Chap 5

Superposition Theorem :

Linear Element →

$$V_o = \underline{A v_1}_{V_{in1}} + B v_2^2 + C v_3^{V_{in2}} \Rightarrow (1)$$

quad

Linear ✗

→ $$\boxed{V_o = A e^{(av+t)}_r}$$ ✗ linear → (2)

V_o is depending linearly on v_1 and v_3

$$\boxed{V_o = A V_1 + C V_3}$$ linear

(2) is Linear when ~~a=0~~ $(av+t) \ll 1$

$$e^{(av+t)} = \left[\boxed{1 + \frac{(av+t)}{1!}} + \frac{(av+t)^2}{2!} + \frac{(av+t)^3}{3!} + \ldots \right]$$

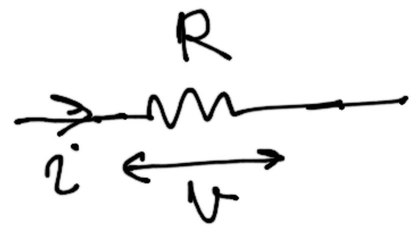
A	B	C	D
129	138	120	124
10	10	8	10
10	10	10	10

$$\frac{(av+t)^2}{L^2} \longrightarrow 0$$

$$\boxed{(av+t) << 1}$$

2, 3, 4... order can be neglected.

<u>Linear element</u> i vs V



$$\underbrace{V = iR}_{\text{Linear}}$$

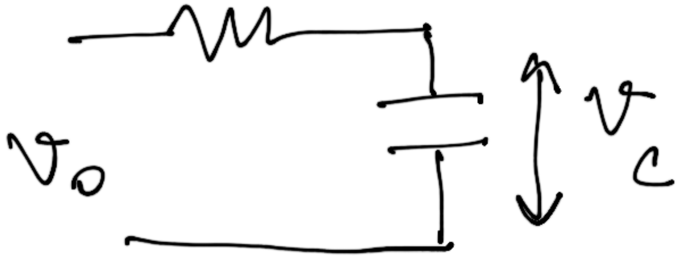
Cap.

Not lin.

$$\begin{cases} V_c = \int \frac{i}{C}\, dt \\ V_c = \frac{it}{C} \end{cases}$$

Capacitor

$$v_c = V_0 \left(e^{\frac{t}{RC}} - 1\right) \rightarrow$$

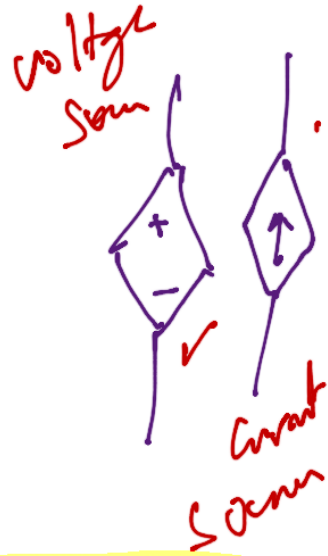


V_c is linear when $e^{t/RC} \rightarrow 1 + \frac{t}{RC}$ i.e. when $\underbrace{\left(\frac{t}{RC} << 1\right)}_{\text{Condition for Linearity.}}$

Capacitor or any element displayin e^x is not linear always.

Linear Dependent Source

→

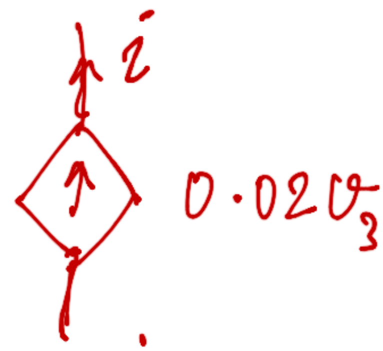


$$\text{Dependent Source} \begin{cases} v = A v_0 + B \\ v = A_2 i_0 + B_2 \end{cases}$$

Lin. Dependent Source : whose o/p i or v is ∝ to first power of a specified current or voltage.

o/p : Output

∝ : proportional



$i = .02 v_3 + 2$

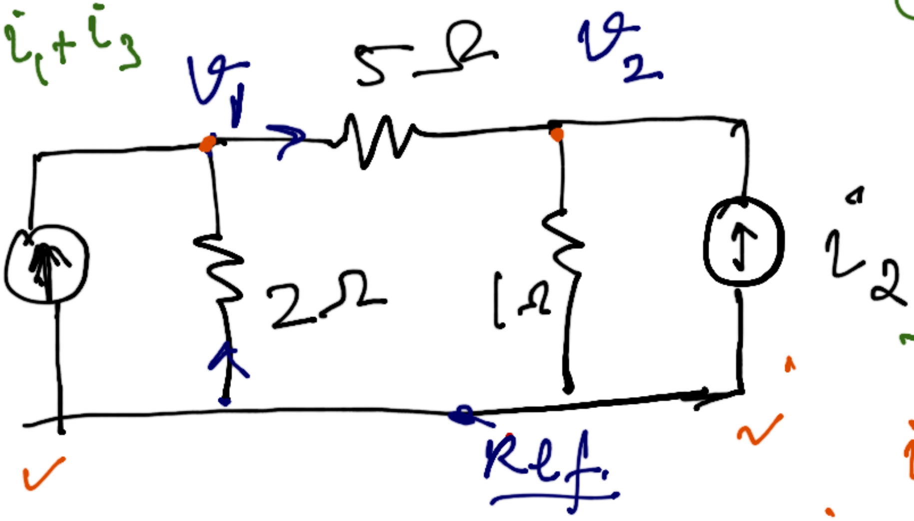
Voltage drop across the current source.

$\boxed{4.16}$

Super position Theorem

$i_5 = i_1 + i_3$

$i_6 = i_2 + i_4$



i_3

i_4

$i_1 \quad i_2 \quad \left\{ \begin{array}{l} v_1 = 2 \\ v_2 = 4 \end{array} \right.$

$i_3 \quad i_4 \rightarrow$

$v_1' \qquad + i_1 + \dfrac{0 - v_1}{2} - \dfrac{v_1 - v_2}{5} = 0 \quad (1)$

$v_2' \qquad i_2 - \dfrac{v_2 - v_1}{5} - \dfrac{v_2}{1} = 0 \quad (2)$

(1) $\quad i_1 - 0.5 v_1 - 0.2 v_1 + 0.2 v_2 = 0$

$\rightarrow \boxed{i_1 = 0.7 v_1 - 0.2 v_2} \quad — (3)$

(2) $\quad i_2 - 0.2 v_2 + 0.2 v_1 - v_2 = 0$

$\rightarrow \quad \Rightarrow \boxed{i_2 = -0.2 v_1 + 1.2 v_2} \quad (4)$

Let us replace i_1 by i_3 & i_2 by i_4

V_1 & V_2 are values of node caused by i_1 & i_2

Now, if input is changed to i_3 & i_4

$\Rightarrow$ Voltage of node will change $\rightarrow$ V_3 & V_4.

$$\rightarrow \quad i_3 = 0.7V_3 - 0.2V_4 \quad (5)$$

$$\rightarrow \quad i_4 = -0.2V_3 + 1.2V_4 \quad (6)$$

Replace i_1 & i_2 by i_5 & i_6

w

$$i_5 = 0.7V_5 - 0.2V_6 \quad (7)$$

$$i_6 = -0.2V_5 + 1.2V_6 \quad (8)$$

$$i_5 = i_1 + i_3 \quad (3) + (5)$$

$$i_6 = i_2 + i_4 \quad (4) + (6)$$

$$i_5 = i_1 + i_3 = 0.7(v_1 + v_3) - 0.2(v_2 + v_4)$$

$$i_6 = i_2 + i_4 = -0.2(v_1 + v_3) + 1.2(v_2 + v_4)$$

In linear resistive ckt, the voltage across any resistor or source can be calculated by adding algebraically all the individual voltages caused by separate independent source.

$\Rightarrow$ Principle of superposition.