

**BASIC
ELECTRICITY
AND
ELECTRONICS 1**

JIM PYTEL

Open Oregon Educational Resources



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CONTENTS

<u>Introduction</u>	1
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UNIT 1: PREREQUISITES

<u>DC Math</u>	5
<u>Engineering Notation and Prefixes</u>	6
<u>General Industrial Safety</u>	7
<u>Unit Conversion</u>	8

UNIT 2: BASIC ELECTRICAL PROPERTIES

<u>Energy and Power</u>	11
<u>Energy and Power Examples</u>	12
<u>Efficiency</u>	13
<u>Efficiency Examples</u>	14
<u>Capacity Factor</u>	15

<u>Capacity Factor Examples</u>	16
<u>Basic Electrical Quantities</u>	17
<u>Power Generation, Transmission, and Use</u>	18

UNIT 3: RESISTANCE

<u>Resistance</u>	21
<u>4 Band Resistor Color Code</u>	22
<u>Series Resistors</u>	23
<u>Parallel Resistors</u>	24
<u>Ohmmeters: BK Precision 2831E</u>	25
<u>Ohmmeters: Fluke 87</u>	27
<u>Variable Resistors</u>	29
<u>Prototyping Boards</u>	30

UNIT 4: DC OHM'S LAW

<u>DC Ohm's Law</u>	33
<u>DC Power</u>	34
<u>DC Ohm's Law and Power Examples</u>	35
<u>DC Voltmeters: BK Precision 2831E</u>	36
<u>DC Voltmeters: Fluke 87 V</u>	37
<u>DC Power Supplies</u>	38

<u>DC Ammeters: BK Precision 2831E</u>	39
<u>Verifying DC Ohm's Law</u>	40
<u>Electrical Safety and Ohm's Law</u>	41

UNIT 5: SERIES DC CIRCUIT ANALYSIS

<u>Series DC Circuits</u>	45
<u>DC Kirchhoff's Voltage Law</u>	46
<u>DC Voltage Divider Rule</u>	47
<u>Switches in Series DC Circuits</u>	48
<u>Circuit Protection Devices</u>	49

UNIT 6: PARALLEL DC CIRCUITS

<u>Parallel DC Circuits</u>	53
<u>DC Kirchhoff's Current Law</u>	54
<u>DC Current Divider Rule</u>	55
<u>DC Current Sources</u>	56

UNIT 7: SERIES-PARALLEL DC CIRCUIT ANALYSIS

<u>Series-Parallel DC Circuit Analysis</u>	59
<u>DC Source Conversion</u>	60
<u>DC Voltage Divider Circuits</u>	61
<u>Instrument Loading Effects</u>	62

<u>Resistive Delta-Y Conversions</u>	63
<u>Complex DC Circuit Analysis</u>	64
<u>UNIT 8: DC CIRCUIT ANALYSIS THEOREMS</u>	
<u>DC Superposition Theorem</u>	67
<u>DC Thevenin's Theorem</u>	68
<u>DC Norton's Theorem</u>	69
<u>DC Maximum Power Transfer Theorem</u>	70
<u>Appendix</u>	71

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This course is the 1st in a three part series intended to support the flipped classroom approach for traditional basic electronics classes. Basic Electronics 1 covers the order of operations, algebraic manipulation, engineering prefixes, unit conversion, general industrial safety, energy, power, efficiency, capacity factor, basic electrical properties: voltage, current, resistance, fixed resistors, variable resistors, protoboards, ohmmeters, series resistors, parallel resistors, 4 band resistor color code, DC

Ohm's Law, DC power, voltmeters, ammeters, series DC circuit properties, DC Kirchhoff's Voltage Law, DC voltage divider rule, parallel DC circuit properties, DC Kirchhoff's Current Law, DC current divider rule, series-parallel DC circuit properties, instrument loading effects, DC current sources, source conversion, resistive delta-Y conversion, complex DC circuits, DC Superposition Theorem, DC Thevenin's Theorem, DC Maximum Power Transfer Theorem, and DC Norton's Theorem.

UNIT 1:

PREREQUISITES

Objective: Demonstrate understanding of the order of operations, algebraic manipulation, negative and fractional exponents, scientific calculators, rounding, engineering prefixes, unit conversion, and general industrial safety.

DC MATH

DC Math

Objective - Review the order of operations, negative and fractional exponents, algebraic manipulations, scientific calculators, and rounding as applied to DC circuit analysis.

① $E = V_1 + V_2 + V_3$
 $E = 12V$
 $V_1 = 4V$
 $V_3 = 3V$
 $V_2 = ?$

② $A = \frac{E}{R}$
 $I = ?$
Solve for A in terms of E and R

③ Use results of ② to solve for A in terms of E

④ $I = \frac{E}{R}$
 $E = 12V$
 $I = 2A$
 $R = ?$

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

$R \cdot I = E$

$\frac{R \cdot I}{I} = \frac{E}{I}$

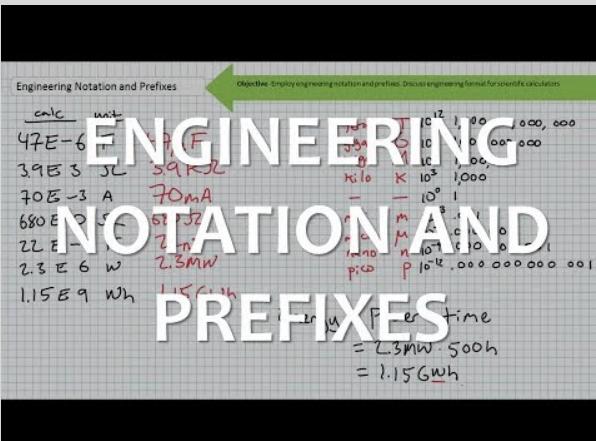
$R = \frac{E}{I}$



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DC Math Study Guide

ENGINEERING NOTATION AND PREFIXES



Engineering Notation and Prefixes

Objectives: Employ engineering notation and prefixes. Discuss engineering format for scientific calculations.

calc units

47E-6 T $\frac{47}{10^6}$ F

3.9E3 JL 3.9×10^3 KJ

70E-3 A 70×10^{-3} mA

680E0 J 680×10^0 J

22 E-7 m 22×10^{-7} m

2.3 E 6 W 2.3×10^6 MW

1.15E9 Wh 1.15×10^9 Wh

Engineering
NOTATION AND
PREFIXES

per time
 $= 2.3 \text{MW} \times 500 \text{h}$
 $= 1.15 \text{GWh}$

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[Engineering Notation and Prefixes Study Guide](#)

GENERAL INDUSTRIAL SAFETY



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electronics1/?p=36](https://openoregon.pressbooks.pub/electronics1/?p=36)*

[General Industrial Safety Study Guide](#)

UNIT CONVERSION

Unit Conversion Objectives: Convert between two different systems of units. Convert between units employing different engineering prefixes.

$$746 \text{ W} = 1 \text{ hp}$$
$$550 \frac{\text{ft.lbf}}{\text{s}} = 1 \text{ hp}$$

UNIT CONVERSION

$$60 \cancel{\text{hp}} \left(\frac{746 \text{ W}}{1 \text{ hp}} \right) = 44,760 \text{ W} = 44.76 \text{ kW}$$
$$60 \cancel{\text{hp}} \left(\frac{550 \frac{\text{ft.lbf}}{\text{s}}}{1 \text{ hp}} \right) = 33,000 \frac{\text{ft.lbf}}{\text{s}}$$

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[Unit Conversion Study Guide](#)

UNIT 2: BASIC ELECTRICAL PROPERTIES

Objective: Demonstrate understanding of energy, power, efficiency, capacity, voltage, current, and resistance.

ENERGY AND POWER



**ENERGY AND
POWER**

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[Energy and Power Study Guide](#)

ENERGY AND POWER EXAMPLES

Energy and Power Examples

OBJECTIVE: Learn the different examples of energy and power calculations.

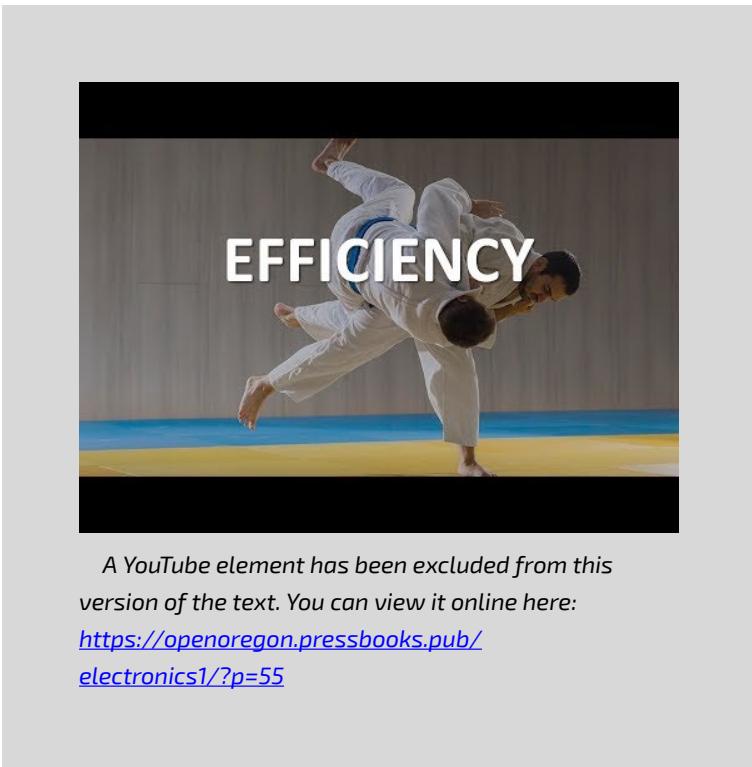
TECHNOTRON

ENERGY AND POWER EXAMPLES

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[Energy and Power Examples Study Guide](#)

EFFICIENCY



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<https://openoregon.pressbooks.pub/electronics1/?p=55>*

[Efficiency Study Guide](#)

EFFICIENCY EXAMPLES

The slide is titled "Efficiency Examples" and includes the "OBJECTIVE" statement: "Demonstrate illustrated examples of efficiency calculations." It features a "VOCABULARY" section with the word "EFFICIENCY" in large letters.

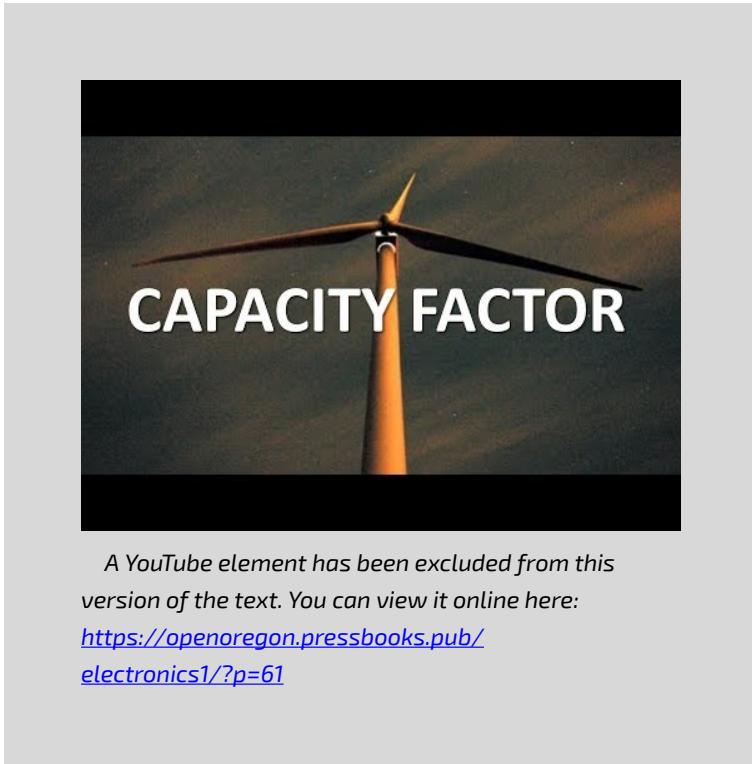
The diagram illustrates the calculation of efficiency through a series of components:

- Input:** 12kW (represented by a sun icon)
- Module:** 1000W/m² (8 modules, AREA = 1.5m²) → 12kW (labeled "15% EFFICIENT")
- Inverter:** 1250W → 1250W = 1250W (labeled "100% EFFICIENT")
- Losses:** 1250W → 1250W = 1250W (labeled "10% LOSSES")
- Output:** 1125W (labeled "100% EFFICIENT")
- Efficiency Formula:** $\text{TOTAL EFFICIENCY} = \frac{\text{OUT}_{\text{P}}}{\text{IN}_{\text{P}}} = \frac{1125\text{W}}{12\text{kW}} = .1429 \rightarrow 14.3\%$
- Efficiency Breakdown:** $\text{TOTAL EFFICIENCY} = \text{EFFICIENCY}_1 \cdot \text{EFFICIENCY}_2 \cdot \text{EFFICIENCY}_3 \cdots$
= .15 \cdot .172 \cdot .98 \cdot .1429 \rightarrow 14.3\%

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[Efficiency Examples Study Guide](#)

CAPACITY FACTOR



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electronics1/?p=61](https://openoregon.pressbooks.pub/electronics1/?p=61)*

[Capacity Factor Study Guide](#)

CAPACITY FACTOR EXAMPLES

Capacity Factor Examples

OBJECTIVE: Provide illustrative examples of capacity factor calculations.



CAPACITY FACTOR EXAMPLES

70MW 45% CF

$DD = CF \cdot CWD$
 $= 45\% \cdot 24$
 $= 10.8\text{h}$

$\text{ENERGY} = \text{POWER} \cdot \text{TIME}$
 $= 70\text{MW} \cdot 10.8\text{h}$
 $= 756\text{MWh}/\text{Day}$

$756\text{MWh}/\text{Day} \cdot 365 \frac{\text{days}}{\text{Year}} = 275,940\text{MWh}$
 $= 275.9 \text{GWh}$

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[Capacity Factor Examples Study Guide](#)

BASIC ELECTRICAL QUANTITIES



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[Basic Electrical Quantities Study Guide](#)

POWER GENERATION, TRANSMISSION, AND USE



**POWER GENERATION,
TRANSMISSION, AND
USE**

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electronics1/?p=69](https://openoregon.pressbooks.pub/electronics1/?p=69)

UNIT 3: RESISTANCE

Objective: Demonstrate understanding of resistance, differentiate between conductors and insulators, calculate resistance of conductors of various dimensions and material composition, interpret the 4 band resistor color code, calculate the total resistance of series and parallel combinations of resistors, learn to use potentiometers, protoboards, and ohmmeters.

RESISTANCE



RESISTANCE

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[Resistance Study Guide](#)

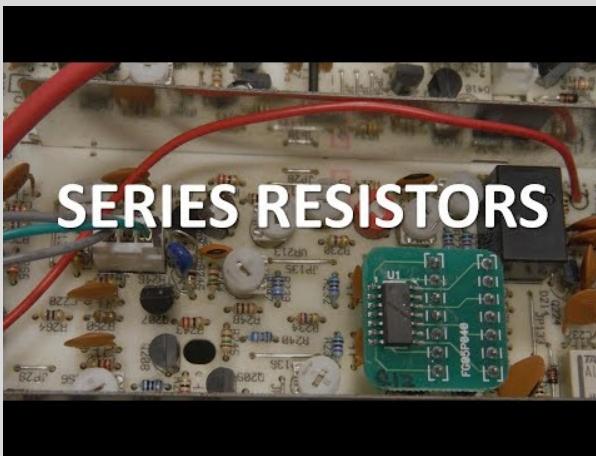
4 BAND RESISTOR COLOR CODE



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electronics1/?p=78](https://openoregon.pressbooks.pub/electronics1/?p=78)*

[Resistor Color Code Study Guide](#)

SERIES RESISTORS



SERIES RESISTORS

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[Series Resistors Study Guide](#)

PARALLEL RESISTORS



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[Parallel Resistors Study Guide](#)

OHMMETERS: BK PRECISION 2831E



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[Ohmmeters BK Precision 2831E Study Guide](#)



OHMMETER DEMONSTRATION

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electronics1/?p=87](https://openoregon.pressbooks.pub/electronics1/?p=87)

OHMMETERS: FLUKE 87



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[Ohmmeters Fluke 87V Study Guide](#)

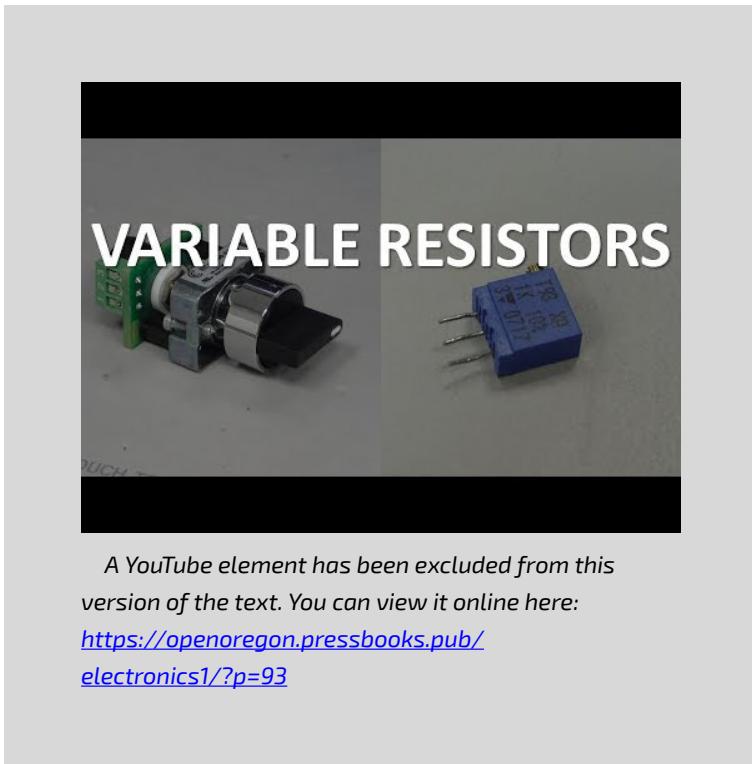


OHMMETER DEMONSTRATION

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electronics1/?p=276](https://openoregon.pressbooks.pub/electronics1/?p=276)

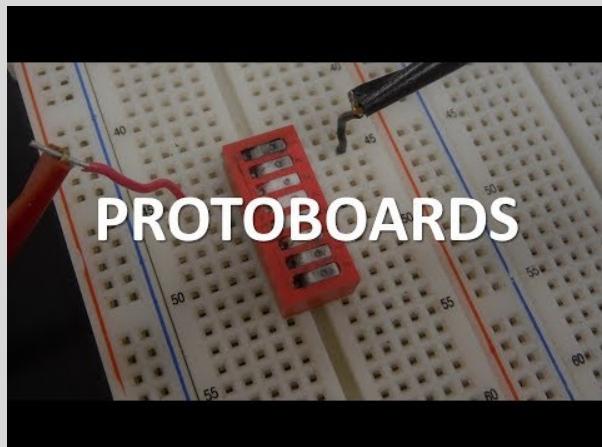
VARIABLE RESISTORS



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[Variable Resistors Study Guide](#)

PROTOTYPING BOARDS



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[Protoboards Study Guide](#)

UNIT 4: DC OHM'S LAW

Objective: Demonstrate understanding of Ohm's Law and the power equations and use these relationships to calculate expected observations of desired electrical properties. Use a DMM in voltmeter and ammeter mode to measure voltage and current.

DC OHM'S LAW



DC OHM'S LAW

A portrait of Georg Simon Ohm, a German physicist and mathematician, is overlaid with the text "DC OHM'S LAW".

The portrait shows a man with curly hair, wearing a dark coat over a white shirt and a bow tie. The background is dark and textured.

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[DC Ohms Law Study Guide](#)

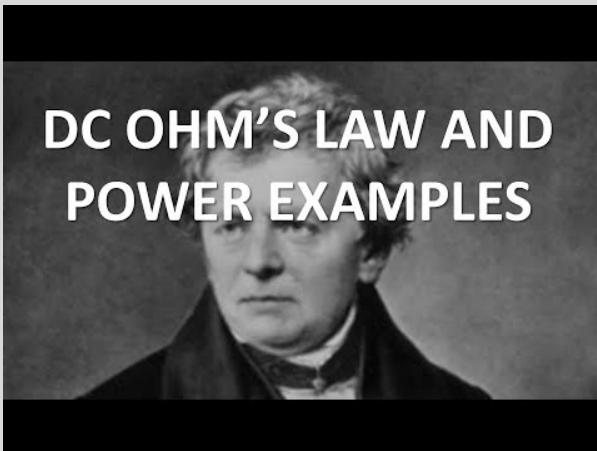
DC POWER



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<https://openoregon.pressbooks.pub/electronics1/?p=230>*

[DC Power Study Guide](#)

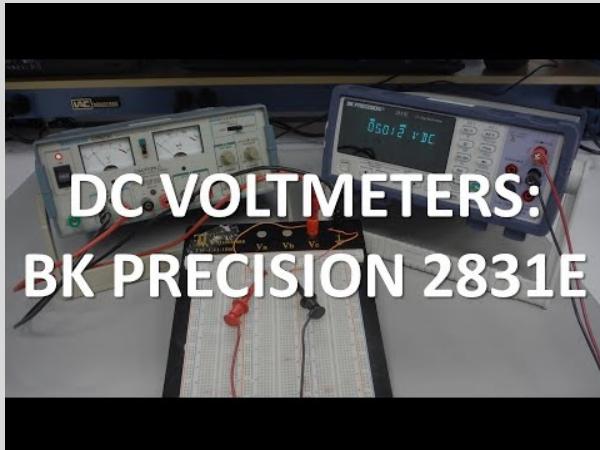
DC OHM'S LAW AND POWER EXAMPLES



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[DC Ohms Law and Power Examples Study Guide](#)

DC VOLTMETERS: BK PRECISION 2831E



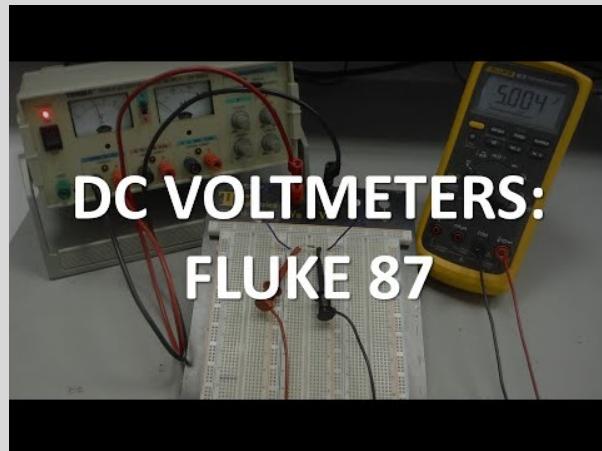
**DC VOLTMETERS:
BK PRECISION 2831E**

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[DC Voltmeters BK Precision 2831E Study Guide](#)

DC VOLTMETERS: FLUKE 87

V



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[DC Voltmeters Fluke 87 Study Guide](#)

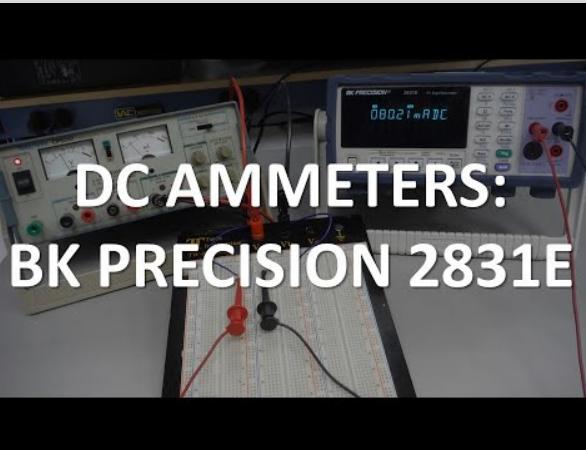
DC POWER SUPPLIES



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[DC Power Supplies Study Guide](#)

DC AMMETERS: BK PRECISION 2831E



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[DC Ammeters BK Precision 2831E Study Guide](#)

VERIFYING DC OHM'S LAW



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[Verifying DC Ohms Law Study Guide](#)

ELECTRICAL SAFETY AND OHM'S LAW



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[Electrical Safety and Ohm's Law Study Guide](#)

UNIT 5: SERIES DC CIRCUIT ANALYSIS

Objective: Demonstrate understanding of basic series DC circuit properties and Kirchhoff's Voltage Law, make use of the DC voltage divider rule, understand the purpose of switches and circuit protection devices in series circuits, use circuit simulation software, and employ instrumentation in a series circuit to verify series circuit properties.

SERIES DC CIRCUITS

Basic Series Circuits

Objective - Examine series electrical relationships and discuss basic properties for series configurations. Learn that current anywhere in a series path is the same and make use of this property to unknown quantities.

$R_T = 510 + 160 + 240 = 910 \Omega$

$I_S = \frac{18V}{910} = 20mA$

$(20mA) 510 = 10.2V \quad 204mW$

$(20mA) 160 = 3.2V \quad 64mW$

$(20mA) 240 = 4.8V \quad 144mW$

$R_1 = 3.2\Omega \quad R_2 = 4.8\Omega \quad R_3 = 160\Omega \quad R_4 = 240\Omega$

$E = 18V$

$P_1 = E^2/R_1 = 18^2/3.2 = 10.2W$

$P_2 = E^2/R_2 = 18^2/4.8 = 7.2W$

$P_3 = U_3 I_3 = U_3^2/R_3 = 160^2/160 = 160W$

$P_4 = U_4 I_4 = U_4^2/R_4 = 240^2/240 = 240W$

$\rightarrow U_1 = U_2 = U_3 = U_4$

$\rightarrow U_1 = U_2 = U_3 = U_4 = 18V$

$\rightarrow U_1 = 3.2V \quad U_2 = 4.8V \quad U_3 = 160V \quad U_4 = 240V$

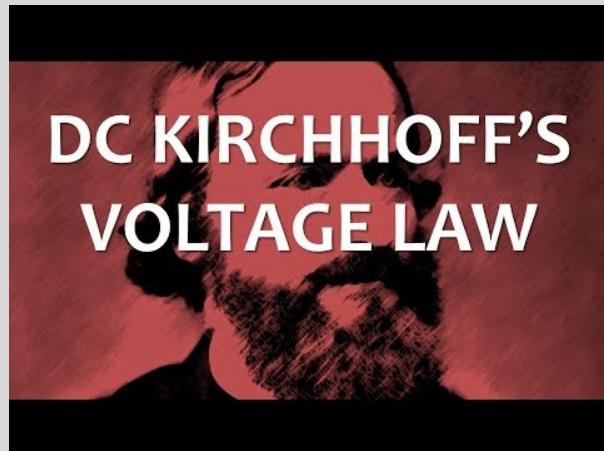
$\rightarrow E = U_1 + U_2 + U_3 + U_4$

SERIES DC CIRCUITS

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[DC Series Circuits Study Guide](#)

DC KIRCHHOFF'S VOLTAGE LAW



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electronics1/?p=147](https://openoregon.pressbooks.pub/electronics1/?p=147)

[DC Kirchhoffs Voltage Law Study Guide](#)

DC VOLTAGE DIVIDER RULE

Basic Voltage Divider Rule

Objective - Apply the voltage divider rule to simple series circuits to quickly and directly solve for unknown voltage quantities without having to solve for intermediate current and total resistance values.

$I_3 = I_2 = I_1$

$V_3 = I_2 R_3$

$V_2 = I_2 R_2$

$V_1 = I_2 R_1$

$E = I \cdot (R_1 + R_2 + R_3) = I \cdot R_1$

$R_T = R_1 + R_2 + R_3$

$P_T = P_1 + P_2 + P_3$

$I_2 = V_2 / R_2 = 9V / 900\Omega = 20mA$

$V_3 = \frac{R_3}{R_1 + R_2 + R_3} E = \frac{450}{(1.8k + 900 + 450)} 63V = \frac{450}{3150} 63V = 9V$

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SWITCHES IN SERIES DC CIRCUITS

Switches

Objective: Examining the electromechanical device known as this switch and discuss the purpose and observable electrical characteristics of switches in the open and closed position. Discuss important switch terminology.

$E = 20V$
 $R_1 = 200\Omega$
 $R_2 = 120\Omega$
 $R_3 = 0\Omega$
 $I = 0A$
Switch closed
Switch open
Voltage across each component
Current flowing through each component
Voltage drop across each component
Total current flowing through the circuit
Total voltage across the circuit

$V_{12} = R_1 I$
 $R_1 = \frac{V_{12}}{I} = \frac{8V}{0.04A} = 200\Omega$
 $I_1 = \frac{V_{12}}{R_1} = \frac{8V}{200\Omega} = 0.04A$
 $V_1 = I_1 R_1 = 0.04A \cdot 200\Omega = 8V$
 $V_{23} = R_2 I$
 $R_2 = \frac{V_{23}}{I} = \frac{12V}{0.04A} = 300\Omega$
 $I_2 = \frac{V_{23}}{R_2} = \frac{12V}{300\Omega} = 0.04A$
 $V_2 = I_2 R_2 = 0.04A \cdot 300\Omega = 12V$
 $V_{13} = R_1 I + R_2 I$
 $R_1 + R_2 = 200\Omega + 300\Omega = 500\Omega$
 $I_3 = \frac{V_{13}}{R_1 + R_2} = \frac{20V}{500\Omega} = 0.04A$
 $V_3 = I_3 R_3 = 0V$
 $E = V_1 + V_2 + V_3 = 8V + 12V + 0V = 20V$

J $R_T = R_1 + R_2 + 0$
 $= 500\Omega$

J $I_1 = I_2 = I_3 = 0.04A$

J $V_1 = I_1 R_1 = 0.04A \cdot 200\Omega = 8V$

J $I_2 = I_3 = 0.04A$

J $V_2 = I_2 R_2 = 0.04A \cdot 300\Omega = 12V$

J $V_3 = 0V$

J $E = V_1 + V_2 + V_3 = 8V + 12V + 0V = 20V$

SWITCHES IN SERIES DC CIRCUITS

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Switches Study Guide

CIRCUIT PROTECTION DEVICES



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electronics1/?p=158](https://openoregon.pressbooks.pub/electronics1/?p=158)*

[Circuit Protection Devices Study Guide](#)

UNIT 6: PARALLEL DC CIRCUITS

Objective: Demonstrate understanding of basic parallel DC circuit properties and Kirchhoff's Current Law, make use of the current divider rule, use circuit simulation software, and employ instrumentation in a parallel circuit to verify parallel circuit properties.

PARALLEL DC CIRCUITS

Basic Parallel Circuits

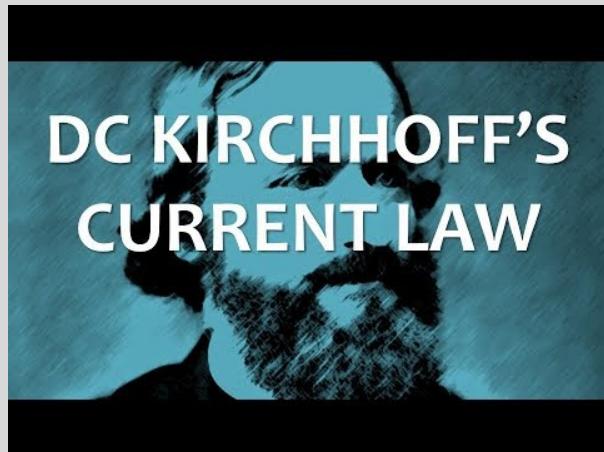
Objective - Examine basic parallel properties and learn how voltage, current and power is distributed within a parallel circuit.
Discuss instrumentation used to measure parallel circuit properties and parallel circuit applications.

$V_{ab} = 12\text{V}$ $I_{ab} = 1\text{A}$ $I_1 = \frac{V}{R_1} = \frac{12}{12} = 1\text{A}$
 $I_2 = I_{ab} - I_1 = 1 - 1 = 0\text{A}$ $I_2 = \frac{V}{R_2} = \frac{12}{24} = 0.5\text{A}$
 $P_{ab} = V_{ab} I_{ab} = \frac{12^2}{12} = 12\text{W}$
 $P_1 = V_{ab} I_1 = \frac{12^2}{12} = 12\text{W}$
 $P_2 = V_{ab} I_2 = \frac{12^2}{24} = 6\text{W}$
 $P_{ab} = P_1 + P_2 = 12 + 6 = 18\text{W}$
 $R_1 = R_2 = 12\Omega$
 $I_1 = I_2 = 1\text{A}$

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[Parallel DC Circuits Study Guide](#)

DC KIRCHHOFF'S CURRENT LAW



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[https://openoregon.pressbooks.pub/
electronics1/?p=169](https://openoregon.pressbooks.pub/electronics1/?p=169)

[DC Kirchhoffs Current Law Study Guide](#)

DC CURRENT DIVIDER RULE

Current Divider Rule

Objective - Apply the current divider rule to simple parallel DC circuits to quickly and directly solve for unknown current quantities.

$$V_i = I_1 R_1$$
$$I_1 = \frac{E - V_i}{R_1}$$
$$I_2 = \frac{V_i}{R_2}$$
$$I_{in} = I_1 + I_2$$
$$I_1 = 31.5\text{ mA}$$
$$I_2 = 10.5\text{ mA}$$
$$= \frac{600}{600 + 200} 42\text{ mA}$$
$$= 10.5\text{ mA}$$

Using Law
Results

DC CURRENT DIVIDER RULE

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<https://openoregon.pressbooks.pub/electronics1/?p=172>

[DC Current Divider Rule Study Guide](#)

DC CURRENT SOURCES

Current Sources

Objective - Examine the current source. Discuss rules, regulations and limitations of current sources and the limitations of real world current sources.

$V_L = I_L R_L$
 $= 252.1mV \cdot 690$
 $= 174.484\dots$
 $\approx 174.5V$

$I_{IN} = I_F + I_L$
 $I_{IN} - I_F = I_L$
 $290 - 252.1 = 37.1 mA$

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<https://openoregon.pressbooks.pub/electronics1/?p=175>

[DC Current Sources Study Guide](#)

UNIT 7:

SERIES-PARALLEL DC

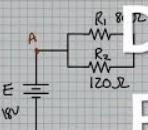
CIRCUIT ANALYSIS

Objective: Demonstrate understanding of basic series-parallel DC circuit properties, analyze loaded and unloaded voltage dividers, convert sources, understand instrument loading effects, use circuit simulation software, and employ instrumentation in a series-parallel circuit to verify series-parallel circuit properties.

SERIES-PARALLEL DC CIRCUIT ANALYSIS

Series-Parallel Circuit Analysis

Objective: Analyze series-parallel circuits and discuss voltage, current, and power distribution within a series-parallel circuit.



The circuit diagram shows a 18V DC voltage source (E) connected in series with a 1Ω resistor (R_s). This combination is then connected in parallel with a branch containing a 3Ω resistor (R₂) and a 2Ω resistor (R₃) in series. The total parallel resistance is 3Ω. The total circuit resistance is R_T = E/I_s = 18/90mA = 200Ω. The total current I_T is 18V / 200Ω = 90mA. The current through R₂ is I₂ = 90mA * 3Ω / (3Ω + 2Ω) = 54mA. The current through R₃ is I₃ = 90mA * 2Ω / (3Ω + 2Ω) = 36mA. The voltage across R₂ is V₂ = 54mA * 3Ω = 162mV. The voltage across R₃ is V₃ = 36mA * 2Ω = 72mV. The total voltage drop across the parallel branch is V₂ + V₃ = 162mV + 72mV = 234mV. The voltage across R_s is V_s = 90mA * 1Ω = 90mV. The total voltage drop across the entire circuit is V_T = 18V - 90mV = 17.91V.

DC SERIES PARALLEL CIRCUIT ANALYSIS

$I_s = I_1 + I_2$

$V_s = I_s R_s$

$V_1 = V_2 = V_{R'}$

$I_2 = I_s R_2 / (R_2 + R_3)$

$I_3 = I_s R_3 / (R_2 + R_3)$

$R_T = (R_1 R_2) / (R_1 + R_2)$

$R_T = E / I_s$

$P = V_s I_s$

$E = V_s + V_1 + V_2 + V_3$

$V_3 = 7.2V$

$I_2 = 54mA$

$I_3 = 36mA$

$I_s = 90mA$

$V_1 = V_2 = V_{R'}$

$V_s = 90mV$

$V_T = 18V - 90mV = 17.91V$

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[Series Parallel DC Circuits Study Guide](#)

DC SOURCE CONVERSION

Source Conversion

Objective - Convert a voltage source in series with a resistor to a current source in parallel with a resistor and vice versa.

The diagram illustrates the conversion between a voltage source and a current source. On the left, a voltage source V_s in series with a resistor R_s is shown. A red arrow points from this circuit to a right-hand circuit. In the right-hand circuit, a current source I_A in parallel with a resistor R_p is shown. A red arrow points from this circuit back to the left circuit, indicating the equivalence of the two configurations.

DC SOURCE CONVERSION

$$V_L = \frac{R_L}{R_s + R_L} V_s = \frac{1}{2k + 2k} \cdot 10V = 2.5V$$

$$I_L = \frac{V_L}{R_L} = \frac{2.5V}{2k} = 37.5mA$$

$$= \frac{1k}{2.2k + 1k} 120mA$$

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<https://openoregon.pressbooks.pub/electronics1/?p=184>

[Source Conversion Study Guide](#)

DC VOLTAGE DIVIDER CIRCUITS

Voltage Divider Circuits

Objective - Predict electrical quantities for voltage divider circuits in both the unloaded and loaded condition.

$E = 10V$

$R_1 = 500\Omega$

$R_L = 1k\Omega$

$R_2 = 2k\Omega$

$R_3 = 3k\Omega$

$R_Y = 2k\Omega$

$I_1 = \frac{V_1}{R_1} = \frac{14.7}{500} = 29.4mA$

$\frac{R_2}{R_1} = \frac{2k\Omega}{500\Omega} = 4$

$I_2 = \frac{V_2}{R_2} = \frac{4.2V}{2k\Omega} = 2.1mA$

$\frac{R_3}{R_2} = \frac{3k\Omega}{2k\Omega} = 1.5$

$I_3 = \frac{V_3}{R_3} = \frac{2V}{3k\Omega} = 0.67mA$

$R_{eq} = 1.2k\Omega$

$R'_{eq} = 2k\Omega$

Unloaded

Y	X	Y'	X'
V_1	$7.1V$	$10V$	$14.7V$
U_2	$4.2V$	$4V$	$3.5V$
V_3	$2V$	$2V$	$2V$
I_2	$0A$	$0A$	$0A$
V_O	$0V$	$0V$	$0V$
V_S	$12V$	$20V$	$20V$
I_1	$14.5mA$	$20mA$	$29.4mA$
T	$14.3V$	$14.3V$	$14.3V$
I_3	$0.67mA$	$0.67mA$	$0.67mA$
V_{Omax}	$12V$	$10V$	$7.1V$
U_{Ymax}	$0V$	$0V$	$4.2V$
I_{Xmax}	$0A$	$0A$	$29.4mA$
V_{Smin}	$28.6V$	$0V$	$0V$
V_Y	$0V$	$2V$	$14.7V$
Z_Y	$0A$	$10mA$	$29.4mA$

Loaded

Y	X	Y'	X'
V_1	$7.1V$	$10V$	$14.7V$
U_2	$4.2V$	$4V$	$3.5V$
V_3	$2V$	$2V$	$2V$
I_2	$0A$	$0A$	$0A$
V_O	$0V$	$0V$	$0V$
V_S	$12V$	$20V$	$20V$
I_1	$14.5mA$	$20mA$	$29.4mA$
T	$14.3V$	$14.3V$	$14.3V$
I_3	$0.67mA$	$0.67mA$	$0.67mA$
V_{Omax}	$12V$	$10V$	$7.1V$
U_{Ymax}	$0V$	$0V$	$4.2V$
I_{Xmax}	$0A$	$0A$	$29.4mA$
V_{Smin}	$28.6V$	$0V$	$0V$
V_Y	$0V$	$2V$	$14.7V$
Z_Y	$0A$	$10mA$	$29.4mA$

DC VOLTAGE DIVIDER CIRCUITS

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<https://openoregon.pressbooks.pub/electronics1/?p=187>

[DC Voltage Divider Circuits Study Guide](#)

INSTRUMENT LOADING EFFECTS

Instrument Loading Effects

Objective - Examine instrument loading effects and how the act of measuring an electrical quantity can influence a circuit's behavior.

INSTRUMENT LOADING EFFECTS

$E = 36$
 $R_1 = 10\Omega$
 $R_2 = 10\Omega$
 $R_3 = 200\Omega$
 $R_4 = 100\Omega$
 $R_5 = 10\Omega$
 $R_6 = 10\Omega$
 $R_m = 10 R_L$
 $R_m = 4 K R_L$
 $R_m = 7.10U$

ideal

$V_1 = 13.2V$ $V_2 = 22.8V$
 $I_1 = 13.5mA$ $I_2 = 114.2mA$
 $V_3 = 13.2V$ $V_4 = 22.8V$
 $I_{D1} = 19.6mA$ $I_{D2} = 126.9mA$
 $I_3 = 241.2mA$

$V_{INT} \approx 1.05U$
 $R_{m1} \approx 7.10U$
 $R_x \approx \begin{cases} R_{m1} & V_1 = 12.76V \\ V_1 & V_1 = 12.36V \\ V_2 & V_2 = 12.36V \end{cases}$
 $R_y \approx \begin{cases} R_{m1} & V_1 = 20.49V \\ V_1 & V_1 = 20.49V \\ V_2 & V_2 = 20.49V \end{cases}$

$V_1 \approx 11.13V$ $V_2 \approx 15.5V$
 $V_m \approx 1.7V$ $V_m \approx 0.78V$
 $V_3 \approx 11.41V$ $V_4 \approx 19.4V$
 $V_{D1} \approx 30.75V$ $V_{D2} \approx 140V$

$I_1 \approx 10.5mA$
 $I_2 = 11.3mA$ $I_3 = 12.85mA$
 $I_{D1} = 8.6mA$ $I_{D2} = 10.8mA$
 $I_m = 3.1mA$ $I_{m1} = 5.1mA$

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Instrument Loading Effects Study Guide

RESISTIVE DELTA-Y CONVERSIONS

Resistive Delta and Y Conversions

Objective- Learn to convert between two common three terminal relationships known as delta and Y configurations.

$R_A = R_B + R_C + R_S$

$R_B = R_A + R_C + R_S$

$R_C = R_A + R_B + R_S$

$R_S = \frac{R_A R_B}{R_A + R_B}$

$R_A = \frac{50(50+30)}{50+30} = 10\Omega$

$R_B = 50\Omega$

$R_C = 30\Omega$

$R_S = R_2$

$R_{Y-A} = \frac{\text{summation of all possible products taken 2 at a time}}{\text{resistor attached to node}}$

$R_A = R_B = R_C = 50\Omega$

$R_{Y-A} = \frac{50 \cdot 50 + 50 \cdot 50 + 50 \cdot 50}{3} = 250\Omega$

RESISTIVE DELTA-Y CONVERSIONS

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<https://openoregon.pressbooks.pub/electronics1/?p=195>

[Resistive Y Delta Conversion Study Guide](#)

COMPLEX DC CIRCUIT ANALYSIS

Complex Circuits

Objective - Examine and analyze complex DC circuits using delta conversions.

$E = 10V$ $R_1 = 1.5K5\Omega$ $R_2 = 500\Omega$ $R_3 = 200\Omega$ $R_4 = 1.2K\Omega$ $R_5 = 126.3\Omega$ $R_6 = 315.85\Omega$

$V_L = ?$ $I_L = ?$ $V_B = \frac{R_B}{R_2 + R_B} V''$ $E = ?$ $R'' = 526.3\Omega$ $R''' = 393.15\Omega$

$R_C = 52.4V$

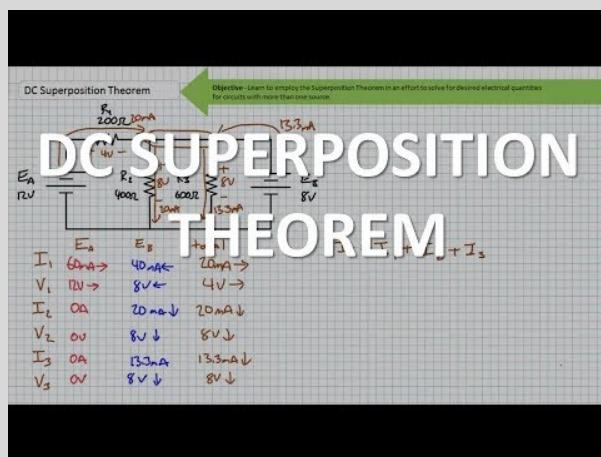
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[Complex DC Circuit Analysis Study Guide](#)

UNIT 8: DC CIRCUIT ANALYSIS THEOREMS

Objective: Demonstrate understanding of the Super Position Theorem, Thevenin's Theorem, and the Maximum Power Transfer Theorem as applied to DC circuits.

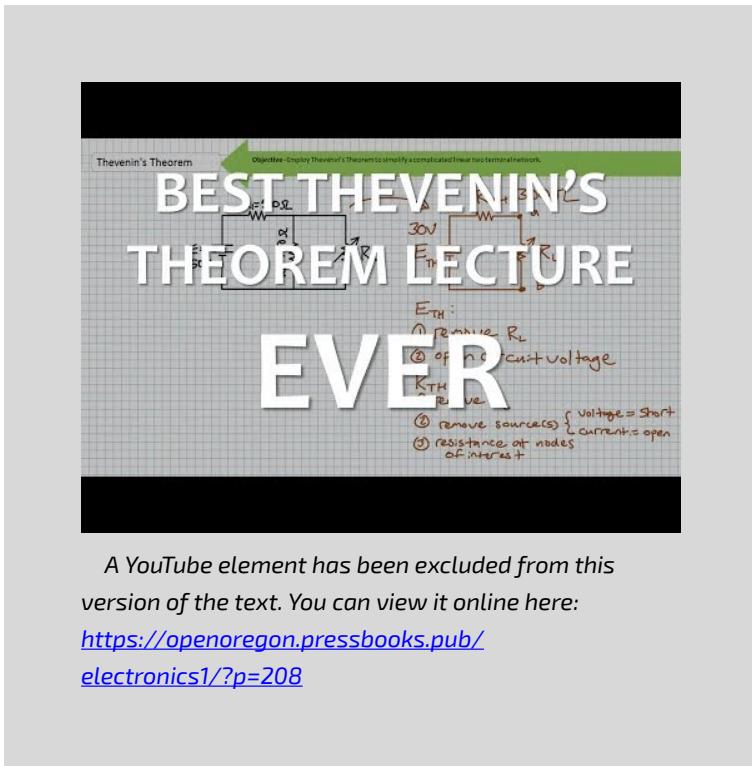
DC SUPERPOSITION THEOREM



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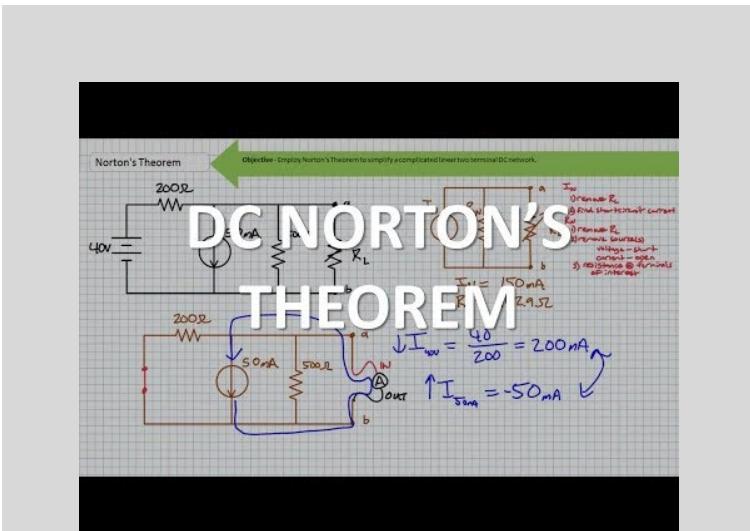
[Superposition Theorem Study Guide](#)

DC THEVENIN'S THEOREM



[Thevenins MPT and Nortons Theorem Study Guide](https://openoregon.pressbooks.pub/electronics1/?p=208)

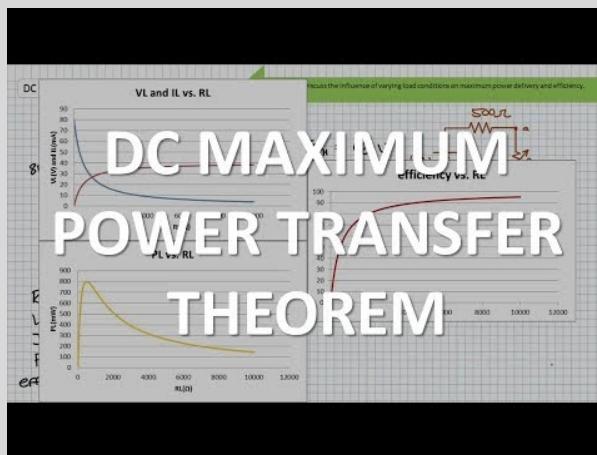
DC NORTON'S THEOREM



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<https://openoregon.pressbooks.pub/electronics1/?p=213>

[Thevenins MPT and Nortons Theorem Study Guide](#)

DC MAXIMUM POWER TRANSFER THEOREM



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<https://openoregon.pressbooks.pub/electronics1/?p=211>

[Thevenins MPT and Nortons Theorem Study Guide](#)

This is where you can add appendices or other back matter.