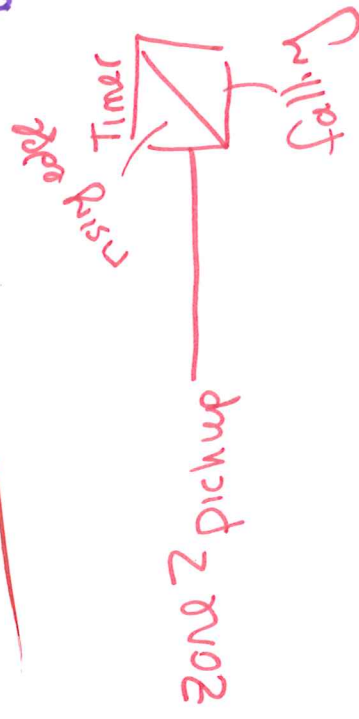
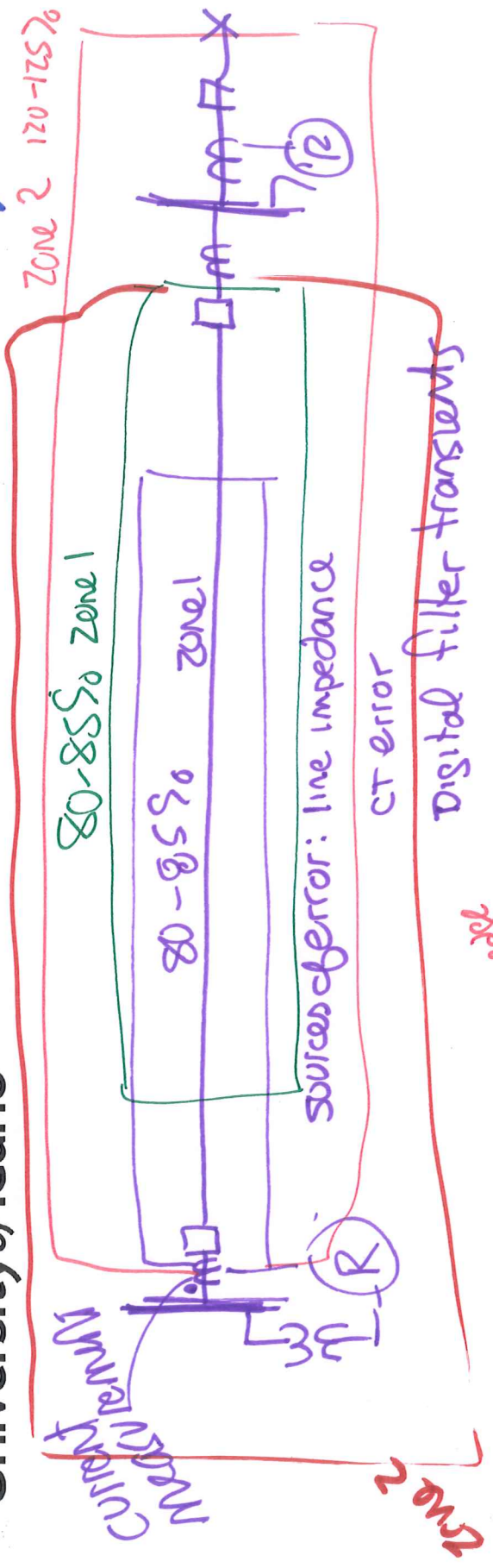


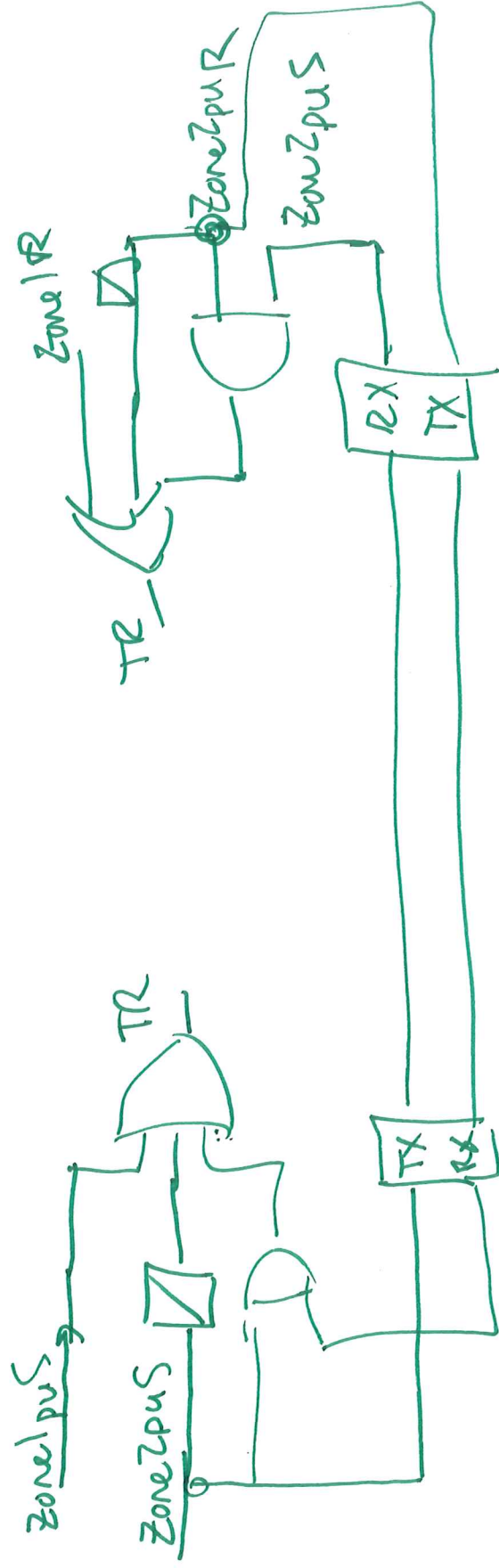
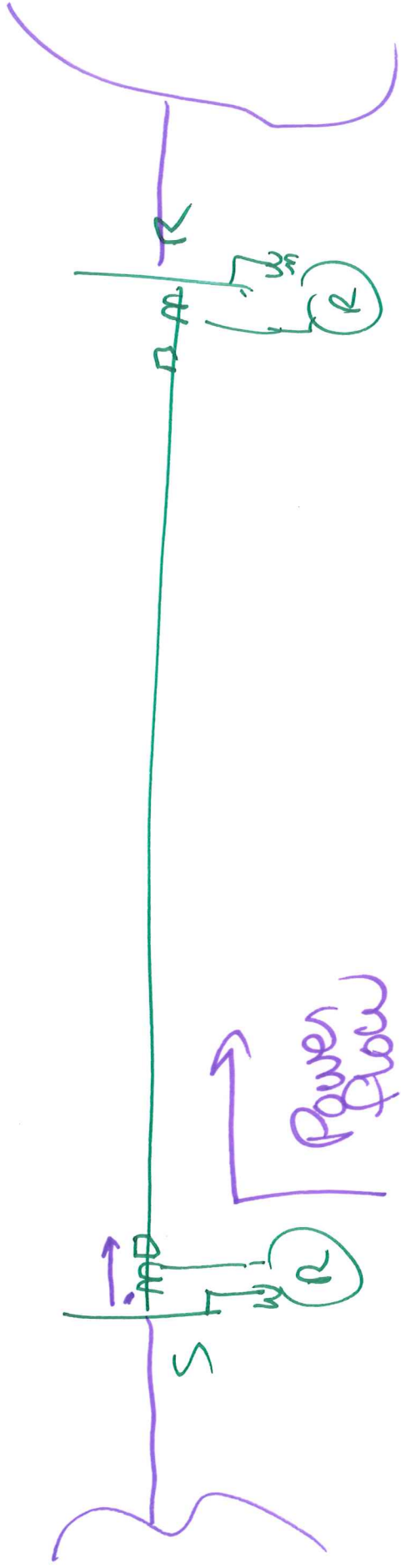
ECE 525

POWER SYSTEM PROTECTION
AND RELAYING

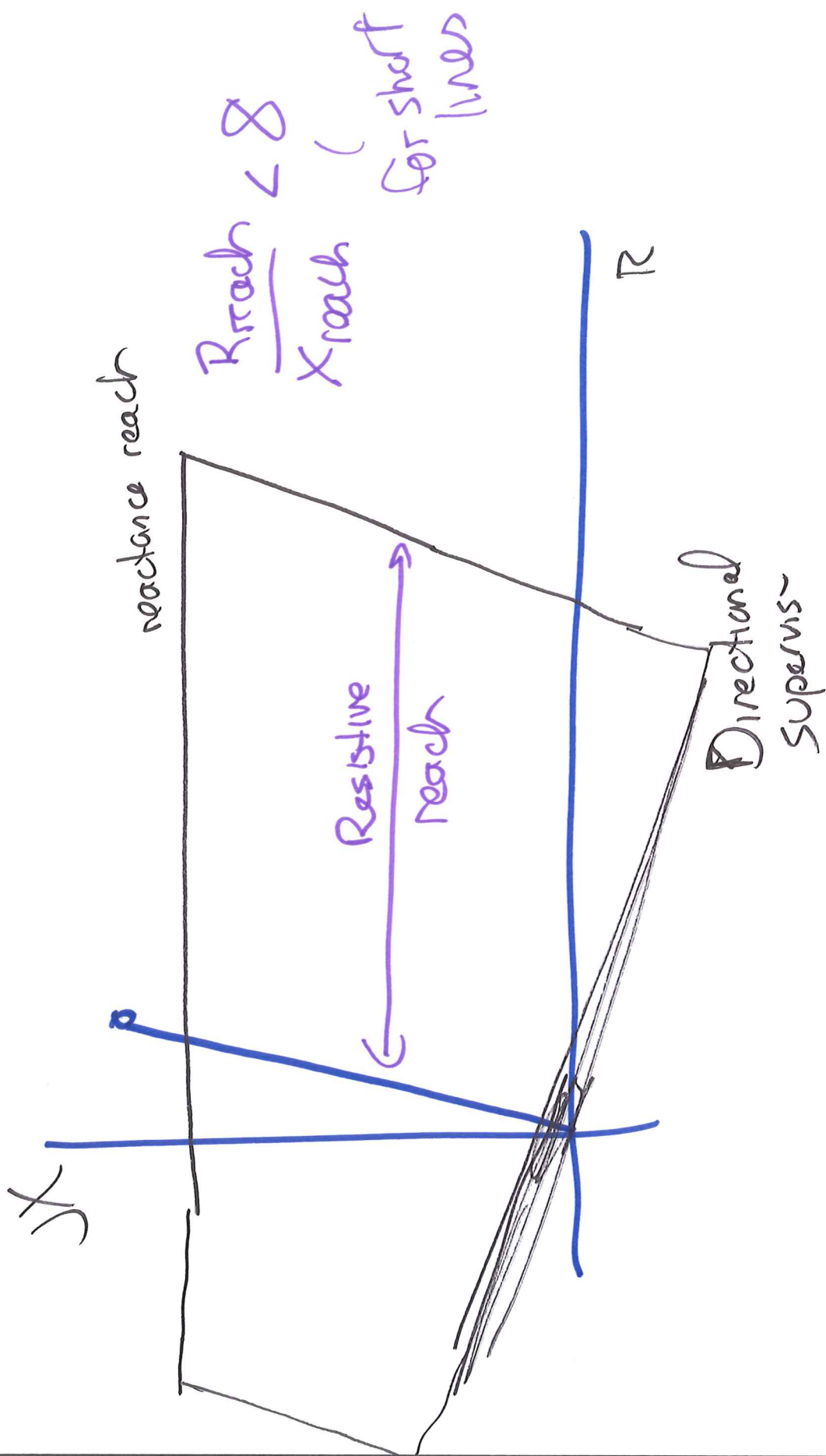
SESSION no. 3



- If fault in zone 1 for both ends - high speed trip
- middle 60% or so of the line
- Add communication to allow high speed tripping for all of the line

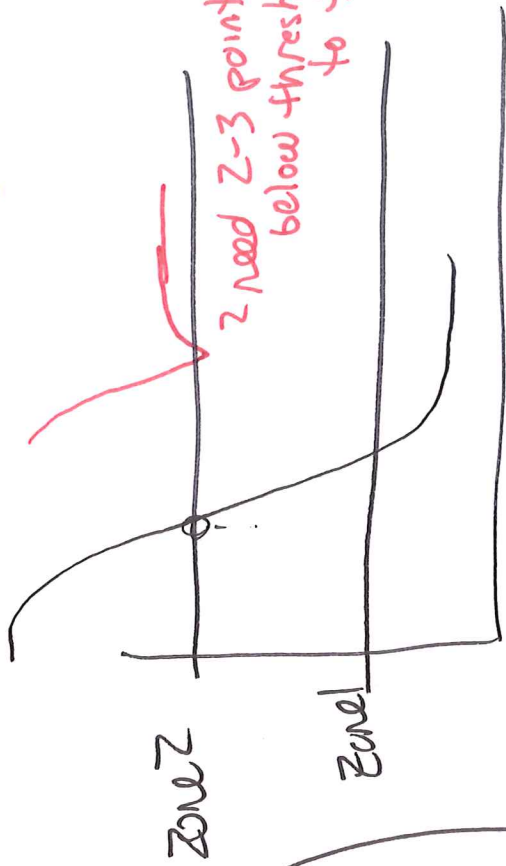
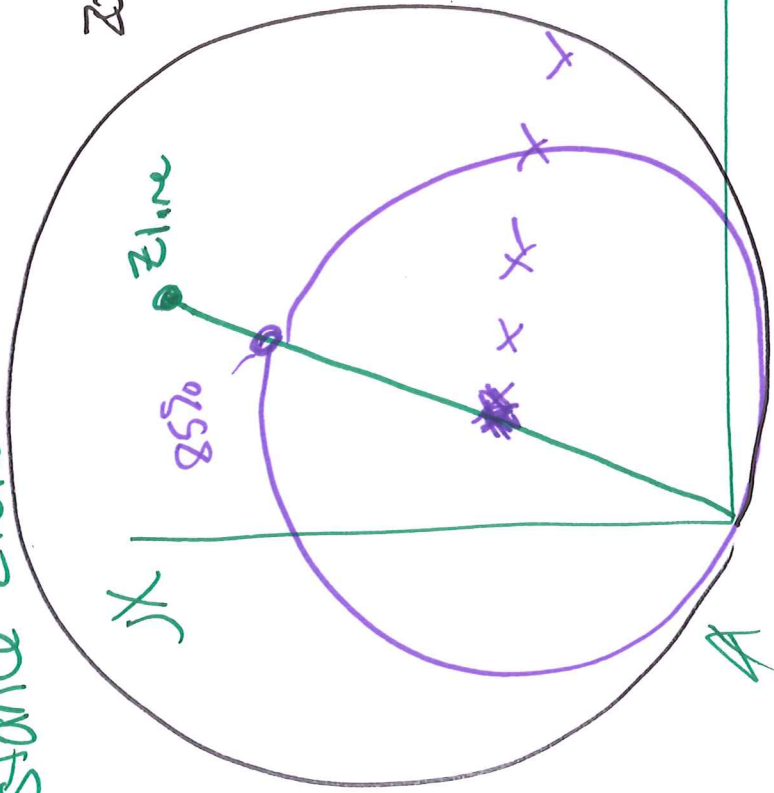


Permissive Overreaching
Transfer Trip



Distance Element

L3 4/11



- power flow out of bus

For measured Vmeas

compare with calculated effective impedance

$$Z_{eff} = \frac{V_{meas}}{I_{meas}}$$

$$Z_{AB} = \frac{V_{AG} - V_{BG}}{I_A - I_B}$$

$$Z_{AG} = \frac{V_{AG}}{I_A + k_0 I_0}$$

— ~~the~~ Polarizing reference

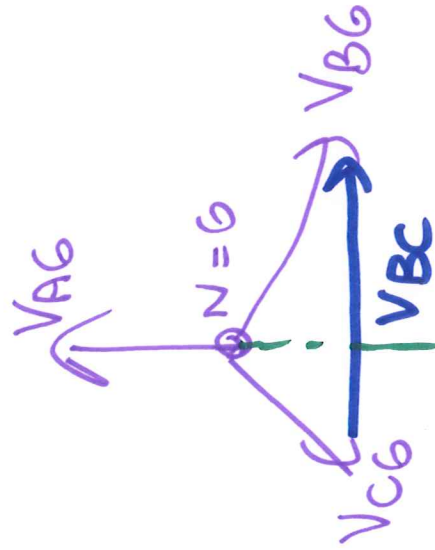
— Angle reference

— self polarizing

V_{AG} as V_{pd} for Z_{AG}

$V_A - V_B$ as V_{pd} for Z_{AB}

— CROSS polarization



V_{BC} as V_{pd} for Z_{AG}

~~V_{BC}~~ as V_{pd} for Z_{AB}

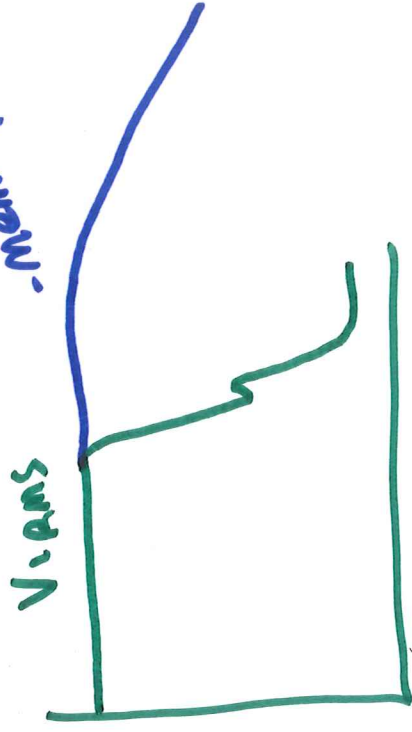
with microprocessor reboys

$-(V_B + V_C)$

$\rightarrow -j\sqrt{3}$

Memory Polarization

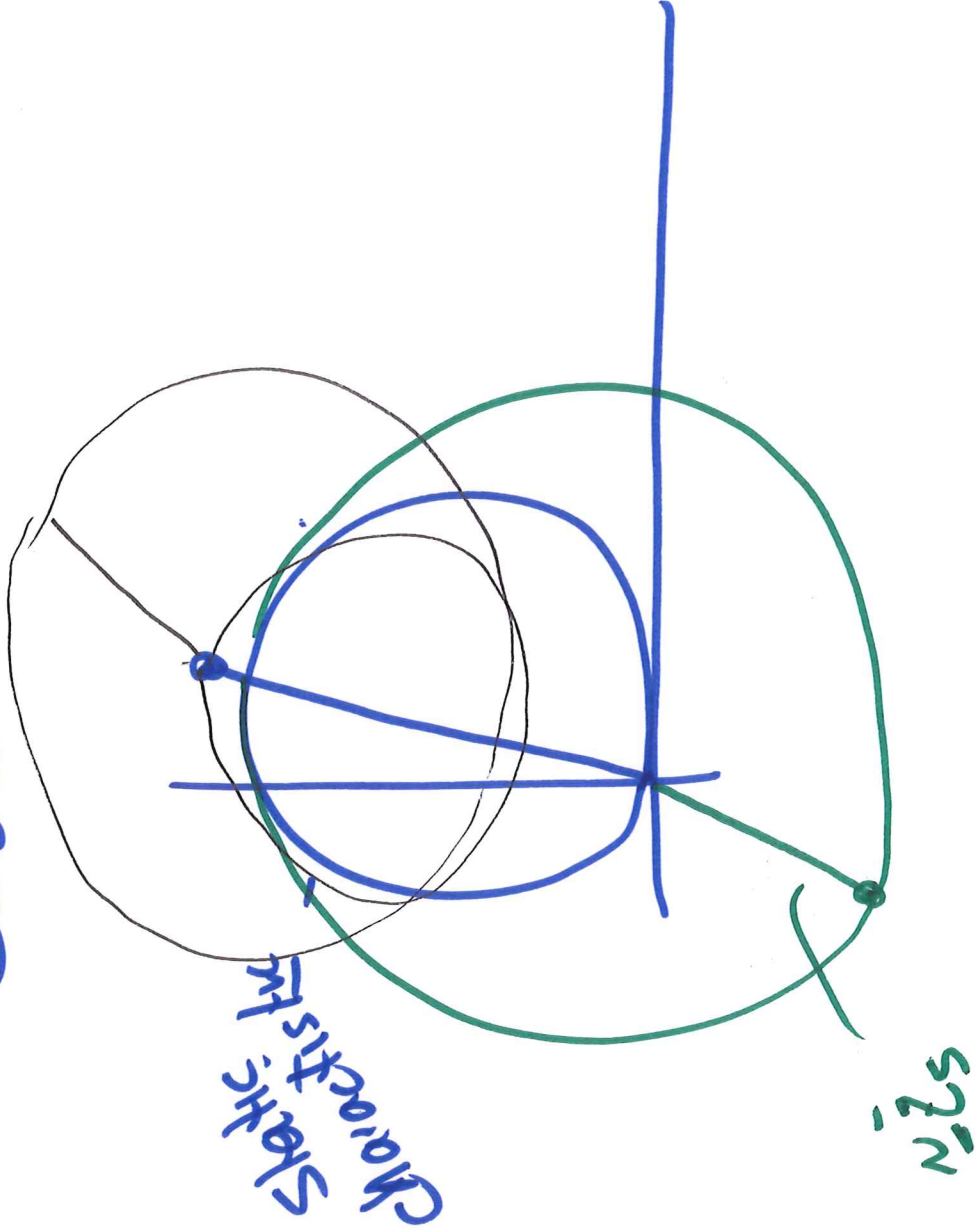
- Memory filter



V_i pos sep

VA6

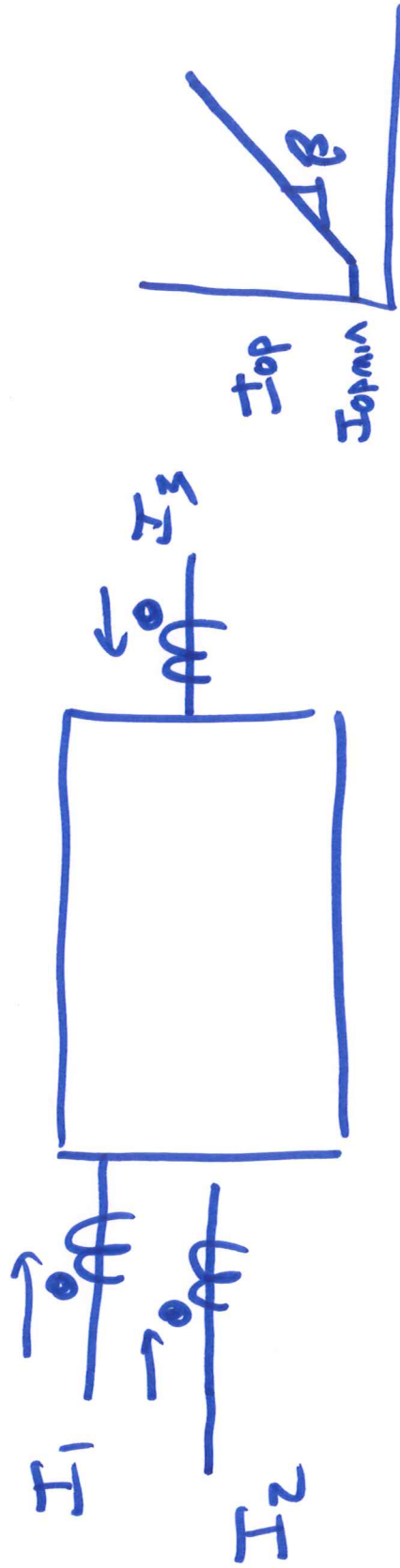
- Cross polarization or memory polarization
causes MnO expansion. ~



Communication Cased

Line current differential protection -

→ Differential Element - (87)



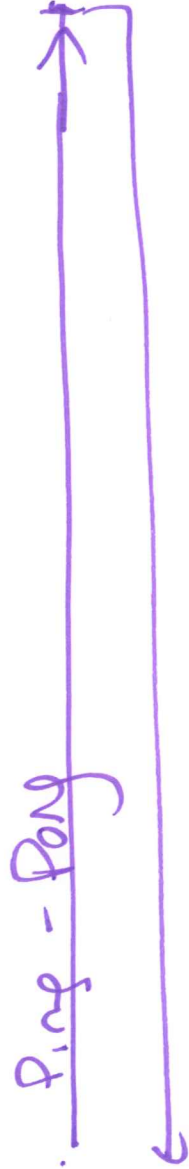
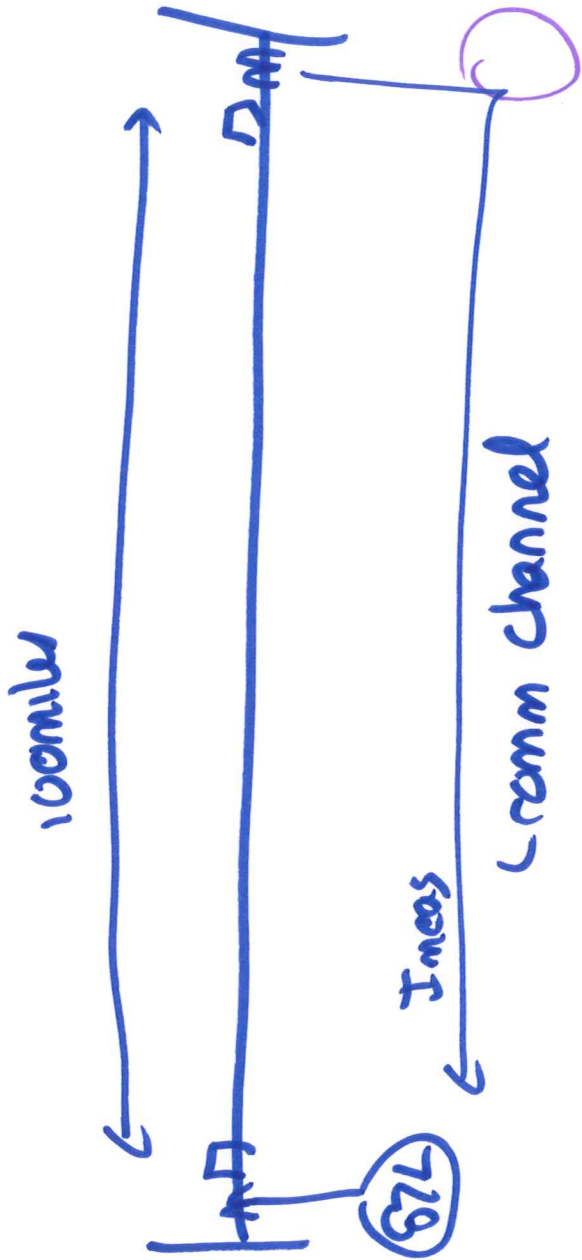
Normally $\bar{I}_1 + \bar{I}_2 + \bar{I}_3 \approx 0$

$$I_{op} = |I_1 + I_2 + I_3 + \dots|$$

$$I_{RT} = |I_1| + |I_2| + |I_3| \dots$$

TR if

$$I_{op} > \beta I_{RT}$$



L3 10/11

U
I

Role of Communication

ECE525

Lecture 1

- Line protection far faster when can compare with other end of line
- Can locate fault zone
- Need to have adequate back-up in case communication is lost
- Redundancy--does communication go as a result of the fault?

Introduction

Fall 2018

U
I

Cybersecurity

ECE525

Lecture 1

- Information technology (IT)
- Operation technology (OT)
 - » Industrial control systems
 - » Referred to as CS in Table 1.1
- Very different priorities
- NERC Critical Infrastructure Protection

Introduction

Fall 2018

L3 11/11

UI

Future Directions

ECES25

Lecture 1

SAMPLED VALUES

- • IEC 61850 Process Bus
 - » Measurements processed at measurement devices and broadcast on substation bus
 - » Relays (possibly more general purpose)
 - Subscribe to measurements
 - Provides more flexibility and speed
 - Design concerns for reliability and security
- Phasor measurement based schemes

- GPS time stamps

Introduction

- wide area

Fall 2018

control
&
protection

