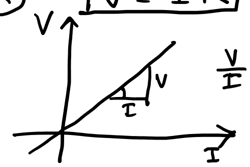
Network Theorems

R, L, C, $\underline{\underline{V}}$, $\underline{\underline{I}}$, Diode, BJT, op-amp.

Passive Element :- R, L, C

Active Element : → sources, amplifier

Linear Element : R : $\boxed{V = IR}$



$\frac{V}{I} = R = \text{slope}$

Inductance ; $V_L = L\frac{di}{dt}$; $\boxed{V_L \propto \frac{di}{dt}}$

Capacitor : $q = CV \Rightarrow \int i\,dt = CV$

$i_c = C\frac{dV}{dt}$

$\boxed{i_c \propto \frac{dV}{dt}}$

Linear Elements → R, L, C.

Linearity Property

1 fruit – 10 Rs

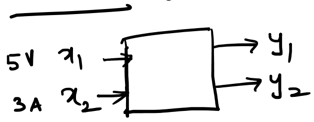
50 fruit → 50 × 10

= 500/-

Additive property (adding)

Homogenity (scaling)

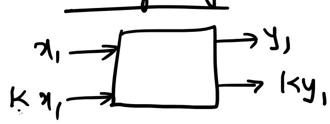
Additivity



$f(x_1 + x_2) = f(x_1) + f(x_2)$

$(x_1 + x_2) \rightarrow (y_1 + y_2)$

Homogenity



$f(ax) = a f(x)$

Linear ckt :

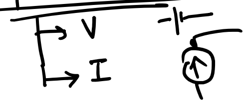
V, I → forcing f^n.

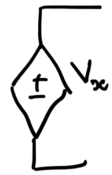
1) Linear Element :- A LE is a passive element that has a linear V–I relationship. R, L, C

2) Linear ckt :- A ckt composed entirely of

independent sources, Linearly dependent sources & Linear elements.

Independent sources



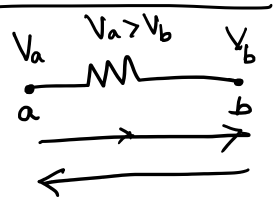


$V_x = k i_x$ ✓

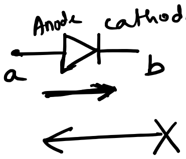
$= k V_a$ ✓

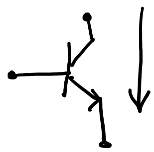
$= k V_a^3 + m V_b^2 + \cdots$

3) Bilateral Element :



Non-Bilateral Element





→ Non-Bilateral Element

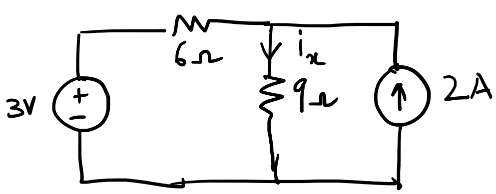
Superposition Principle

An electrical circuit satisfies superposition principle if it has a linear, bilateral, passive network. The voltage across or current through any resistor or source may be calculated by adding algebrically all the individual voltage or currents caused by seperate independent sources acting alone, with all other independent voltage sources short circuited and current sources open circuited.

Network theorems

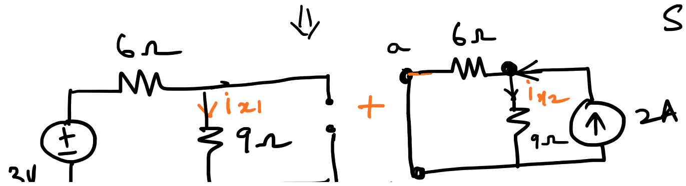
→ Superposition theorem
→ Thevenin's theorem
→ Norton's theorem
→ Max. power transfer
→ Tellegens
→ Reciprocity thm

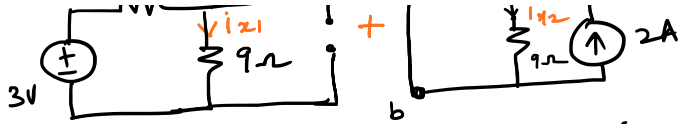
1)



Keep only one Independent source & nullify / kill all other independent Sources

⇓



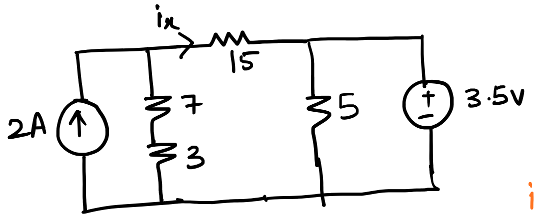


$i_{x1} = \frac{3}{15} = 0.2A$

$i_{x2} = \frac{2 * 6}{6+9} = \frac{4}{5} = 0.8A$

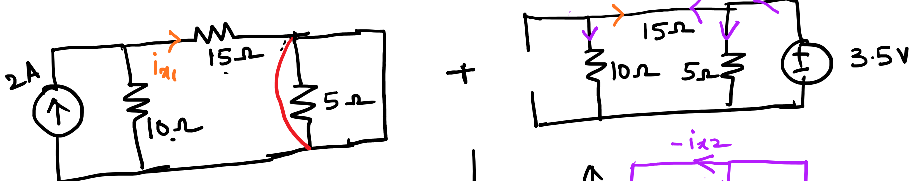
$i_x = i_{x1} + i_{x2} = 0.2 + 0.8 = 1A$

(2)



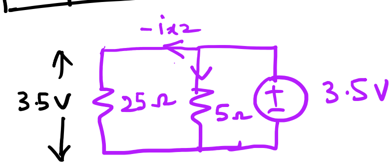
Superposition Theorem

$i_x = ??$



$i_{x1} = \frac{2 * 10}{(10+15)}$

$= 0.8 A$



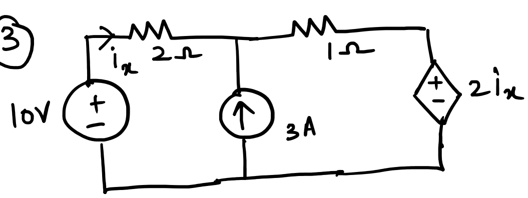
$3.5V = -i_{x2} \cdot 25$

$\Rightarrow i_{x2} = -0.14A$

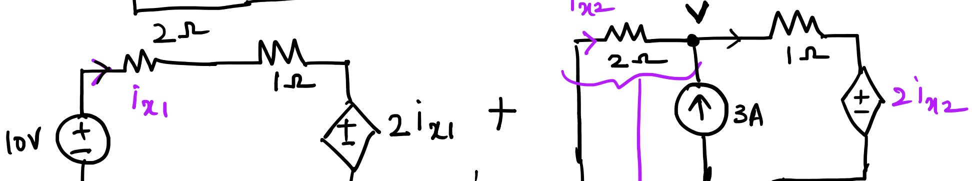
$i_x = i_{x1} + i_{x2} = 0.8 - 0.14 = 0.66A$

$= 660 mA$

(3)



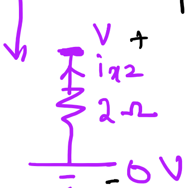
Compute i_x using Superposition Theorem



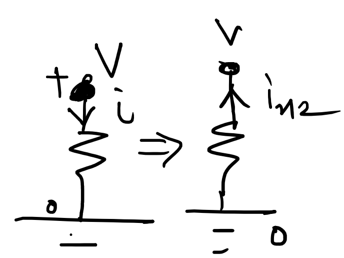
$i_{x1} = \frac{(10 - 2i_{x1})}{3}$

$i_{x1} = 2A$

$i_{x2} + 3 = \frac{(V - 2i_{x2})}{1}$



$V = -2i_{x2}$



$i_{x2} + 3 = (-2i_{x2} - 2i_{x2})$

$i_{x2} = -3/5 = -0.6A$

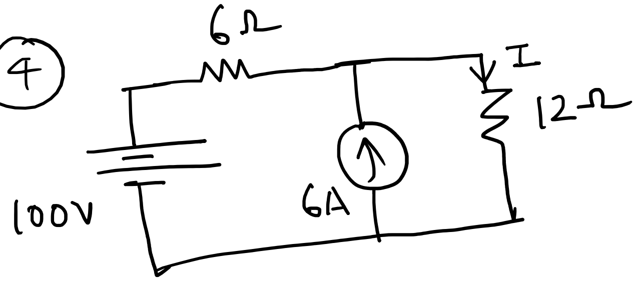
$$i_{x2} + 3 = (-2i_{x2} - i_{x2})$$

$$i_{x2} = -3/5 = \underline{\underline{-0.6A}}$$

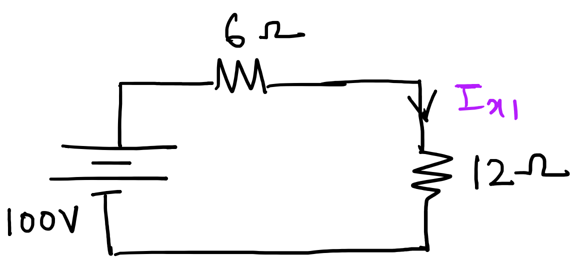
$$i_x = i_{x1} + i_{x2}$$

$$= 2 - 0.6 = \underline{\underline{1.4A}}$$

4



Use superposition theorem to find power absorbed by 12Ω resistor



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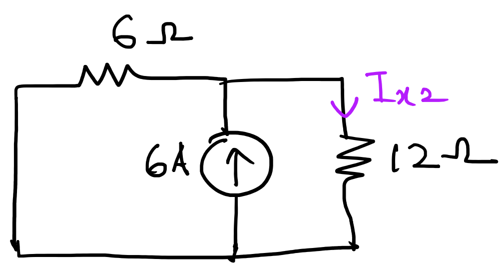

684.03W

$$P_{loss} = I^2 \cdot R$$

$$= (I_{x1} + I_{x2})^2 \cdot 12 = (2 + 5.55)^2 \cdot 12 = 684.03W$$

$$\left\{ \begin{array}{l} P_{loss} \text{ in ckt 1} \Rightarrow I_{x1}^2 \cdot (12) \\ P_{loss} \text{ in ckt 2} \Rightarrow I_{x2}^2 \cdot (12) \end{array} \right\} \times$$