

→ Thevenin Equivalent

Voltage Divider:  $V = \frac{R_L}{R_{th} + R_L} V_{th}$

Power dissipated in load  $R_L$ :

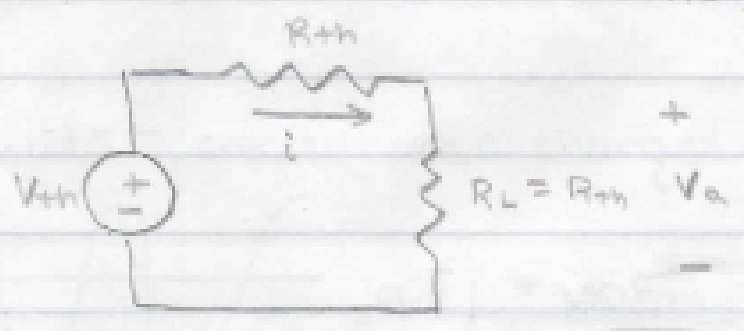
$$P_L = VI = \frac{V^2}{R_L} = \frac{1}{R_L} \left( \frac{R_L}{R_{th} + R_L} \right)^2 V_{th}^2$$

Differentiate to find extremum:

$$\frac{dP_L}{dR_L} = \frac{d}{dR_L} \left( \frac{R_L}{(R_{th} + R_L)^2} V_{th}^2 \right) = \left[ \frac{(R_{th} + R_L)^2 - 2R_L(R_{th} + R_L)}{(R_{th} + R_L)^2} \right] V_{th}^2 = 0$$

$$(R_{th}^2 - R_L^2) V_{th}^2 = 0$$

$R_L = R_{th} \rightarrow$  condition for max. power transfer



$$i = \frac{V_{th}}{2R_{th}}$$

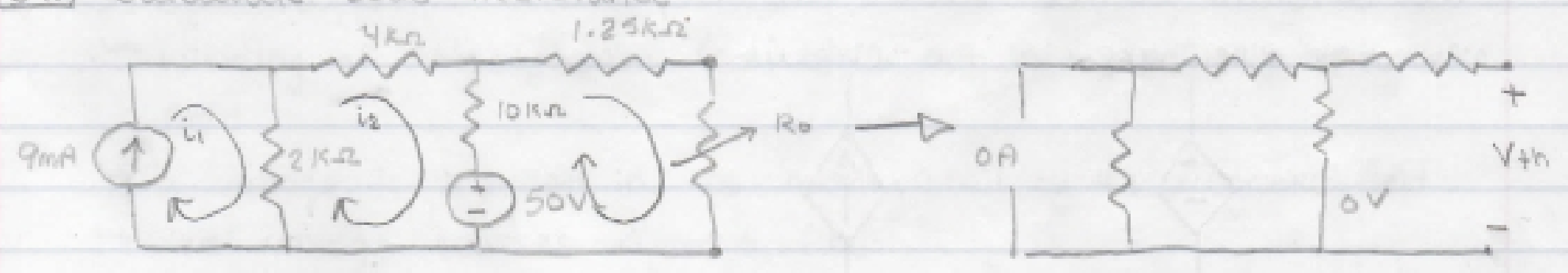
$$P_{max} = i^2 R_{th} = \frac{V_{th}^2}{4R_{th}}$$

↳ Max. power delivered

\* Maximum Power Transfer

March 2, 2015

Ex. Calculate Load Resistance



$$R_{th} = 1.25k\Omega + (10k\Omega) \parallel (2k\Omega + 4k\Omega)$$

$$= 5k\Omega$$



w/ Superposition:

1A Source

$$i_{o-1} = 1A, V_{o-1} = 1A(4\Omega) = 4V$$

2A Source

$$i_{o-2} = 2A, V_{o-2} = 2A(4\Omega) = 8V$$

3A Source

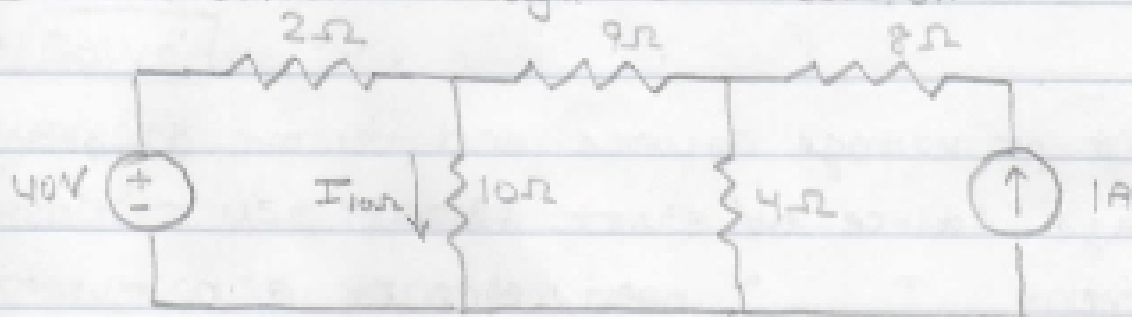
$$i_{o-3} = 3A, V_{o-3} = 3A(4\Omega) = 12V$$

$$\Rightarrow V_o = V_{o-1} + V_{o-2} + V_{o-3} \\ = 24V$$

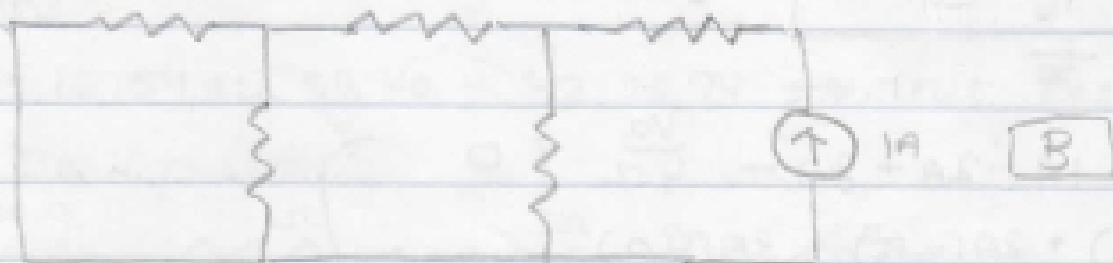
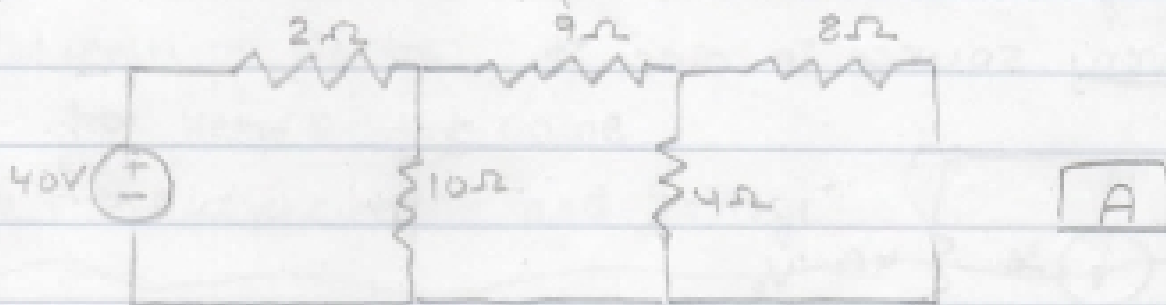
$$i_o = i_{o-1} + i_{o-2} + i_{o-3} \\ = 6A$$

Same as NVM

**Ex.** Find current through  $10\Omega$  resistor

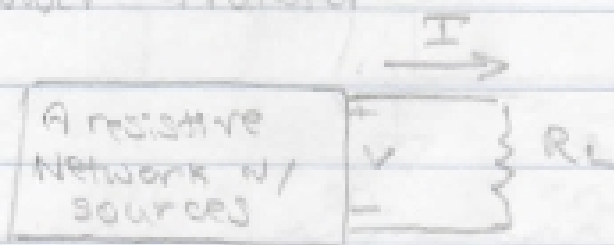


\* Replace sources w/ open/shorts

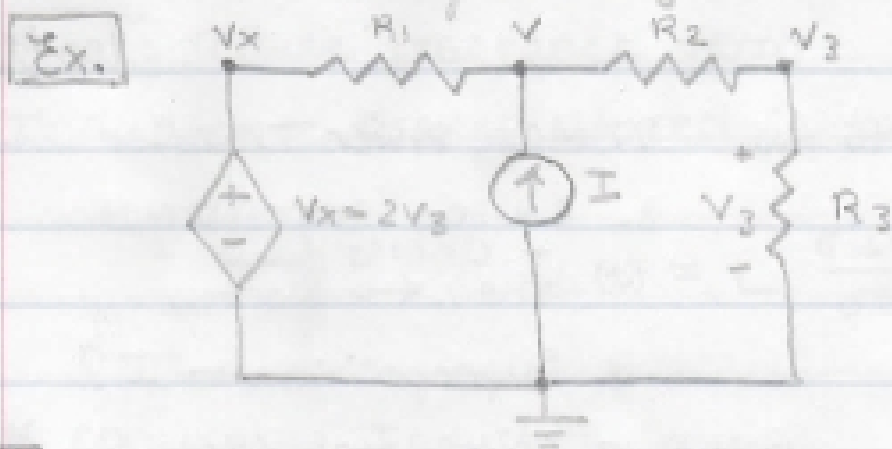


\* Solve for each circuit

\* Max. Power Transfer



- Each device will add another equation to the mesh current or node voltage analysis



If  $V_s = 2.5V$ ,  $V_x = 5V$

$n = 4, m = 1$

$n - 1 - m = 2 + 1 + 1 = 4$

### \* AC Circuits

$V = IZ$  [V]

↳ impedance [ $\Omega$ ]

$Z = \sqrt{R^2 + X^2}$

↳ reactance [ $\Omega$ ]

$X_L - X_C$   
 $(\omega L - \frac{1}{\omega C})$

$j(2\pi fL - \frac{1}{2\pi fC})$

L: inductance [mH]

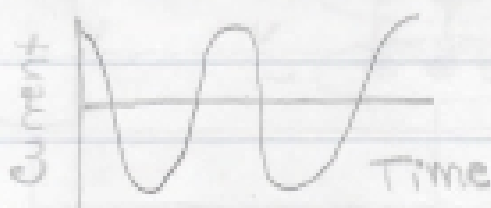
C: capacitance [ $\mu F$ ]

$\omega$ : angular frequency

f: frequency [Hz]

$j = \sqrt{-1}$

AC Circuits - current can change magnitude and direction over time



\* voltage changes over time too

• Why do AC currents occur?

- Generator Operation

↳ winding of a generator (coil of wire) is turned in a magnetic field

↳ a voltage is induced in the moving coil by the magnetic field

↳ the voltage causes current flow