

BASIC ELECTRICITY AND ELECTRONICS 1

JIM PYTEL

Open Oregon Educational Resources



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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 $E = V_1 + V_2 + V_3$
 $E = 120V$
 $V_1 = 40V$
 $V_2 = 30V$
 $V_3 = ?$

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

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

④ $I = \frac{E}{R}$ $E = 120V$
 $I = 2A$
 $R = ?$

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

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

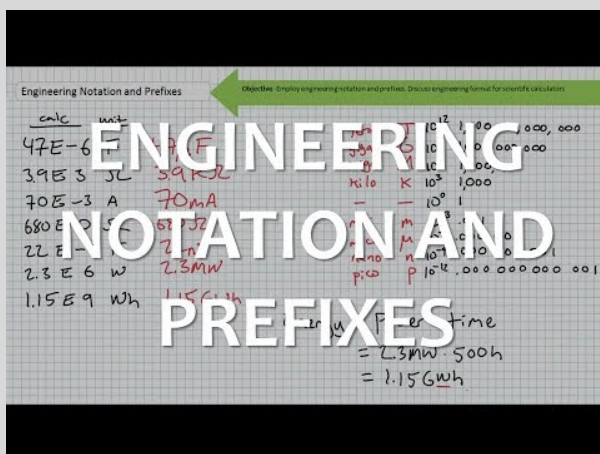
$R = \frac{120V}{2A}$

$R = 60\Omega$

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[DC Math Study Guide](#)

ENGINEERING NOTATION AND PREFIXES



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[Engineering Notation and Prefixes Study Guide](#)

GENERAL INDUSTRIAL SAFETY



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[General Industrial Safety Study Guide](#)

UNIT CONVERSION

Unit Conversion

Objective: Convert between two different systems of units. Convert between units employing different engineering prefixes.

$746 \text{ W} = 1 \text{ hp}$ $550 \frac{\text{ft} \cdot \text{lb}_f}{\text{s}} = 1 \text{ hp}$

UNIT CONVERSION

$60 \cancel{\text{hp}} \left(\frac{746 \text{ W}}{1 \cancel{\text{hp}}} \right) = 44,760 \text{ W} = 44.76 \text{ kW}$

$60 \cancel{\text{hp}} \left(\frac{550 \frac{\text{ft} \cdot \text{lb}_f}{\text{s}}}{1 \cancel{\text{hp}}} \right) = 33,000 \frac{\text{ft} \cdot \text{lb}_f}{\text{s}}$

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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.

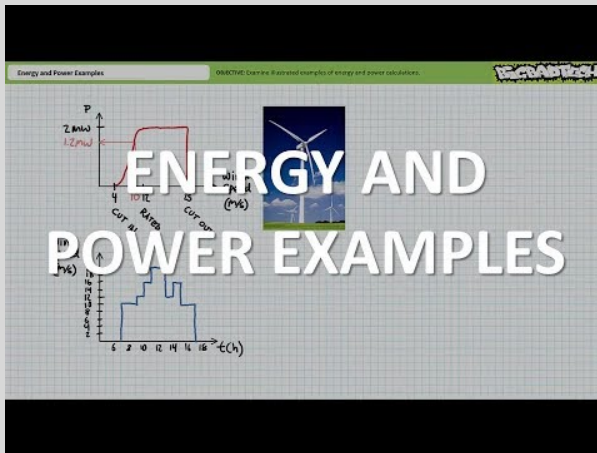
ENERGY AND POWER



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[Energy and Power Study Guide](#)

ENERGY AND POWER EXAMPLES



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[Energy and Power Examples Study Guide](#)

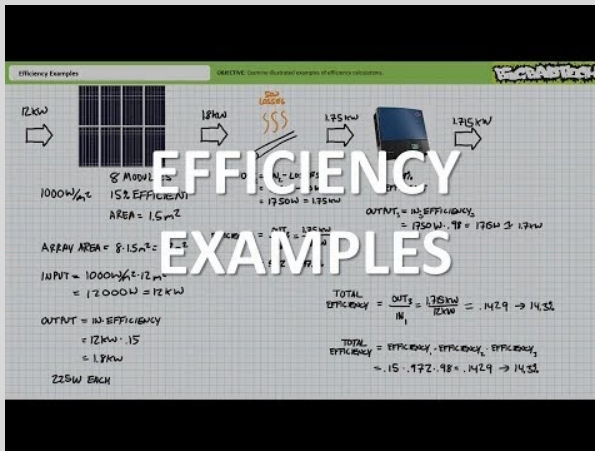
EFFICIENCY



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[Efficiency Study Guide](#)

EFFICIENCY EXAMPLES



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[Efficiency Examples Study Guide](#)

CAPACITY FACTOR



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[Capacity Factor Study Guide](#)

CAPACITY FACTOR EXAMPLES

The screenshot shows a video player interface. At the top, there's a green header with the text 'Capacity Factor Examples' and 'OBJECTIVE: Demonstrate examples of capacity factor calculations.' Below this, the video content is displayed on a grid background. It features a small image of a power plant turbine and the following calculations:

$$\begin{aligned} \text{70 MW} & \quad 43\% \text{ CF} \\ \text{Max CF could} & \\ &= 85\% \\ &= 10.4\text{h} \\ \text{Energy} = \text{Power} \times \text{Time} & \\ &= 70\text{ MW} \times 85\% \\ &= 75,000\text{ MWh/yr} \\ \frac{75,000\text{ MWh/yr}}{365\text{ days}} &= 205.4\text{ MWh/day} \\ &= 275.4\text{ GWh/yr} \end{aligned}$$

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[Capacity Factor Examples Study Guide](#)

BASIC ELECTRICAL QUANTITIES

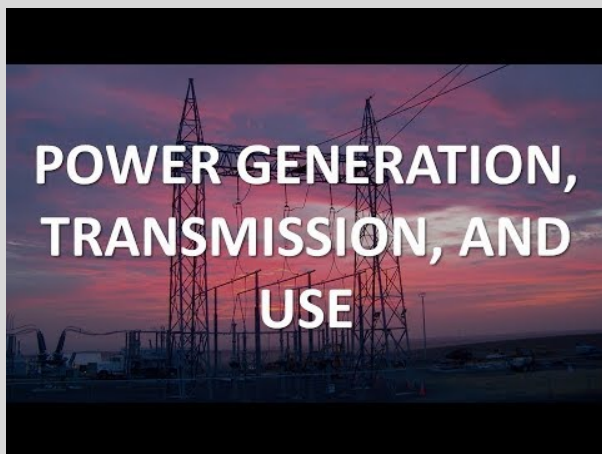


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[Basic Electrical Quantities Study Guide](#)

POWER GENERATION, TRANSMISSION, AND USE



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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



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[Resistance Study Guide](#)

4 BAND RESISTOR COLOR CODE

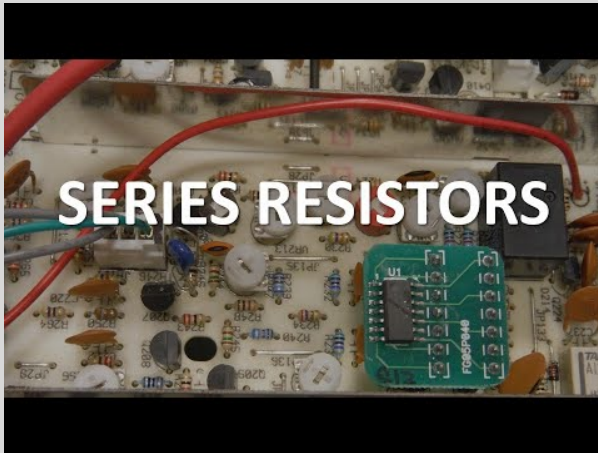


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[Resistor Color Code Study Guide](#)

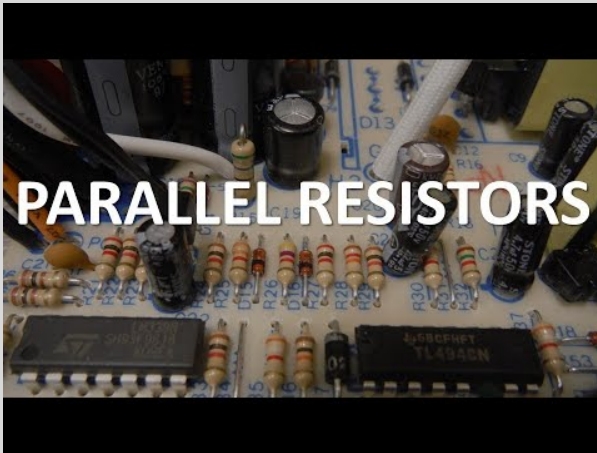
SERIES RESISTORS



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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](#)



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OHMMETERS: FLUKE 87



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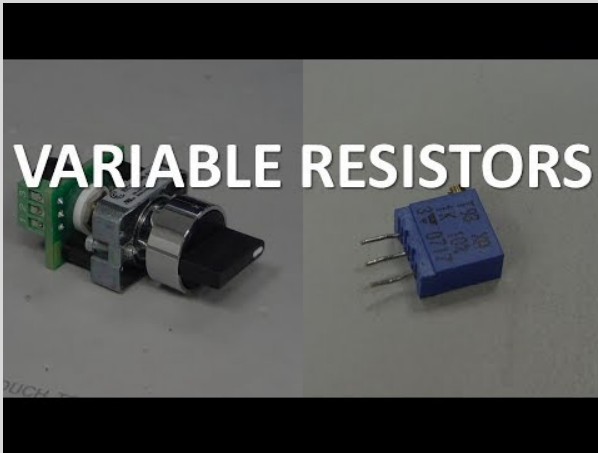
[Ohmmeters Fluke 87V Study Guide](https://openoregon.pressbooks.pub/electronics1/?p=276)



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<https://openoregon.pressbooks.pub/electronics1/?p=276>

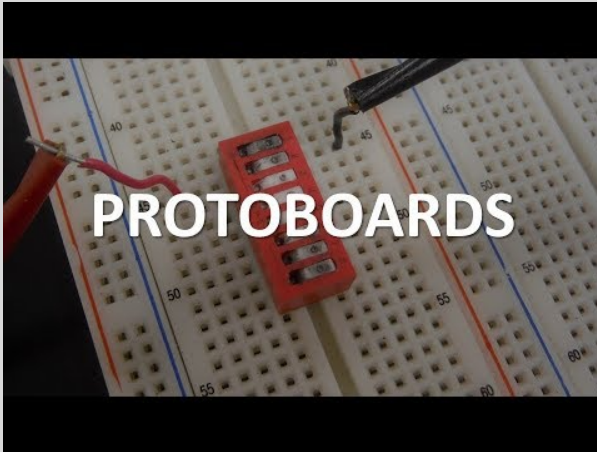
VARIABLE RESISTORS



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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



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[DC Ohms Law Study Guide](#)

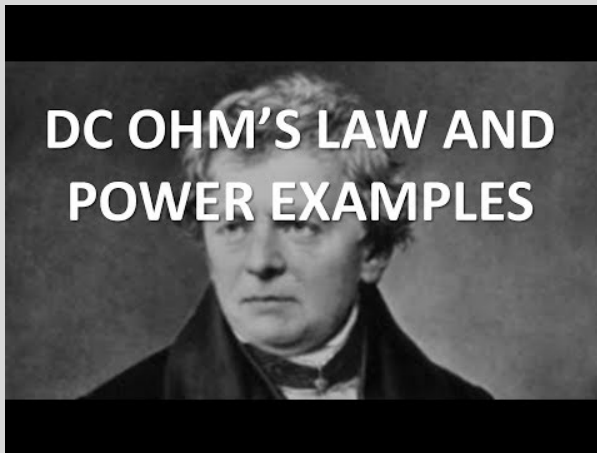
DC POWER



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[DC Power Study Guide](#)

DC OHM'S LAW AND POWER EXAMPLES

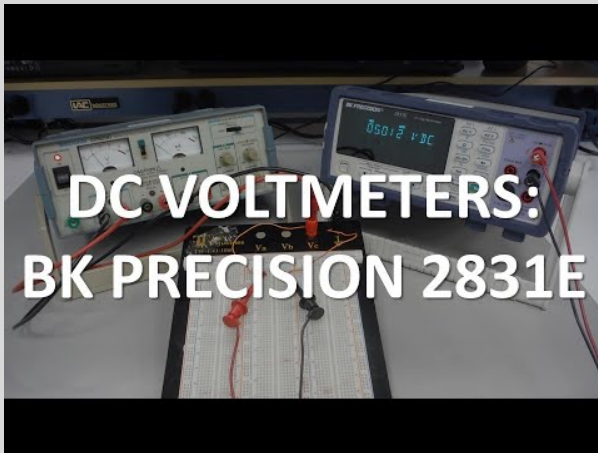


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[DC Ohms Law and Power Examples Study Guide](#)

DC VOLTMETERS: BK PRECISION 2831E



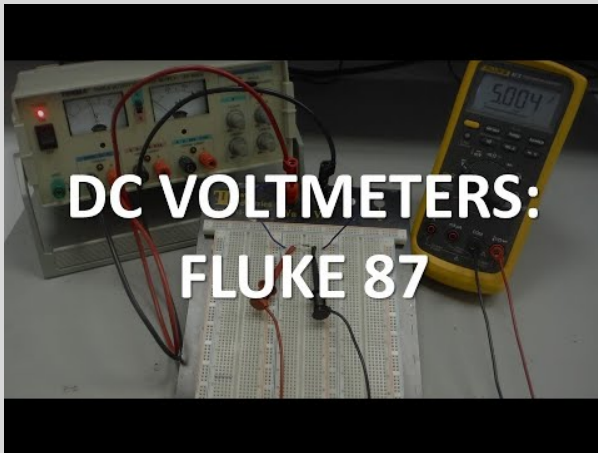
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[DC Voltmeters BK Precision 2831E Study Guide](#)

DC VOLTMETERS: FLUKE 87

V



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[DC Voltmeters Fluke 87 Study Guide](#)

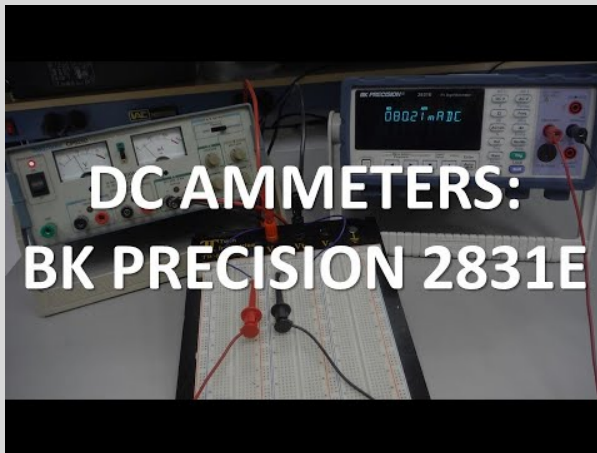
DC POWER SUPPLIES



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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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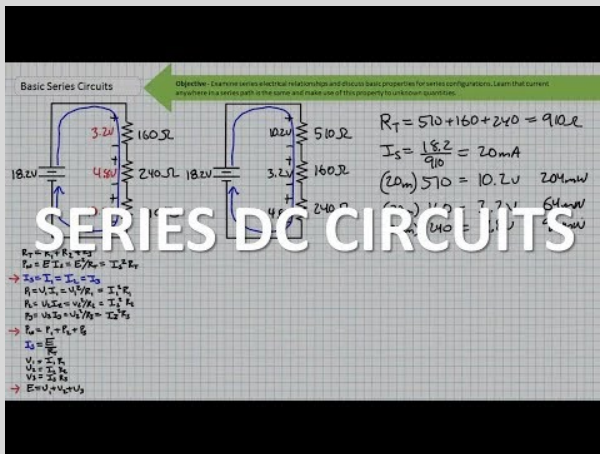
<https://openoregon.pressbooks.pub/electronics1/?p=233>

[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

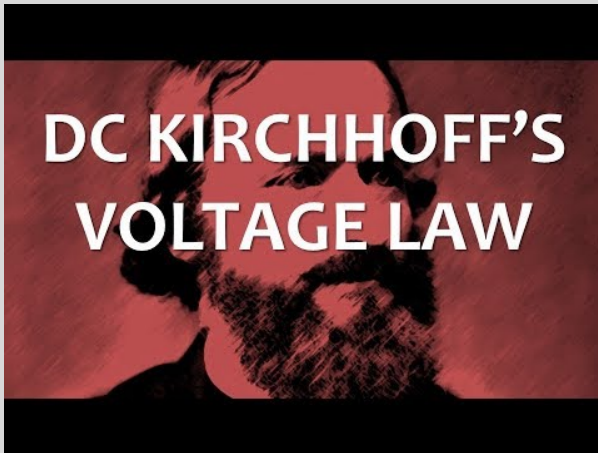


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DC Series Circuits Study Guide

DC KIRCHHOFF'S VOLTAGE LAW



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[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.

Handwritten calculations on graph paper:

$$I_2 = \frac{V_2}{R_2} = \frac{18}{900} = 20 \text{ mA}$$

$$V_2 = \frac{R_2}{R_1 + R_2} E = \frac{450}{1800 + 450} 63 = 9 \text{ V}$$

Other handwritten notes:

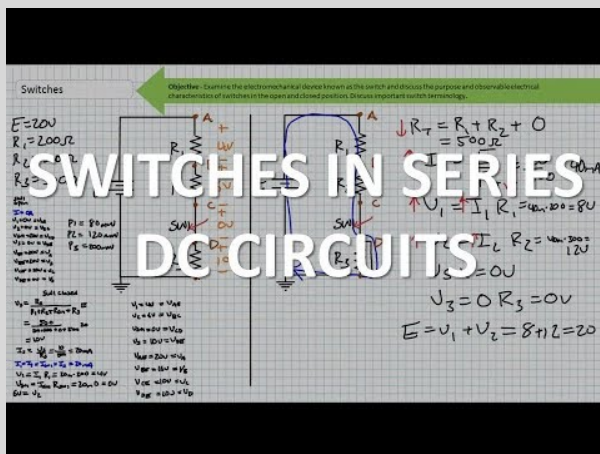
- $I_1 = I_2 = I$
- $E = V_1 + V_2 + V_3$
- $V_1 = I R_1$
- $V_2 = I R_2$
- $V_3 = I R_3$
- $E = I (R_1 + R_2 + R_3) = I R_T$
- $R_T = R_1 + R_2 + R_3$
- $P_T = P_1 + P_2 + P_3$
- Ohm's Law: $V_1 = I R_1$, $V_2 = I R_2$, $V_3 = I R_3$

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[DC Voltage Divider Rule Study Guide](#)

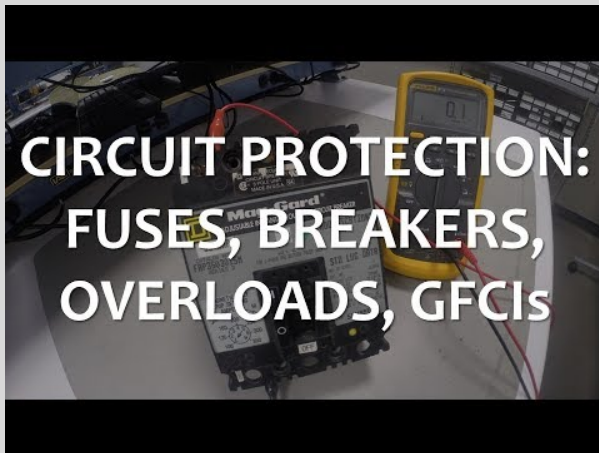
SWITCHES IN SERIES DC CIRCUITS



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[Switches Study Guide](#)

CIRCUIT PROTECTION DEVICES



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[Circuit Protection Devices Study Guide](#)

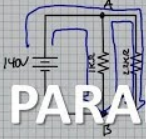
UNIT 6: PARALLEL DC CIRCUITS

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.



Handwritten calculations on graph paper:

$$V_A = 140V \quad I_{A1} = \frac{V_A}{R_1} = \frac{140V}{10\Omega} = 14mA$$

$$V_{A2} = 140V \quad I_{A2} = \frac{V_{A2}}{R_2} = \frac{140V}{20\Omega} = 7mA$$

$$I_{A3} = I_{A1} + I_{A2} = 14mA + 7mA = 21mA$$

$$P_A = V_A I_{A3} = \frac{V_A^2}{R_A} = I_{A3}^2 R_A$$

$$= 140V \cdot 21mA = 2.94W$$

$$R_A = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{10\Omega} + \frac{1}{20\Omega}} = 6.67\Omega$$

$$= 6.67\Omega \approx 6.7\Omega$$

Summary of properties:

$$R_T = R_1 \quad I_1 = I_2$$

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[Parallel DC Circuits Study Guide](#)

DC KIRCHHOFF'S CURRENT LAW

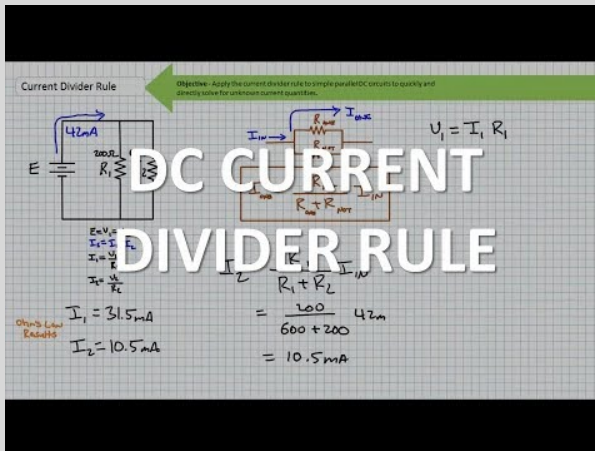


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[DC Kirchhoffs Current Law Study Guide](#)

DC CURRENT DIVIDER RULE



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[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.

DC CURRENT SOURCES

$V_L = I_L R_L$
 $= 252.9\mu\text{A} \cdot 690$
 $= 174.484\text{V} \dots$
 $\approx 174.5\text{V}$

$I_{IN} = I_F + I_L$
 $I_{IN} - I_L = I_F$
 $290 - 252.9 = 37.1\mu\text{A}$

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[DC Current Sources Study Guide](https://openoregon.pressbooks.pub/electronics1/?p=175)

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 Circuit Analysis

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

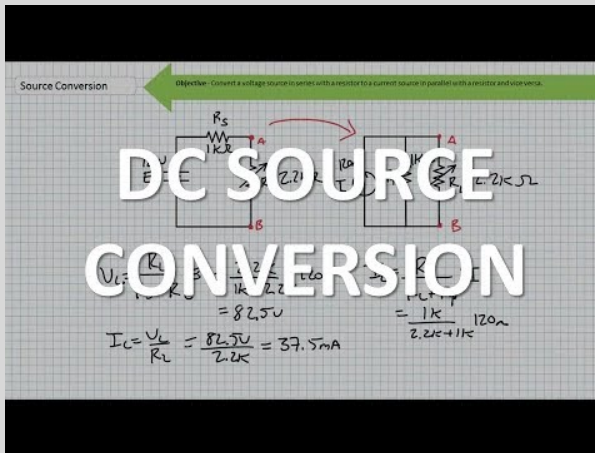
DC SERIES PARALLEL CIRCUIT ANALYSIS

$R_1 = 8\Omega$
 $R_2 = 120\Omega$
 $R_3 = 32\Omega$
 $E = 18V$
 $I_s = 725mA$
 $I_1 = 125mA$
 $I_3 = 600mA$
 $R_T = (R_1 R_2) + R_3$
 $R_T = 80\Omega$
 $V_3 = 7.2V$
 $90mA = I_2$
 $V_1 = V_2 = V_3$
 $7.2 = V_3$

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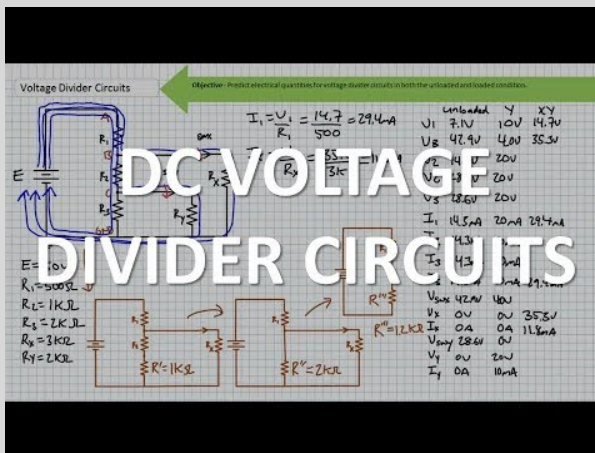
DC SOURCE CONVERSION



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[Source Conversion Study Guide](#)

DC VOLTAGE DIVIDER CIRCUITS

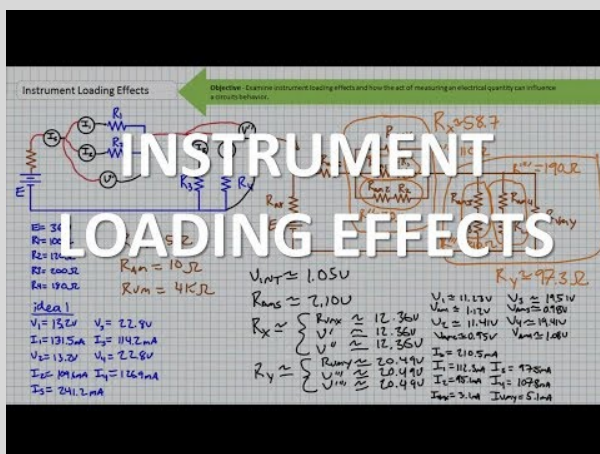


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[DC Voltage Divider Circuits Study Guide](#)

INSTRUMENT LOADING EFFECTS

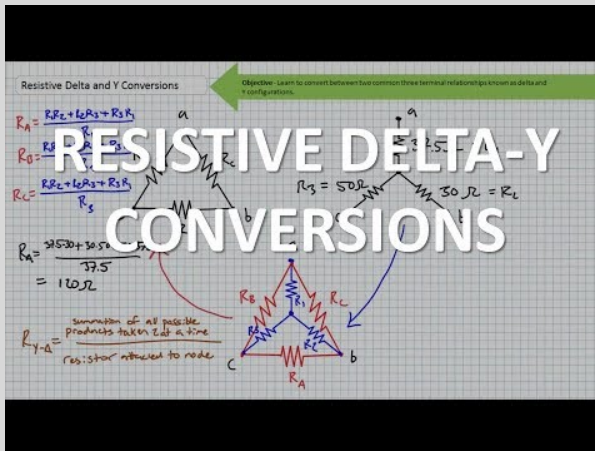


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[Instrument Loading Effects Study Guide](#)

RESISTIVE DELTA-Y CONVERSIONS

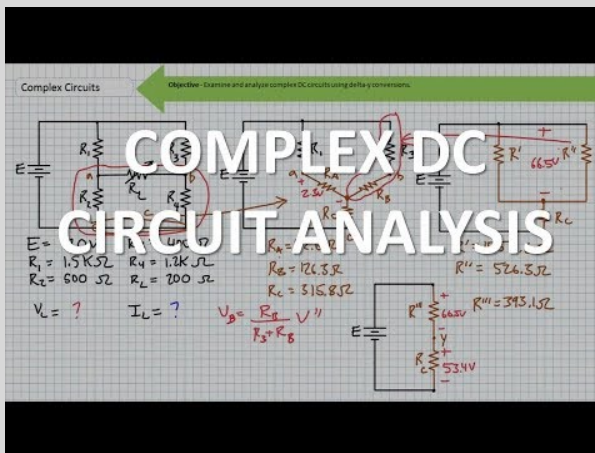


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[Resistive Y Delta Conversion Study Guide](#)

COMPLEX DC CIRCUIT ANALYSIS



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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

DC Superposition Theorem

Objective: Learn to employ the Superposition Theorem in an effort to solve for desired electrical quantities for circuits with more than one source.

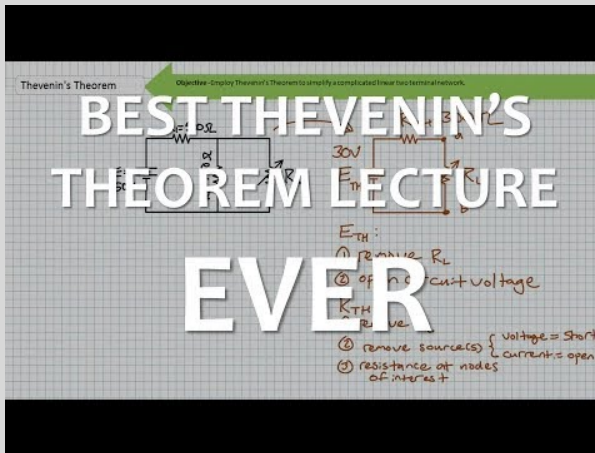
	E_A	E_B	I_3	$I = I_1 + I_2 + I_3$
I_1	60mA →	40mA ←	20mA →	
V_1	12V →	8V ←	4V →	
I_2	0A	20mA ↓	20mA ↓	
V_2	0V	8V ↓	8V ↓	
I_3	0A	15.3mA ↓	15.3mA ↓	
V_3	0V	8V ↓	8V ↓	

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[Superposition Theorem Study Guide](#)

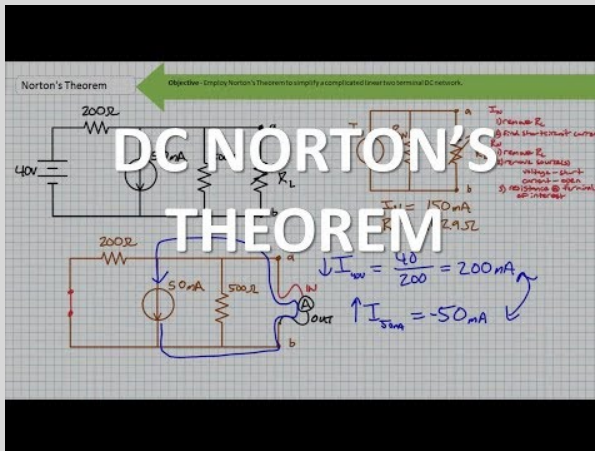
DC THEVENIN'S THEOREM



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

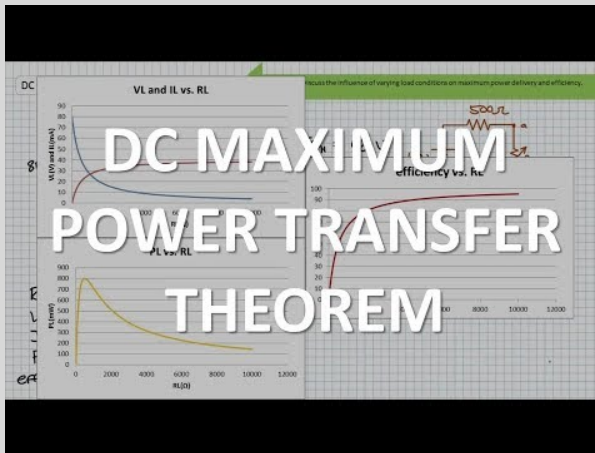
DC NORTON'S THEOREM



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

DC MAXIMUM POWER TRANSFER THEOREM



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

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