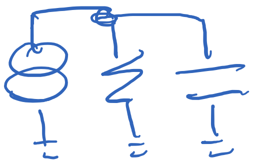
@ $R_L = R$, POWER TO LOAD IS $\frac{V^2}{4R}$ (1:1 VOLTAGE DIVIDER)

7.



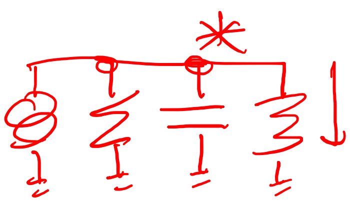
V_{oc}?

$\Downarrow$ (NO CURRENT THRU L)



$$V_{oc} = I\left(\frac{-j}{\omega_0 C}\right) = -j\frac{R}{Q}I$$

NEXT, WANT I_{SC}

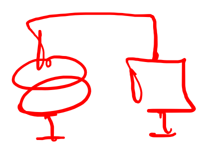


I_{SC}

$V_* = IR$ ON RESONANCE $[Z(LC) \to \infty]$

$$\therefore I_{SC} = \frac{IR}{j\omega_0 L} = -jQI$$

$\therefore$ NORTON EQUIVALENT: $-jQI$



R/Q^2

[NOTE CONSERVATION OF POWER]