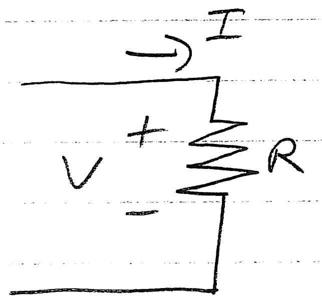
CIRCUIT REVIEW

OHMS LAW



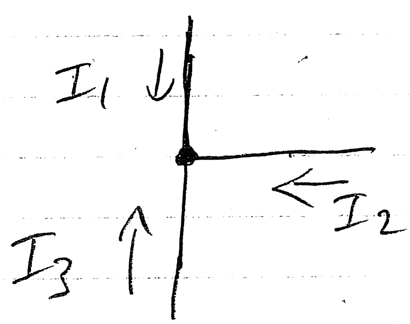
$$I = \frac{V}{R}$$

$$V = IR$$

* IMPORTANT TO GET V "±" CORRECT WITH RESPECT TO I "→"

POWER DISSIPATED $P = VI$

KCL (KIRCHHOFF CURRENT LAW)

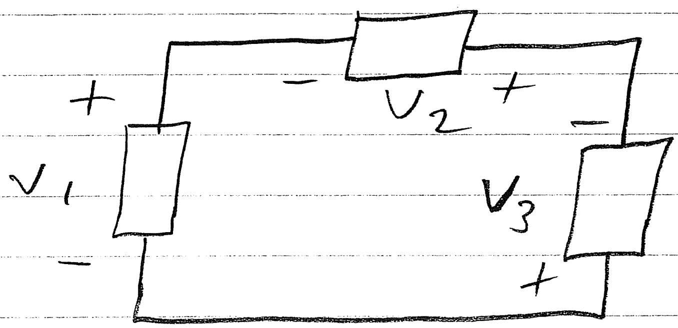


$$I_1 + I_2 + I_3 = 0$$

$$\sum_{k=1}^{n} I_k = 0$$

SUM OF CURRENTS FLOWING INTO A NODE EQUALS 0

KVL (KIRCHHOFF VOLTAGE LAW)



$$V_1 + V_2 + V_3 = 0$$

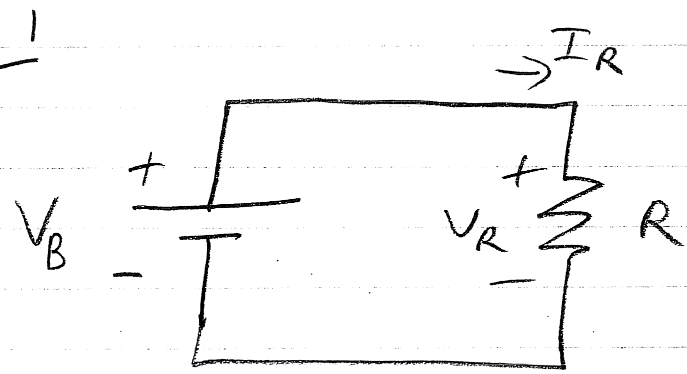
$$\sum_{k=1}^{n} V_k = 0$$

SUM OF VOLTAGES AROUND A LOOP EQUALS 0

GETTING SIGNS CORRECT

CAN DEFINE I (OR **V**) ANYWAY YOU WANT BUT MUST HAVE I, V FOR ONE DEVICE TO BE CONSISTENT

Ex 1



KVL

$$V_B - V_R = 0$$

$$V_R = V_B$$

$$I_R = \frac{V_R}{R}$$ ✓

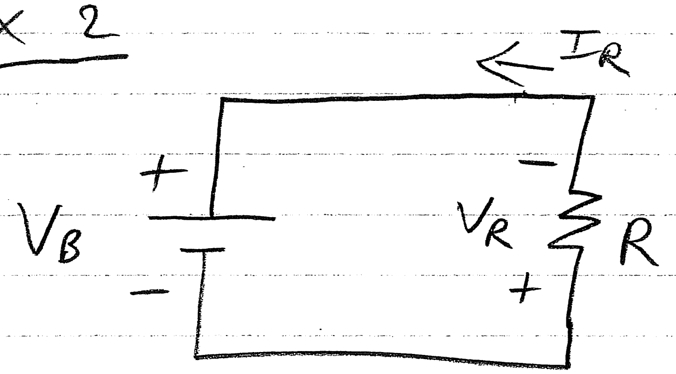
IF $V_B = +1V$

$R = 1\Omega \Rightarrow I_R = 1A$

$V_R = 1V$

CR3

Ex 2



KVL

$$V_B + V_R = 0$$

$$V_R = -V_B$$

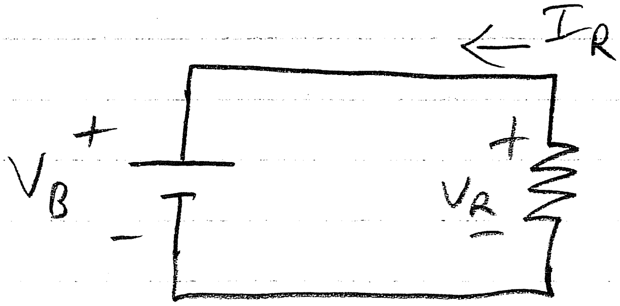
$$I_R = \frac{V_R}{R}$$

IF $V_B = 1V$, $R = 1\Omega$ $\Rightarrow$ $I_R = \frac{-1V}{1\Omega} = -1A$ ✓

$$V_R = -1V$$

Ex 3

WRONG — I_R, V_R INCONSISTENT



$$V_R = V_B$$

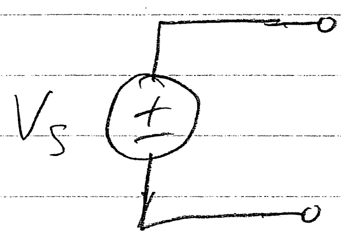
$$I_R = \frac{V_R}{R} \quad \times$$

IF $V_B = 1V$, $R = 1\Omega$ $\Rightarrow$ $I_R = 1A$ ✗

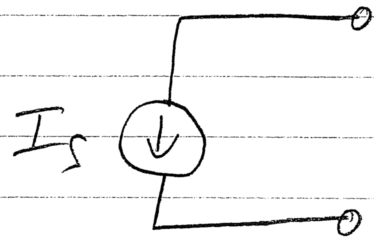
ACTUALLY $I_R = -1A$

COULD USE $I_R = \frac{-V_R}{R}$ BUT WHY NOT JUST GET DEVICE I, V CONSISTENT.

INDEPENDENT SOURCES

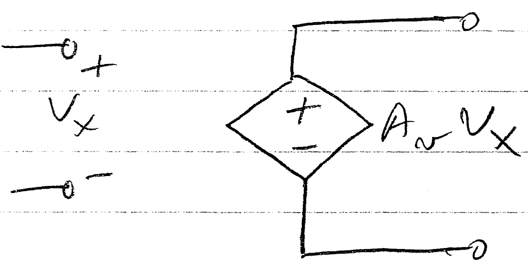


VOLTAGE



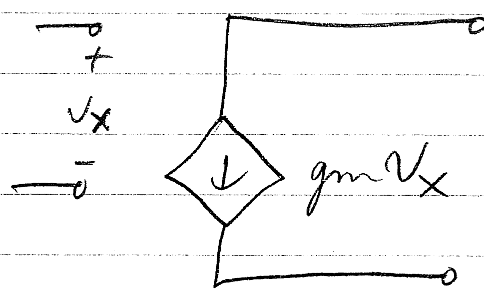
CURRENT

DEPENDENT SOURCES



VCVS

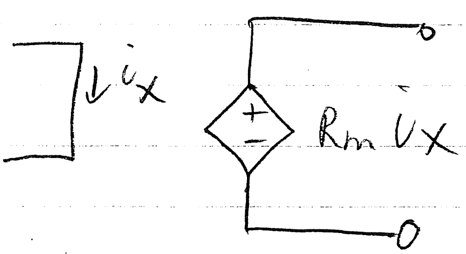
VOLTAGE CONTROLLED VOLTAGE SOURCE



g_m [Ω^{-1}]

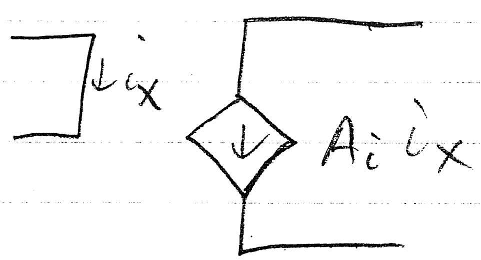
VCCS

VOLTAGE CONTROLLED CURRENT SOURCE



CCVS

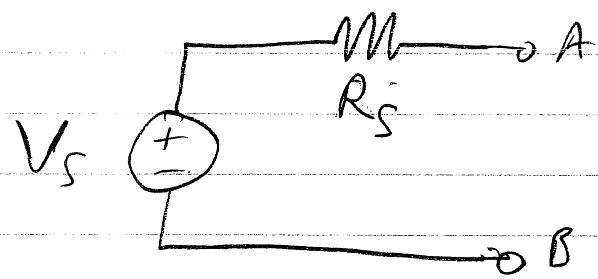
R_m [Ω]



CCCS

VOLTAGE SOURCE EQUIVALENT (THEVENIN EQUIVALENT)

A CIRCUIT OF VOLTAGE SOURCES, CURRENT SOURCES AND RESISTORS (INDEPENDENT + DEPENDENT SOURCES) CAN BE CONVERTED TO

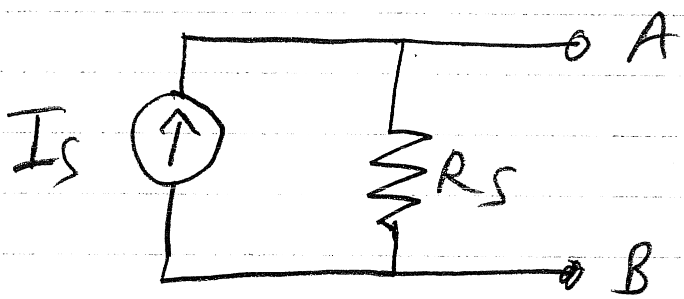


WHERE V_S IS OPEN CIRCUIT VOLTAGE, V_{OC} SEEN AT A−B & R_S IS RESISTANCE SEEN AT A−B WHEN <u>INDEPENDENT</u> SOURCES ARE <u>ZEROED</u>.

VOLTAGE SOURCE ZEROED ⇒ SHORT CIRCUIT
CURRENT " " OPEN "

CURRENT SOURCE EQUIVALENT (NORTON EQUIVALENT)

A VOLTAGE SOURCE EQUIVALENT CAN BE CONVERTED TO



$$I_S = V_S / R_S$$

I_S IS SHORT CIRCUIT CURRENT, I_{SC} AT A-B

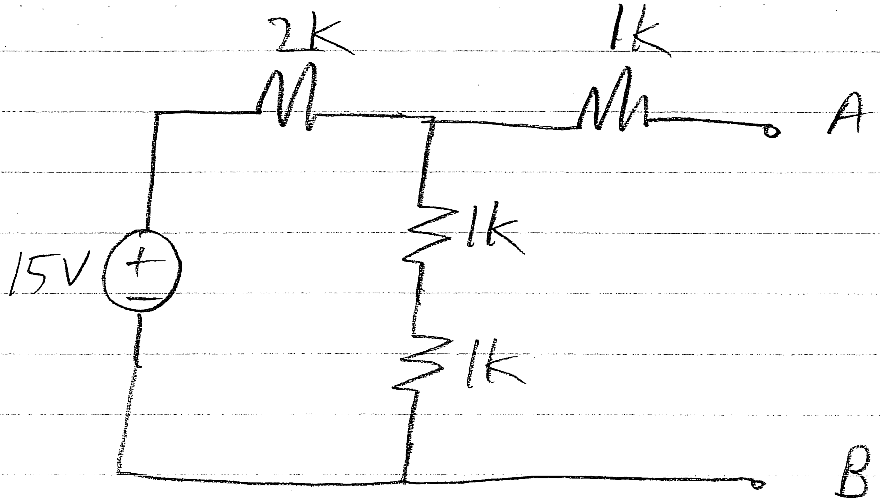
R_S IS RESISTANCE SEEN AT A-B WHEN INDEPENDENT SOURCES ARE <u>ZEROED</u>

NOTE $R_S = \dfrac{V_S}{I_S}$ OR $R_S = \dfrac{V_{OC}}{I_{SC}}$

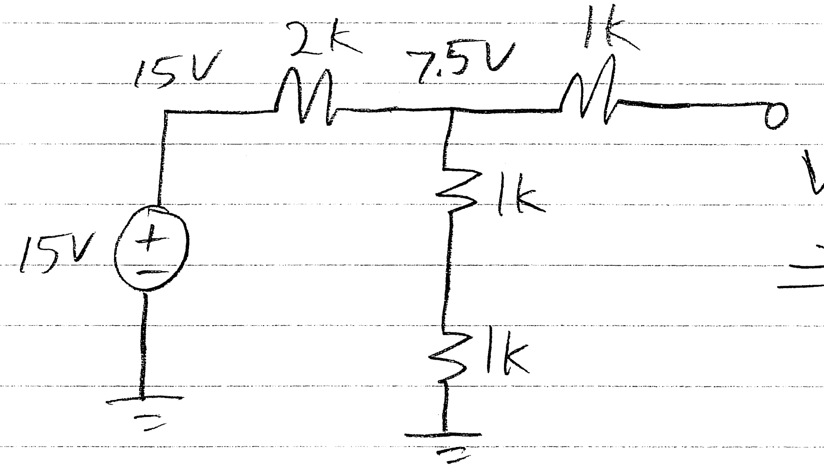
$V_{OC} \Rightarrow V_{AB}$ WHEN OPEN CIRCUIT

$I_{SC} \Rightarrow I_{AB}$ WHEN SHORT CIRCUIT

Ex



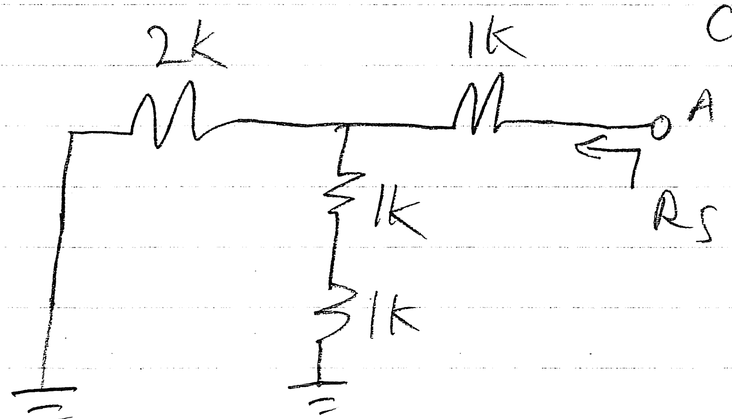
CALCULATE V_{oc}



$V_{oc} = 7.5V$

$\Rightarrow V_S = 7.5V$

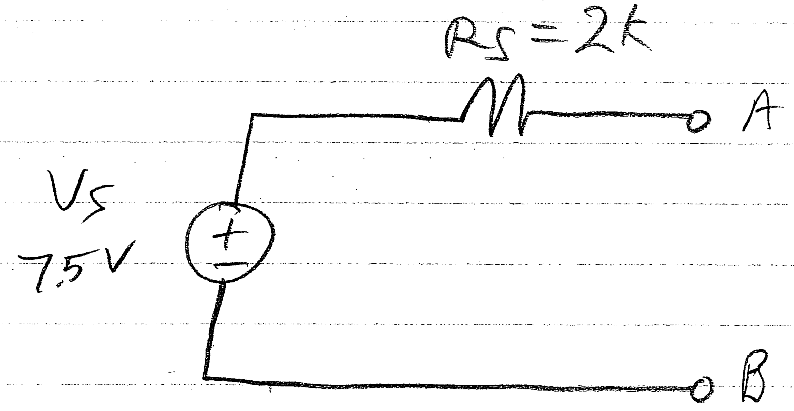
CALCULATE R_S

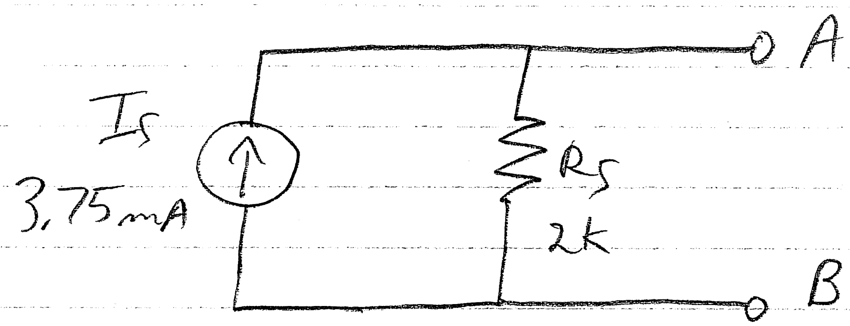


$R_S = 2K$

CR8

VOLTAGE SOURCE EQUIVALENT





$$I_S = \frac{V_S}{R_S} = 3.75\ mA$$

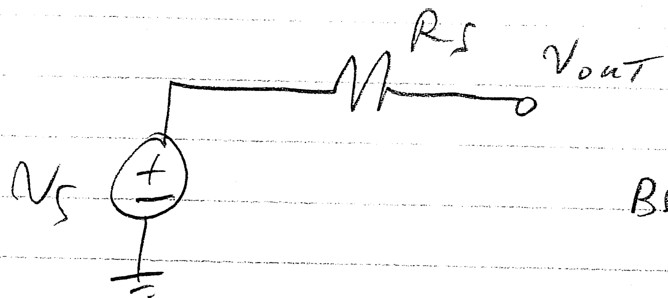
CR8A

WHEN TO USE VOLTAGE SOURCE OR CURRENT SOURCE?

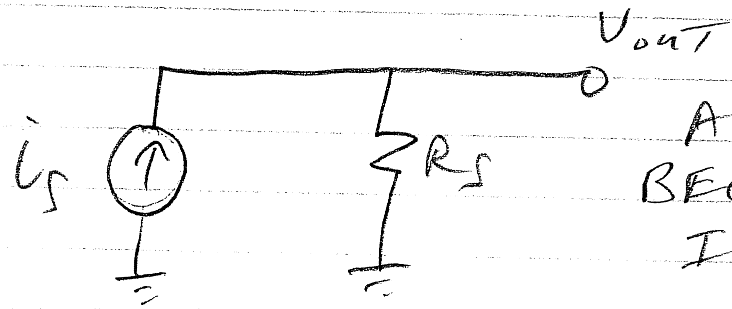
EITHER CAN BE USED BUT BETTER INSIGHT IF...

R_S SMALL => VOLTAGE SOURCE

R_S LARGE => CURRENT SOURCE



AS $R_S \to 0$ BECOMES MORE IDEAL



AS $R_S \to \infty$ BECOMES MORE IDEAL.

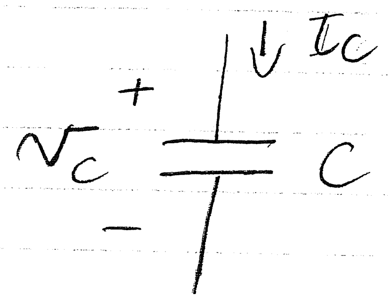
LARGE OR SMALL COMPARED TO NEXT STAGE INPUT RESISTANCE

THIS KEEPS VALUE OF "V_S" OR "i_S" A REASONABLE VALUE
(NOT UNREASONABLY LARGE)

CAPACITORS + INDUCTORS

CAPACITOR

CAPACITANCE C



$$q = C v_C$$

↑ CHARGE

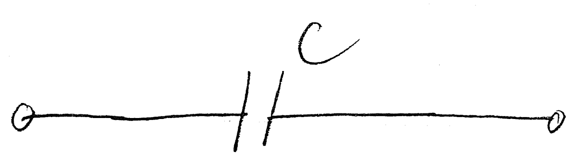
$$\frac{dq}{dt} = C \frac{dv_C}{dt}$$

$$i_C = C \frac{\Delta v_C}{\Delta t}$$ IF CONSTANT CURRENT I_C

CHARGE, q UNITS OF COULOMBS

CURRENT, i_L UNITS OF AMPS ⇒ COULOMBS/SECOND

CAPACITOR IMPEDANCE



$$Z = \frac{1}{sC}$$

s ⇒ LAPLACE TRANSFORM VARIABLE

LET $s = j\omega$ FOR SINUSOIDAL FREQUENCIES

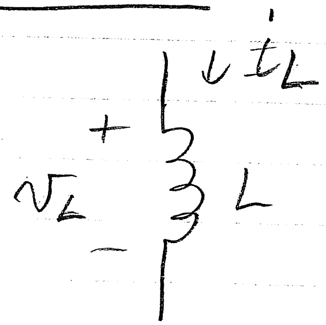
CR10

CAPACITOR ENERGY (POTENTIAL ENERGY) (STORED IN ELECTRIC FIELD)

$$E_C = \frac{1}{2} C v_C^2$$

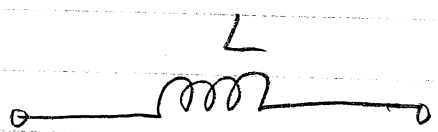
INDUCTOR

INDUCTANCE L



$$v_L = L \frac{di_L}{dt}$$

INDUCTOR IMPEDANCE



$$Z = sL$$

INDUCTOR ENERGY (POTENTIAL ENERGY) (STORED IN MAGNETIC FIELD)

$$E_L = \frac{1}{2} L i_L^2$$