

16/1/2015

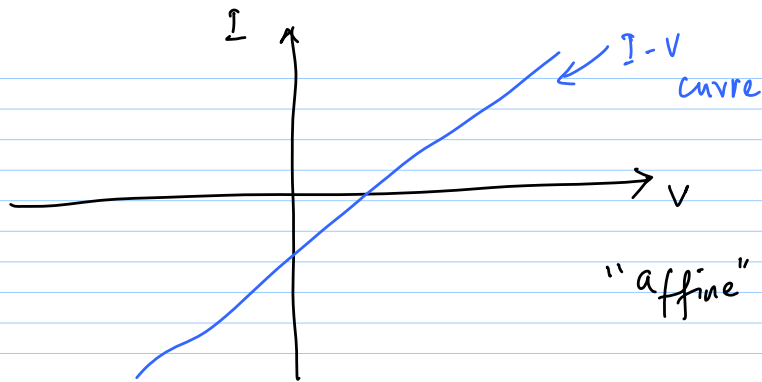
Lec 2

Linearity

* V-I relationship is linear

- 1) $f(x+y) = f(x) + f(y)$ Additive principle
- 2) $f(ax) = a f(x)$ homogeneity

Superposition principle



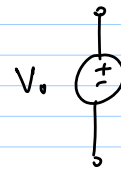
1) Resistor $V = I R$ ← linear

2) Capacitor $I = C \frac{dV}{dt}$ } also

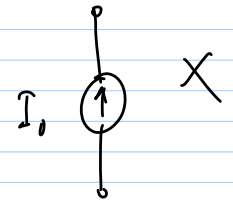
3) Inductor $V = L \frac{dI}{dt}$ } linear

4) V-source

5) I-source

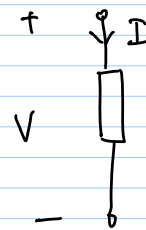


X not linear



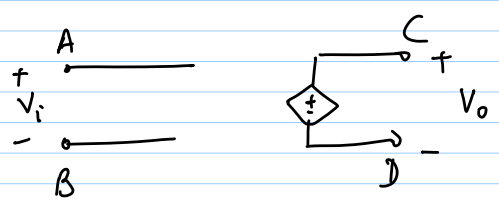
$$\begin{array}{l}
 + \\
 \downarrow I \\
 V \\
 \downarrow L \\
 -
 \end{array}
 \quad
 V = L \frac{dI}{dt}
 \quad
 I(t) = \frac{1}{L} \int_{-\infty}^t V dt$$

L, C — elements with memory



"Passive sign convention"

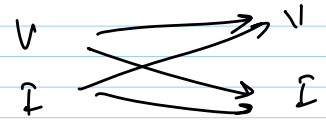
Controlled Sources



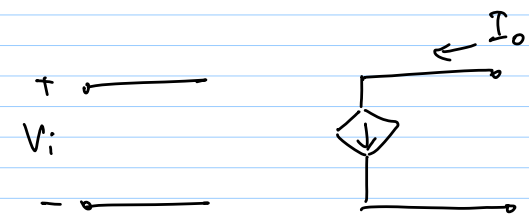
voltage controlled
voltage source
(VCVS)

$$V_o = k \cdot V_i$$

↖ v/v



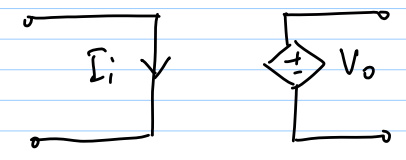
Voltage controlled Current Source (VCCS)



$$I_o = G_c \cdot V_i$$

↑
conductance

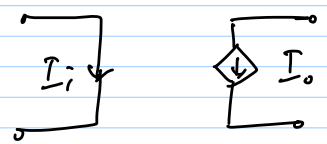
Current controlled voltage source (CCVS)



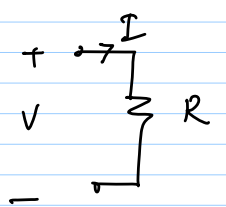
$$V_o = R_c \cdot I_i$$

↑
resistance

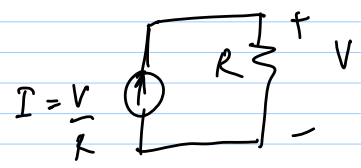
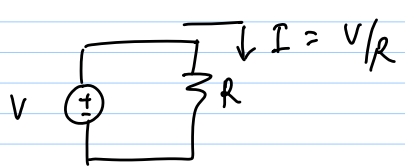
Current controlled current source (CCCS)



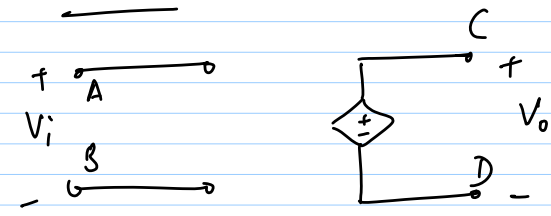
$$I_o = k \cdot I_i$$



$$V = IR$$



VCCVS



$$V_o = k V_i$$

$$V_i = \frac{V_o}{k} \text{ is}$$

only mathematically
valid

cause is V_{AB}
effect is V_{CD}

"Unilateral element"