ELECTRIC CIRCUTS ECSE-2010

Lecture 2.1

## LECTURE 2.1 AGENDA

- Series and Parallel Connections
- Equivalent Circuits
- Series and Parallel Resistors
- Voltage and Current Dividers



## EQUIVALENT CIRCUITS

- Circuit analysis is often much easier if we replace a circuit with an equivalent (usually simpler) circuit:
- 2 Circuits are EQUIVALENT if they have the Same I-V Characteristics at a specified pair of terminals:
- Replace a circuit with its equivalent resistance:
- Let's first look at series and parallel resistors:
$\qquad$
$\qquad$ (4) Rensselaer

RESISTORS IN SERIES
 => They are in Series


## RESISTORS IN SERIES



$$
\mathrm{R}_{\mathrm{eq}}=\mathrm{R}_{1}+\mathrm{R}_{2}
$$

$\qquad$
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RESISTORS IN PARALLEL

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## RESISTORS IN PARALLEL



$$
\frac{1}{\mathrm{R}_{\mathrm{eq}}}=\frac{1}{\mathrm{R}_{1}}+\frac{1}{\mathrm{R}_{2}} \quad \mathrm{R}_{\mathrm{eq}}=\frac{\mathrm{R}_{1} \mathrm{R}_{2}}{\mathrm{R}_{1}+\mathrm{R}_{2}}
$$ (2)Rensselaer ©

## RESISTORS IN PARALLEL

For More than 2 Resistors in Parallel:
$\frac{1}{\mathrm{R}_{\mathrm{eq}}}=\frac{1}{\mathrm{R}_{1}}+\frac{1}{\mathrm{R}_{2}}+\frac{1}{\mathrm{R}_{3}}+\ldots$.

Usually Easier to Reduce 2 in Parallel at a Time

## RESISTORS IN SERIES


$v_{1}=i R_{1}=\left(\frac{v}{R_{\text {eq }}}\right) R_{1}=\left(\frac{R_{1}}{R_{1}+R_{2}}\right) v ; \quad v_{2}=i R_{2}=\left(\frac{R_{2}}{R_{1}+R_{2}}\right) v$
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## VOLTAGE DIVIDER RULE

$\mathrm{v}_{1}=\left(\frac{\mathrm{R}_{1}}{\mathrm{R}_{1}+\mathrm{R}_{2}}\right) \mathrm{v} ; \quad \mathrm{v}_{1} \sim \mathrm{R}_{1}$
$v_{2}=\left(\frac{R_{2}}{R_{1}+R_{2}}\right) v ; v_{2} \sim R_{2}$

Only Works for Resistors in Series

## RESISTORS IN PARALLEL



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## RESISTORS IN PARALLEL



## CURRENT DIVIDER RULE

$$
\begin{aligned}
& i_{1}=\frac{R_{2}}{R_{1}+R_{2}} i ; i_{1} \sim R_{2} \\
& i_{2}=\frac{R_{1}}{R_{1}+R_{2}} i ; \quad i_{2} \sim R_{1}
\end{aligned}
$$

Only Works for Resistors in Parallel
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## LECTURE 2.2 AGENDA

- Equivalent Sources
- Circuit Reduction/Ladder Networks
- Examples



## EQUIVALENT SOURCES



Sometimes makes circuits simpler; Not always

## EQUIVALENT SOURCES



## EQUIVALENT SOURCES



## CIRCUIT REDUCTION

-Whenever possible, replace series and parallel resistors with their equivalent resistance:

- Whenever possible, replace series voltage sources and parallel current sources with their equivalent sources:
-Sometimes, replace voltage source, $\mathrm{v}_{\mathrm{s}}$, in series with a resistor, $\mathrm{R}_{\mathrm{s}}$, with a current source of $i_{s}=v_{s} / R_{s}$, in parallel with resistor, $\mathrm{R}_{\mathrm{s}}$


## SUMMARY

Voltage Divider Rule

$$
\begin{aligned}
& \mathrm{v}_{1}=\left(\frac{\mathrm{R}_{1}}{\mathrm{R}_{1}+\mathrm{R}_{2}}\right) \mathrm{v} \\
& \mathrm{v}_{2}=\left(\frac{\mathrm{R}_{2}}{\mathrm{R}_{1}+\mathrm{R}_{2}}\right) \mathrm{v}
\end{aligned}
$$



Only Works for Resistors in Series

## SUMMARY

## Current Divider Rule

$$
\begin{aligned}
& i_{1}=\frac{R_{2}}{R_{1}+R_{2}} i \\
& i_{2}=\frac{R_{1}}{R_{1}+R_{2}} i
\end{aligned}
$$



Only Works for Resistors in Parallel


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