

ECE 523
Symmetrical Components

Session 1

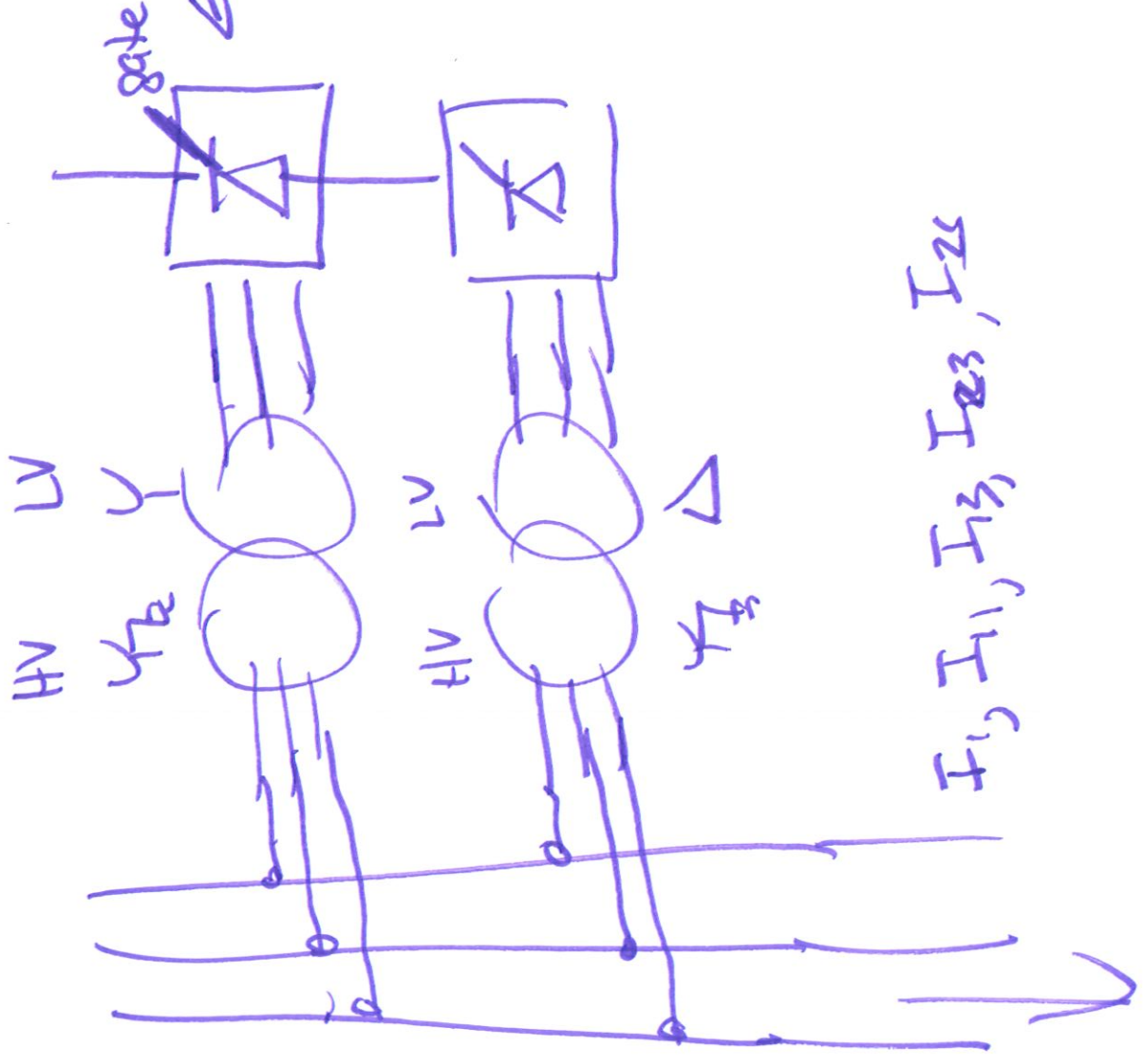
U I	Why Use Symmetrical Components?	<i>ECE523</i> <i>Lecture 1</i>
	Off-Line analysis: <ul style="list-style-type: none">• Analyzing unbalanced circuit conditions<ul style="list-style-type: none">» Steady-state or quasi-steady-state• Simpler computations by hand• Good for matrix methods<ul style="list-style-type: none">» <u>Approach used in most commercial</u> fault programs• But computer tools can overcome phase domain computational disadvantages	
<i>Introduction</i>		Fall 2023

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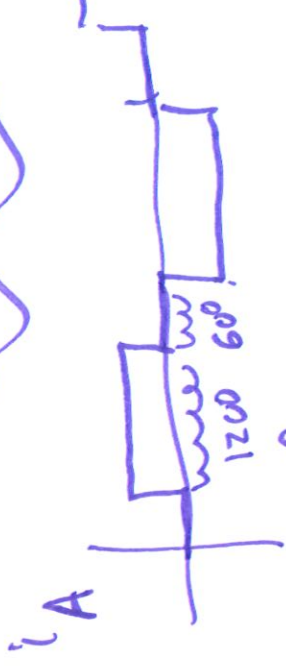
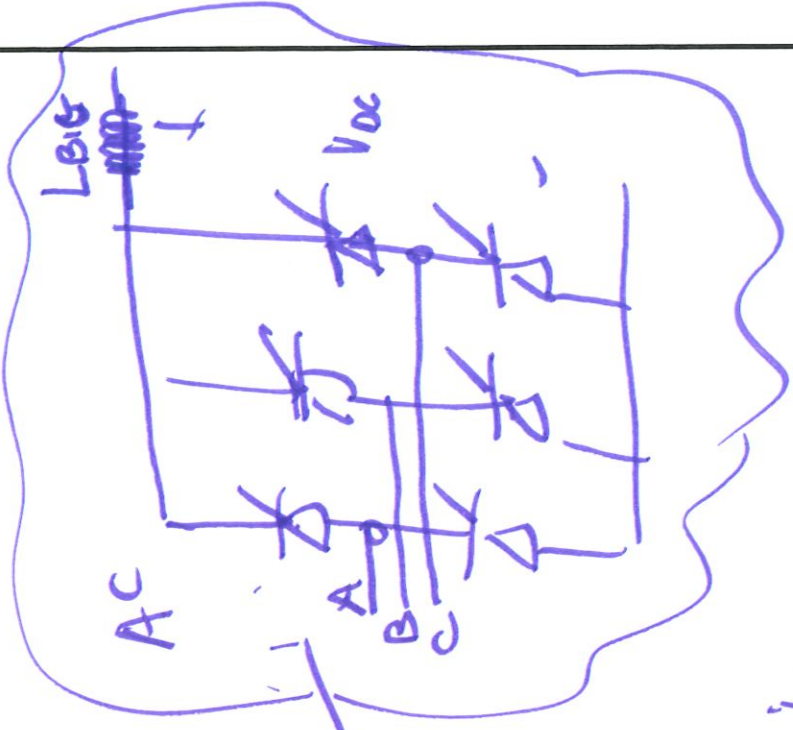
U I	Diagnostic Tools	<i>ECE523</i> <i>Lecture 1</i>
	<ul style="list-style-type: none">• Visualization of faults<ul style="list-style-type: none">» From fault programs» From event results• Signatures for faults to improve protection<ul style="list-style-type: none">» Speed of response» Sensitivity» Security	
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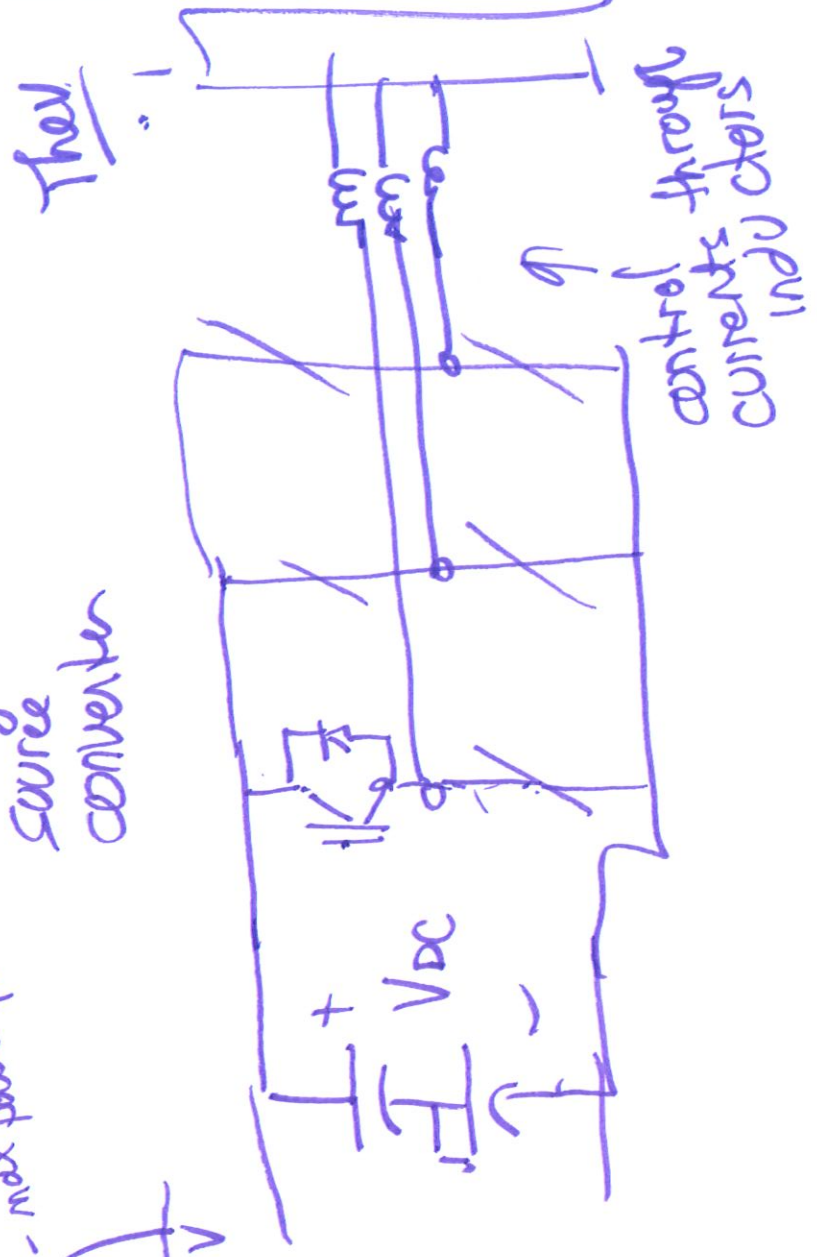
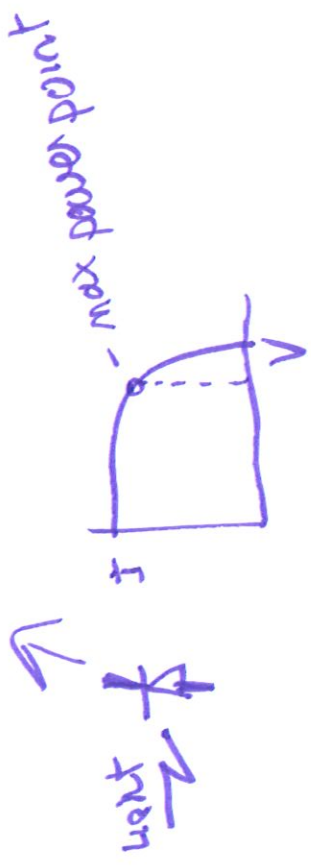
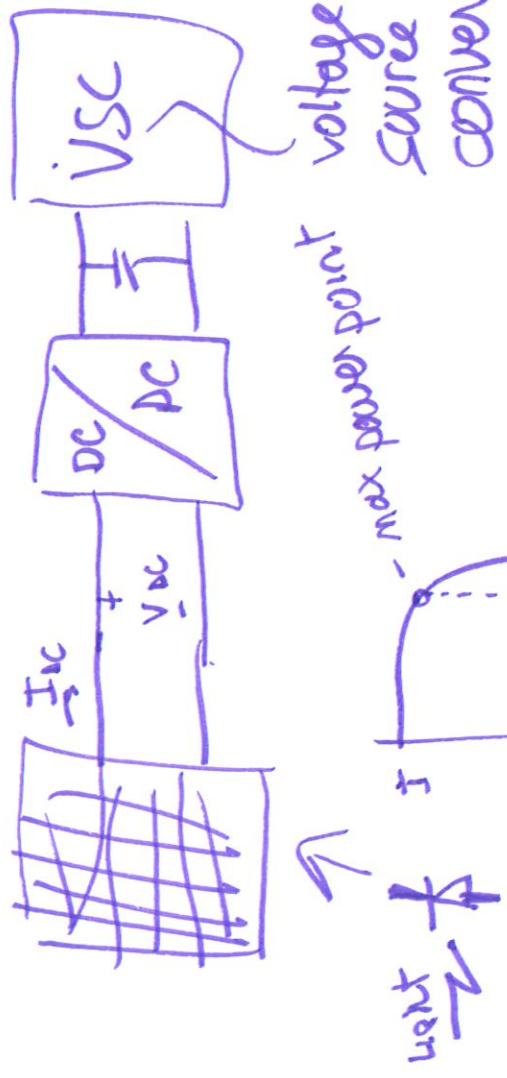
$I_{T1}, I_{T2}, I_{T3}, I_{T4}$



$i_1, i_5, i_7, i_{11}, i_{13}$

$$|I_h| \approx \frac{|I_{11}|}{h}$$

Photovoltaic Inverter (3Ø)



controls so
 converter feeds
 balanced current
 for unbalanced
 fault

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Harmonic Analysis

ECES23

Lecture 1

- Integer harmonics → starting from balanced 3 ϕ voltages
 - » Phase rotation varies for each harmonic
 - » Balanced three phase sets
 - Zero sequence: 0, 3, 6, 9, etc
 - Positive sequence: 1, 4, 7, 10, etc
 - Negative sequence: 2, 5, 8, 11, etc
 - » Design harmonic cancellation in some power converter configurations
- Space harmonics useful in machine design

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Power Converter Control

ECES23

Lecture 1

- Example: Voltage source converter
 - » Combine Park's transform and symmetrical components
 - » Synchronous reference frame for positive and negative sequence
 - » Add filters to remove double frequency

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IEEE 2000 standards repairing inverters to provided set percentages
 $d/I = I_c$ (negative sequence)
→ now angle too

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h/h 17
4/4

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