

**BASIC
ELECTRICITY
AND
ELECTRONICS 3**

JIM PYTEL

Open Oregon Educational Resources



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This course is the 3rd installment in a three part series intended to support the flipped classroom approach for traditional basic electronics classes. Basic Electronics 3 covers apparent, real, and reactive power and power factor, power factor correction, ideal and non-ideal transformers, and transformer connection diagrams, AC circuit analysis techniques and theorems like source conversion, the AC superposition theorem, AC Thevenin's Theorem, and the AC Maximum Power Transfer Theorem, 3 phase AC systems including balanced and unbalanced 4 wire Y configurations, 3 wire Y configurations, and delta configurations, the single wattmeter method and the two wattmeter method. These resources are meant to accompany a hands on lab with the guidance of an instructor.

UNIT 1: AC POWER

Objective: Demonstrate understanding of real, reactive, and apparent power. Determine individual and total real, reactive, and apparent power for elements in series, parallel, and series-parallel AC circuits.

AC POWER



AC POWER

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[AC Power Study Guide](#)

AC POWER EXAMPLES

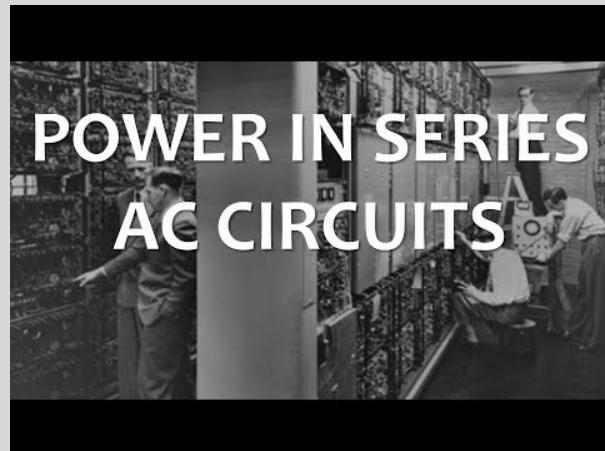


AC POWER
EXAMPLES

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[AC Power Examples Study Guide](#)

POWER IN SERIES AC CIRCUITS



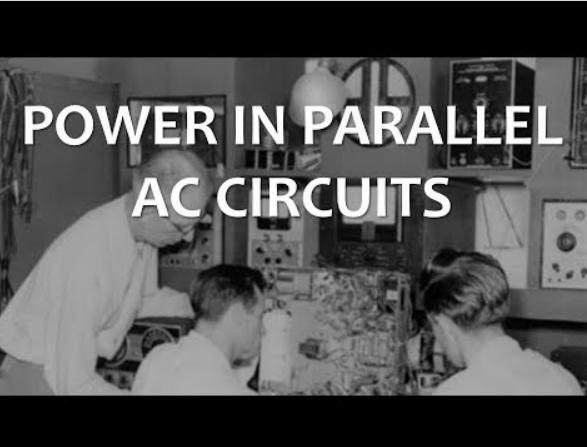
**POWER IN SERIES
AC CIRCUITS**

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[Power in Series AC Circuits Study Guide](#)

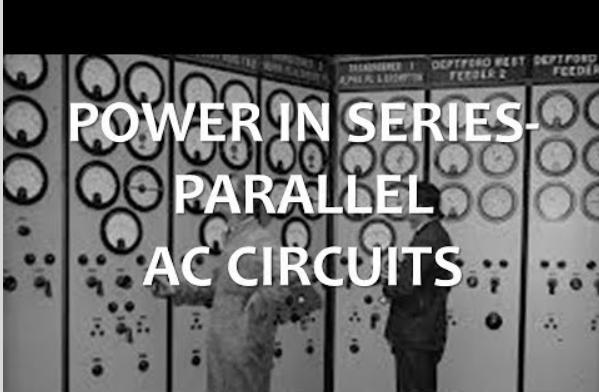
POWER IN PARALLEL AC CIRCUITS



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[Power in Parallel AC Circuits Study Guide](#)

POWER IN SERIES-PARALLEL AC CIRCUITS



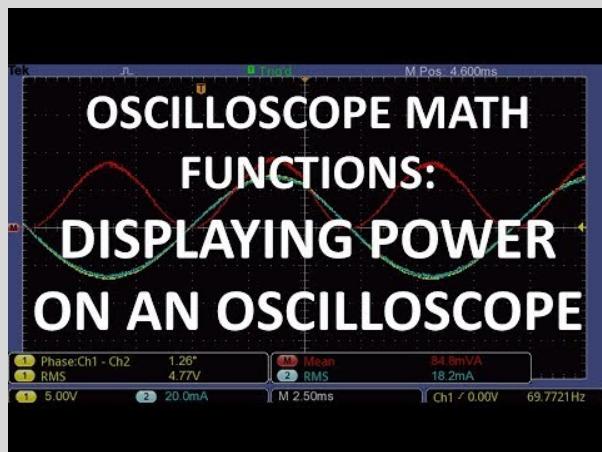
**POWER IN SERIES-
PARALLEL
AC CIRCUITS**

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Power in Series Parallel AC Circuits Study Guide

OSCILLOSCOPE MATH FUNCTIONS: MEASURING POWER ON AN OSCILLOSCOPE



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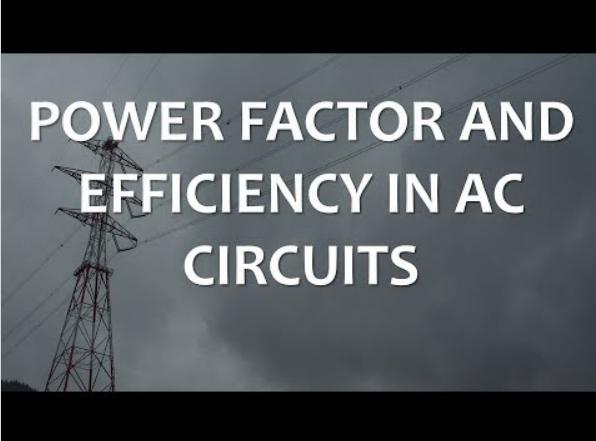
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[Oscilloscope MATH Functions Measuring Power with an
Oscilloscope Study Guide](#)

UNIT 2 POWER FACTOR CORRECTION

Objective: Demonstrate understanding of power factor and efficiency. Power factor correct a system. Identify characteristics of non-power factor corrected and power factor corrected systems.

POWER FACTOR AND EFFICIENCY IN AC CIRCUITS



**POWER FACTOR AND
EFFICIENCY IN AC
CIRCUITS**

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[Power Factor and Efficiency in AC Circuits Study Guide](#)

POWER FACTOR CORRECTION

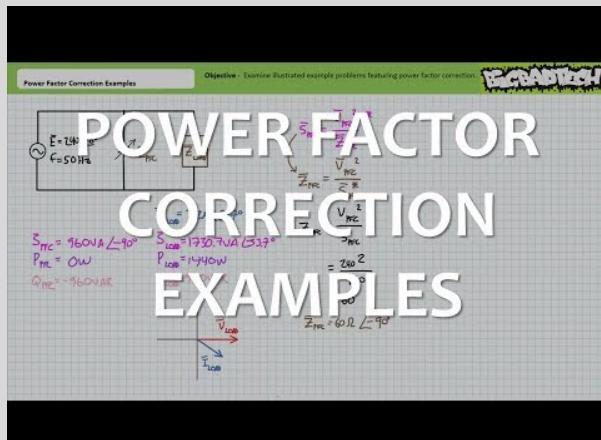


**POWER FACTOR
CORRECTION**

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[Power Factor Correction Study Guide](#)

POWER FACTOR CORRECTION EXAMPLES



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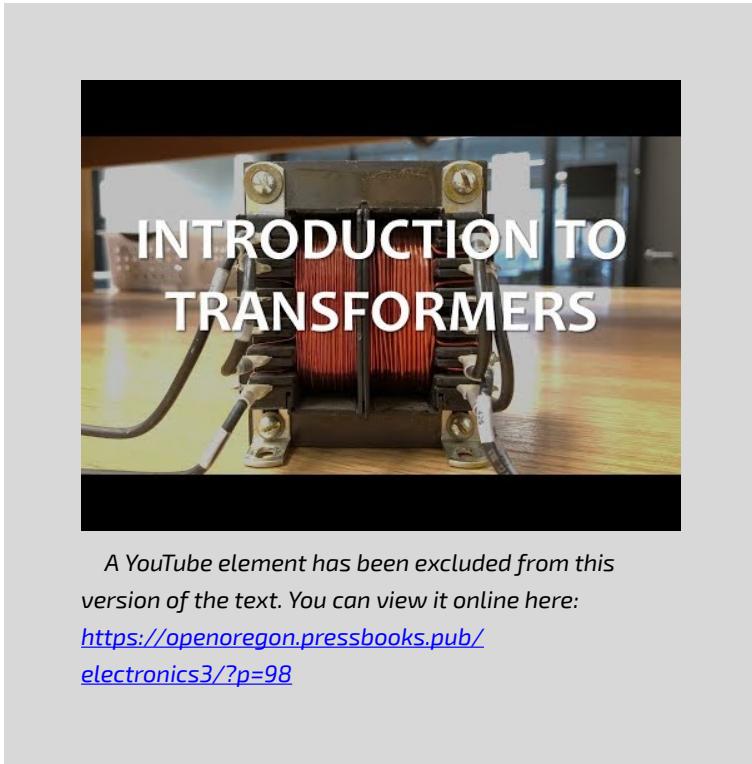
[Power Factor Correction Examples Study Guide](#)

UNIT 3:

TRANSFORMERS

Objectives: Demonstrate understanding of the theory of operation and construction of transformers. Demonstrate understanding of turns ratio, voltage, current, and power transformation in transformers. Demonstrate understanding of transformer connection diagrams, transformer ratings, phase dot notation, parallel connections of transformer windings, series aiding connections of transformer windings, and series opposing connections of transformer windings. Demonstrate understanding of copper losses, iron losses (hysteresis and eddy currents), and magnetizing current. Demonstrate understanding of transformer efficiency and voltage regulation.

TRANSFORMERS



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[Introduction to Transformers Study Guide](#)

TRANSFORMER CONNECTION DIAGRAMS



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[Transformer Connection Diagrams Study Guides](#)

NON-IDEAL TRANSFORMERS



**NON-IDEAL
TRANSFORMERS**

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[Non Ideal Transformers Study Guide](#)

UNIT 4: AC CIRCUIT ANALYSIS TECHNIQUES

Objectives: Demonstrate understanding of current sources, source conversions, and delta/Y conversions using complex impedances.

AC CURRENT SOURCES

AC Current Sources

Objective - Introduce the AC current source and examine electrical properties of circuits containing AC current sources.

SINUSOIDAL AC CURRENT SOURCES

$E_{100} = 312V \angle 0^\circ$

$I = \frac{E}{Z_{100}}$

$= 80mA \angle 0^\circ$

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<https://openoregon.pressbooks.pub/electronics3/?p=114>

[AC Current Sources Study Guide](#)

AC SOURCE CONVERSION

AC Source Conversion

Objective - Examine the means of converting between AC voltage sources and AC current sources.

$I = 400\text{mA } \angle 0^\circ$

$Z_s = 60\Omega \angle 0^\circ$

$\bar{V}_s = 120\text{V } \angle 0^\circ$

$\bar{I}_s = 10\text{A } \angle 0^\circ$

$Z_s = 12\Omega \angle 0^\circ$

$\bar{V}_s = 120\text{V } \angle 0^\circ$

$\bar{V}_L = \bar{V}_s \angle 0^\circ$
 $= 16.2\text{V } \angle 64^\circ$

AC SOURCE CONVERSION

$\bar{V}_L = \bar{V}_s \angle 0^\circ$
 $= 16.2\text{V } \angle 64^\circ$

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[AC Source Conversion Study Guide](#)

DELTA AND Y CONVERSIONS WITH COMPLEX IMPEDANCES

Delta and Y Conversions with Complex Impedances

Objective: Learn to convert between delta and Y configurations with complex impedances.

$Z_{Y_{AB}} = \frac{\text{sum of all combinations of } Z_{\text{Y}} \text{ taken 2 at a time}}{Z_{\text{Y}} \text{ opposite}}$

$Z_{Y_{AB}} = \frac{22.6 + 9.2 \angle 24.8^\circ}{22.6 - 9.2 \angle 24.8^\circ}$

$Z_{Y_{BC}} = \frac{22.6 + 9.2 \angle 24.8^\circ}{57.3 \angle 130^\circ}$

$Z_{Y_{CA}} = \frac{22.6 + 9.2 \angle 24.8^\circ}{193.2 \angle 20^\circ}$

$= 170.3 \angle 224.6^\circ$

$Z_{\Delta_{AB}} = 193.2 \angle 20^\circ$

$Z_{\Delta_{BC}} = 57.3 \angle 130^\circ$

$Z_{\Delta_{CA}} = 22.6 + 9.2 \angle 24.8^\circ$

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electronics3/?p=121](https://openoregon.pressbooks.pub/electronics3/?p=121)

Impedance Delta Y Conversion Study Guide

UNIT 5: AC CIRCUIT ANALYSIS THEOREMS

Objectives: Demonstrate understanding of the Superposition Theorem, Thevenin's Theorem, Norton's Theorem, and the Maximum Power Transfer Theorem as applied to AC circuits. Demonstrate understanding of impedance matching transformers. Demonstrate understanding of bridge circuit analysis.

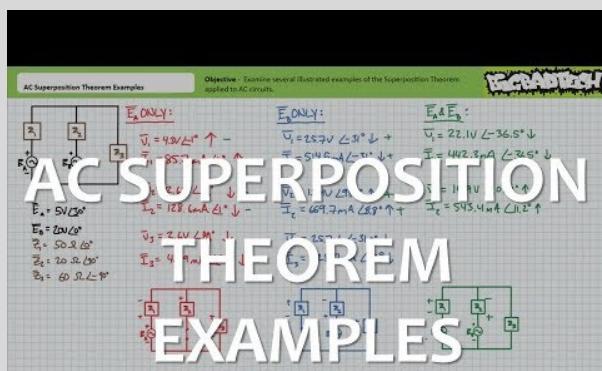
AC SUPERPOSITION THEOREM



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[AC Superposition Theorem Study Guide](#)

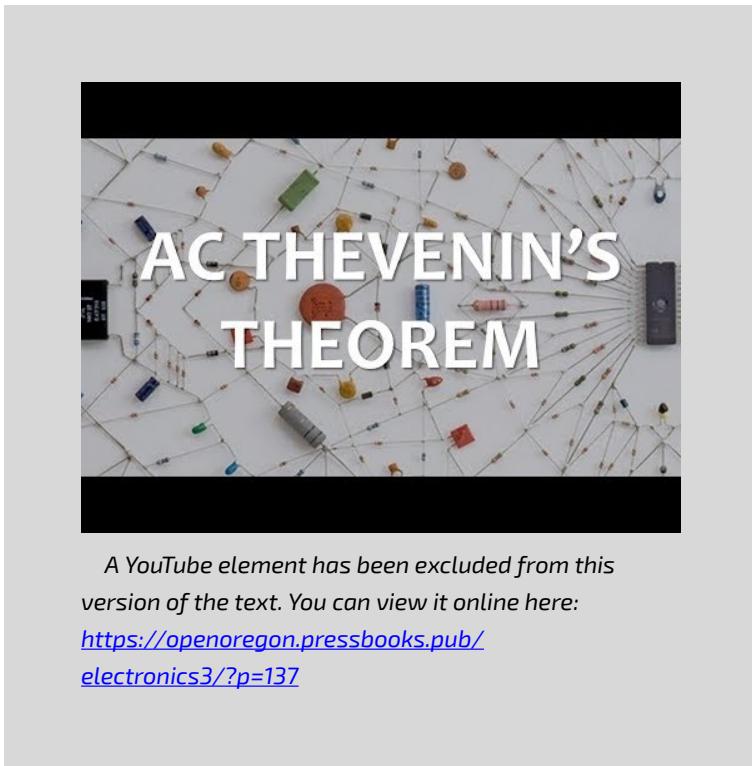
AC SUPERPOSITION THEOREM EXAMPLES



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[AC Superposition Theorem Examples Study Guide](#)

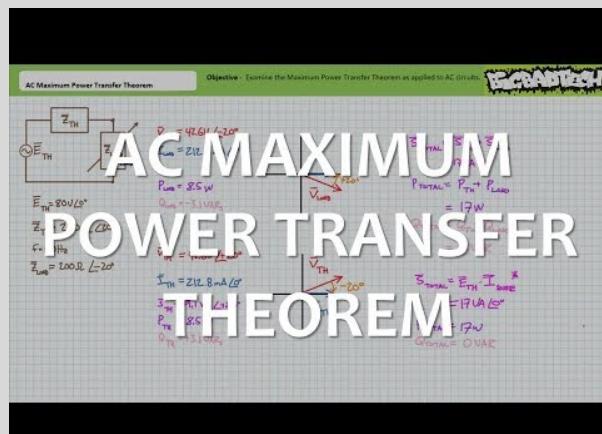
AC THEVENIN'S THEOREM



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[AC Thevenins Theorem Study Guide](#)

AC MAXIMUM POWER TRANSFER THEOREM



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<https://openoregon.pressbooks.pub/electronics3/?p=140>

[AC Maximum Power Transfer Theorem Study Guide](#)

AC THEVENIN'S THEOREM AND AC MAXIMUM POWER TRANSFER THEOREM EXAMPLES

AC Thevenin's and Maximum Power Transfer Theorem Examples

Objective - Exercise several illustrated examples of AC Thevenin's and AC Maximum Power Transfer Theorems.

TEGRADASH

AC THEVENIN'S AND
MAXIMUM POWER
TRANSFER THEOREM
EXAMPLES

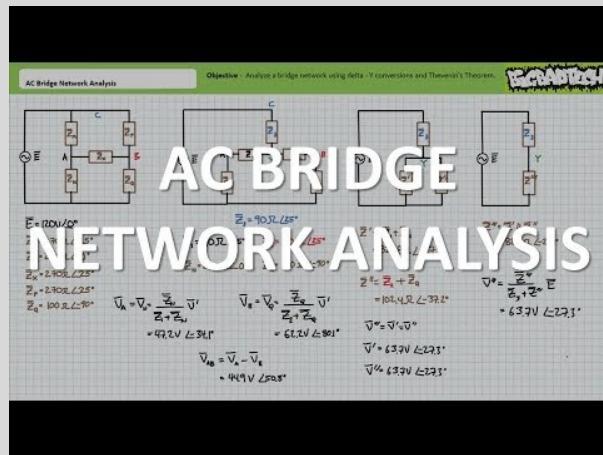
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[AC Thevenins Theorem and Maximum Power Transfer
Theorem Examples Study Guide](#)

AC BRIDGE NETWORK ANALYSIS



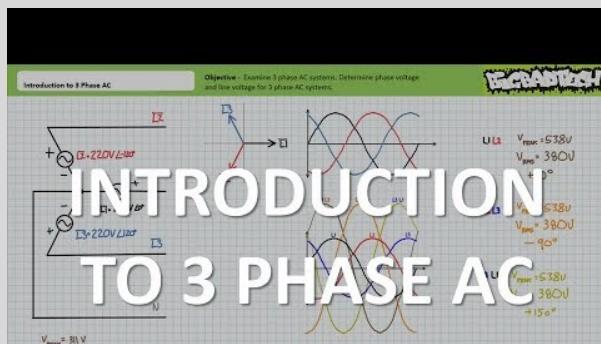
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[AC Bridge Network Analysis Study Guide](#)

UNIT 6: 3 PHASE AC CIRCUIT ANALYSIS

Objectives: Demonstrate understanding of line to neutral voltage and line to line voltage. Analyze balanced and unbalanced 4 and 3 wire Y and delta configured loads in 3 phase AC systems. Examine the 3 wattmeter, single wattmeter, and two wattmeter method in 3 phase AC systems.

INTRODUCTION TO 3 PHASE AC SYSTEMS



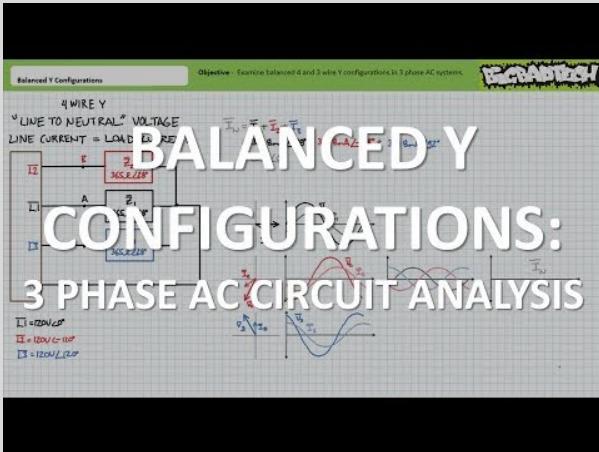
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[Introduction to 3 Phase AC Study Guide](#)

BALANCED Y CONFIGURATIONS

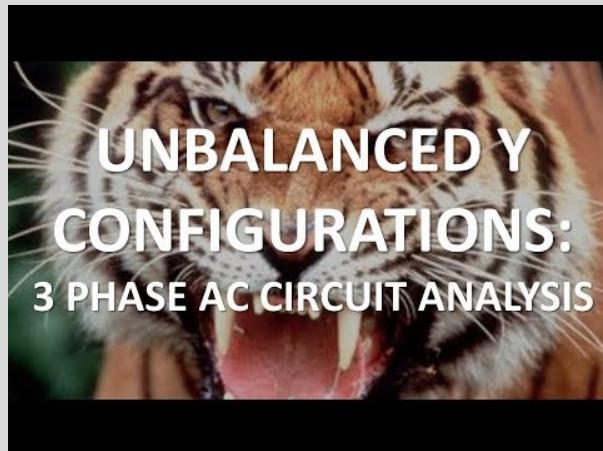
BALANCED Y CONFIGURATIONS:
3 PHASE AC CIRCUIT ANALYSIS

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[Balanced Y Configurations Study Guide](#)

UNBALANCED Y CONFIGURATIONS

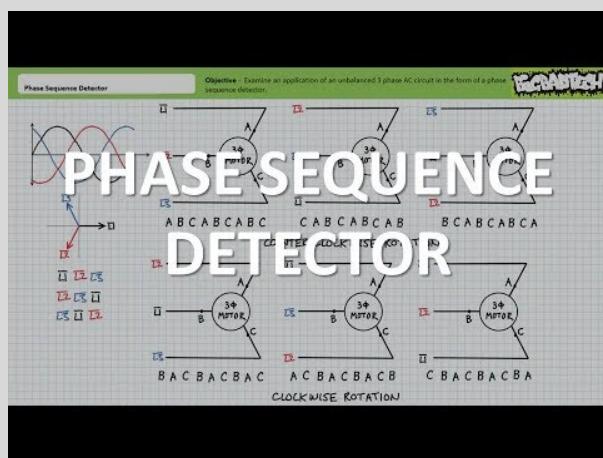


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[Unbalanced Y Configurations Study Guide](#)

PHASE SEQUENCE AND PHASE SEQUENCE DETECTION

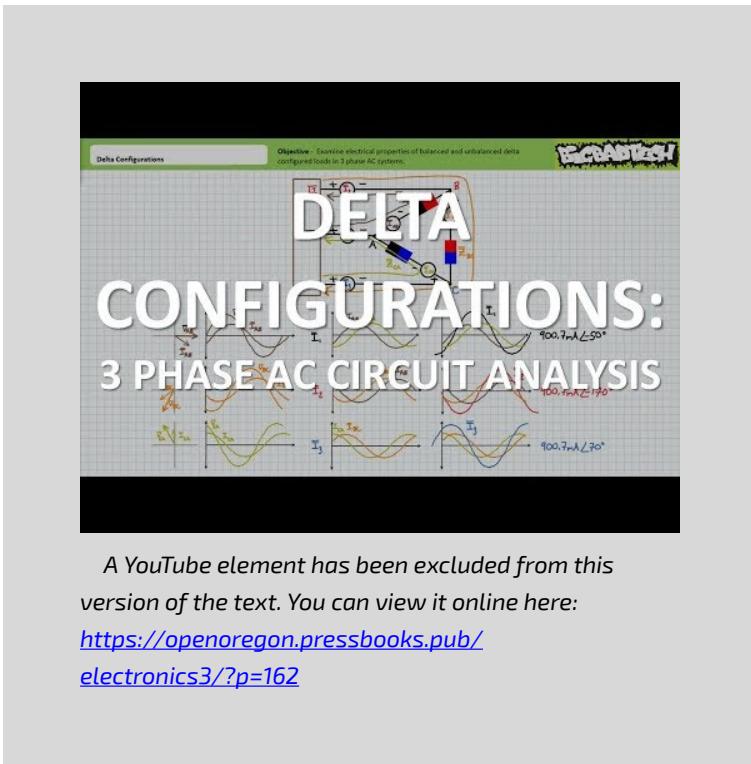


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Phase Sequence Detector Study Guide

DELTA CONFIGURATIONS



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[Delta Configurations Study Guide](#)

3 PHASE AC CIRCUIT ANALYSIS EXAMPLES

3 Phase AC Circuit Analysis Examples

Objective - Examine balanced and unbalanced 4-wire Y, 3-wire Y, and delta connected loads in 3 phase AC systems.

ECGRADWISH

The slide features a large watermark '3 PHASE AC EXAMPLES' across the center. It includes a circuit diagram with three phases (A, B, C) and a neutral wire (N). Handwritten calculations show phase-to-phase voltages like $U_{AB} = 208 V \angle 0^\circ$, $U_{BC} = 208 V \angle -120^\circ$, and $U_{CA} = 208 V \angle 120^\circ$. It also shows line-to-line currents $I_L = 120\text{A}$ and line-to-neutral currents $I_N = 60\text{A}$. Load impedances $Z_A = 36\Omega$, $Z_B = 40.5\Omega \angle 10^\circ$, and $Z_C = 40.5\Omega \angle -10^\circ$ are given. Power calculations include $P = 16\text{W}$, $Q = 14.88\text{VAr}$, and $S = 16.4\text{VA}$. A photograph of a three-phase power meter is shown at the bottom right.

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[3 Phase AC Examples Study Guide](#)

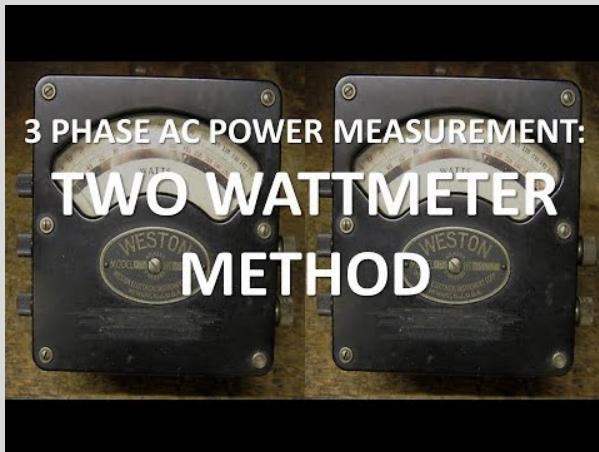
SINGLE WATTMETER METHOD



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[Single Wattmeter Method Study Guide](#)

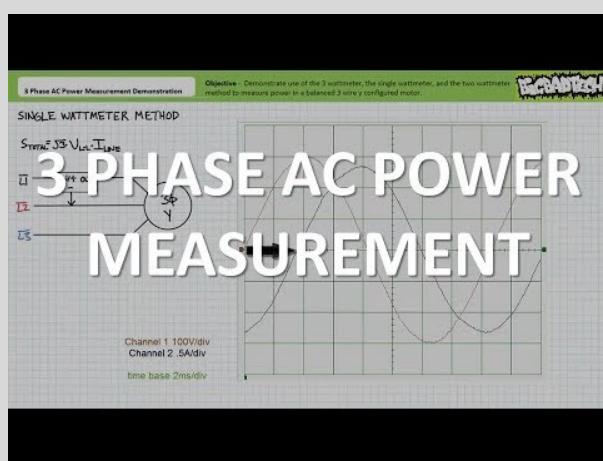
TWO WATTMETER METHOD



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[2 Wattmeter Method Study Guide](#)

3 PHASE AC POWER MEASUREMENT EXAMPLES



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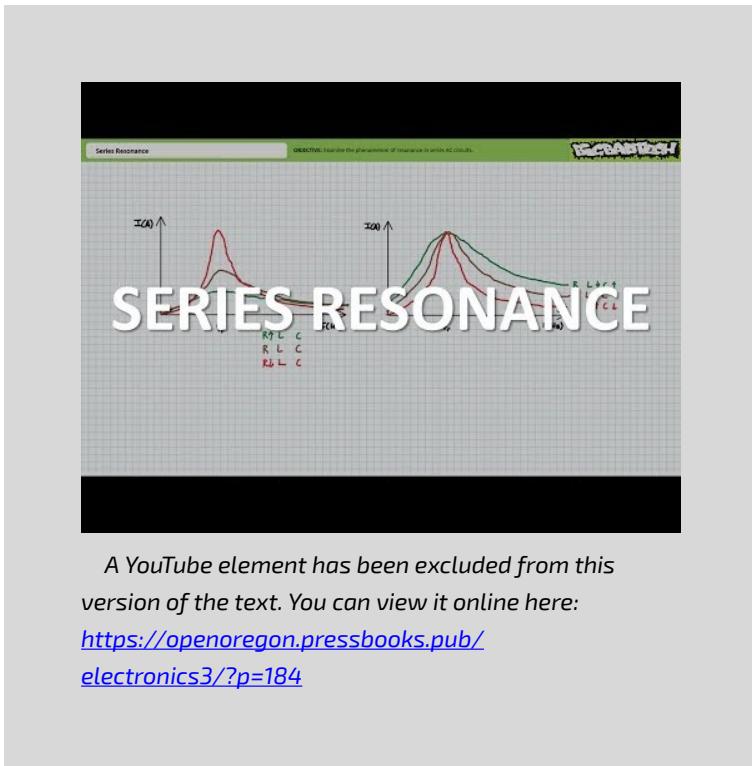
[https://openoregon.pressbooks.pub/
electronics3/?p=178](https://openoregon.pressbooks.pub/electronics3/?p=178)

[3 Phase AC Power Measurement Application Study
Guide](#)

UNIT 7: RESONANCE AND FILTERS

Objectives: Determine the resonant frequency of a series AC circuit. Evaluate electrical properties of series AC circuit at resonant and at other than resonant conditions. Determine bandwidth and quality factor of a resonant circuit. Calculate common logarithms. Use semi-log plots. Calculate gain in unit of decibels (dB). Determine the critical frequency for an RC filter. Evaluate electrical properties of RC filters below, at, and above the critical frequency. Differentiate between low and high pass RC filters.

SERIES RESONANCE



[Series Resonance Study Guide](#)

SERIES RESONANT CIRCUIT EXAMPLES

SERIES RESONANT CIRCUIT EXAMPLES

Series Resonant Circuit Example OBJECTIVE: Examine resonance in series AC circuits by way of an illustrative example



$QF = \frac{R_m}{X_L} = \frac{697.9}{50} = 13.9$

$X_L = \frac{1}{2\pi f C} = \frac{1}{2\pi \cdot 1000 \cdot C} = 33.33 \text{ mH}$

$C_1 = 49.4 \text{ nF} = \frac{33.33 \text{ mH}}{2} = 44.29 \text{ Hz}$

$f_c = \frac{1}{2\pi C} = \frac{1}{2\pi \cdot 44.29 \text{ Hz}} = 7.26 \text{ GHz}$

$Z_C = \frac{1}{2\pi f C} = 692.8 \Omega$

$I_{source} = \frac{V_s}{Z_C} = 1740 \text{ mA } 0^\circ$

$V_L = QF \cdot E = 166.3 \text{ V}$

$V_R = 166.3 \text{ V } \angle 90^\circ$

$V_C = QF \cdot E = 166.3 \text{ V}$

$\vec{V}_L = 166.3 \text{ V } \angle 90^\circ$

$QF = \frac{\text{REAL}}{\text{REAL+REACTIVE}}$ → REAL-QF+REACTIVE
 $2.9 \text{ mH}-13.9 = 27.9 \text{ mH}$

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Series Resonant Circuit Example Study Guide

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LOGARITHMS AND DECIBELS

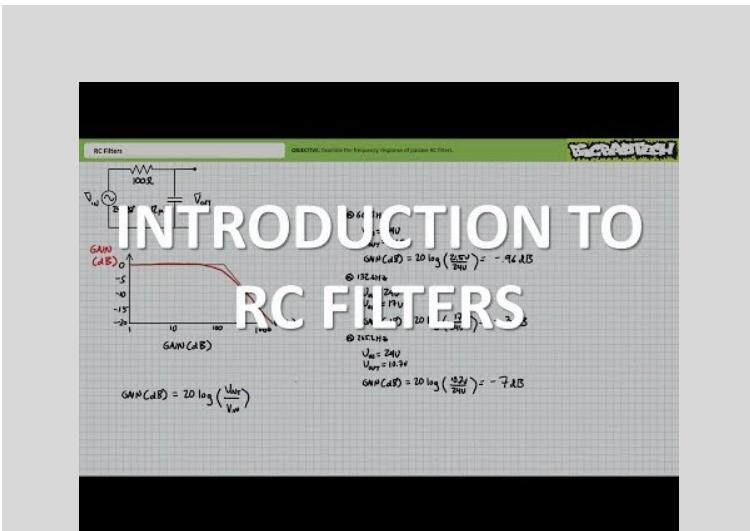


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[Logarithms and Decibels Study Guide](#)

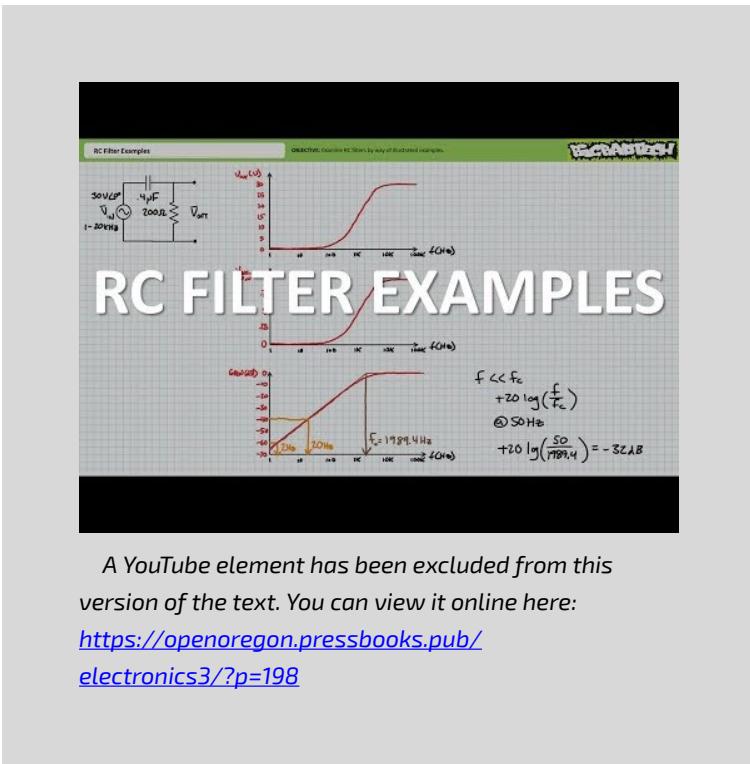
RC FILTERS



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[RC Filters Study Guide](#)

RC FILTER EXAMPLES



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RC Filter Examples Study Guide

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

ABOUT THE AUTHOR

Jim Pytel is currently an instructor at Columbia Gorge Community College's Electro-Mechanical Technology program where he teaches basic electronics, hydraulics and pneumatics, motor control, PLCs, digital logic, and power generation and transmission. He is a former Captain in the US Army and has worked in the semiconductor manufacturing and wind power generation industries. To see more of his online content check out his YouTube channel at: <https://www.youtube.com/user/bigbadtech>