ECE 526

PROTECTION OF POWER SYSTEMS II

SESSION no. 31

Motor Protection

→ 3Ø motors

→ Induction motors
- line fed

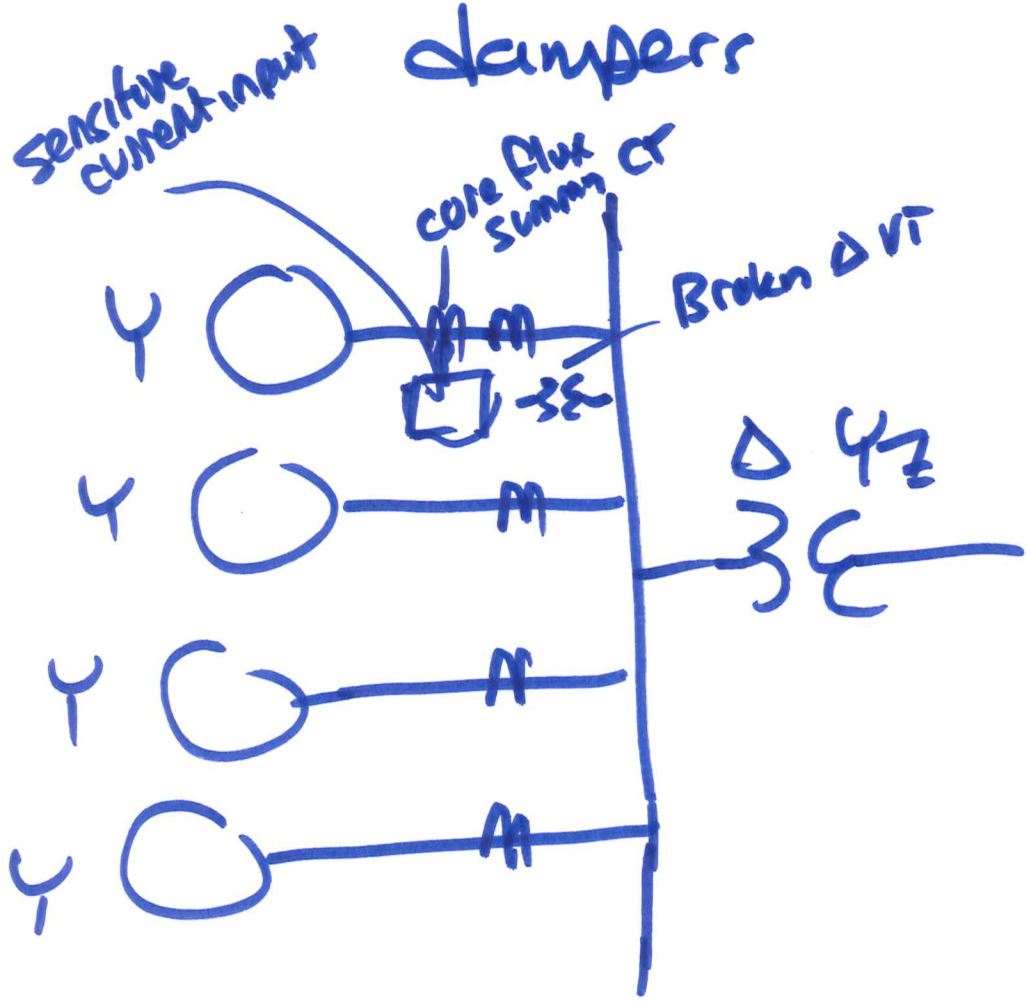
→ Adjustable Speed Drives (or any sort of drive)

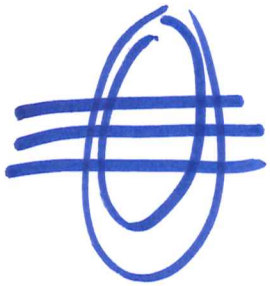
- Drive has own protection

- Synchronous motors
  - Protection scheme mostly similar to synch generator

University of Idaho

- synch motors start as induction motors using dampers





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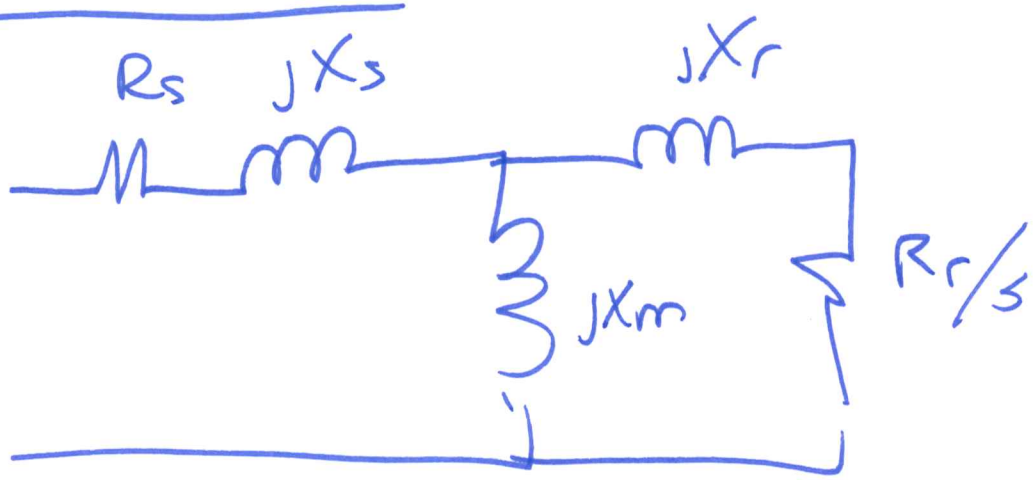
Induction



Protection based on thermal limits

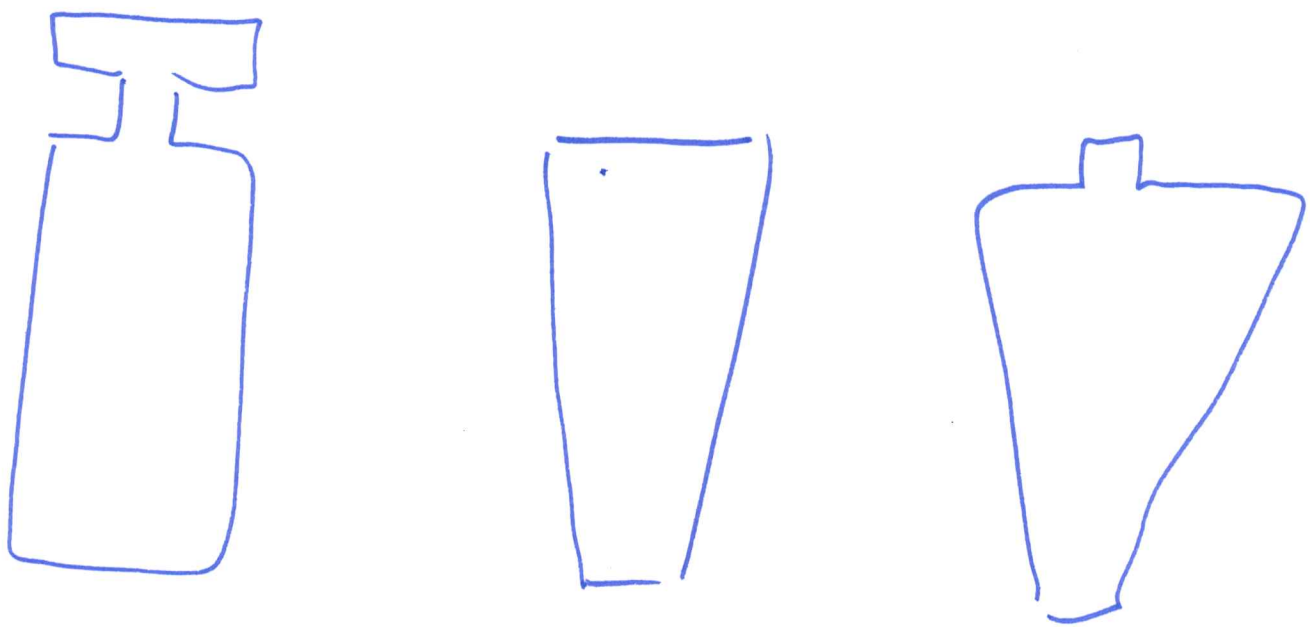
Standard positive sequence equivent circuit

Negative seq

Startup — $s = 1$

Rotor current frequency --- stator frequency

- Heating from I^2R in rotor



- Higher R at startup
- Higher current at startup

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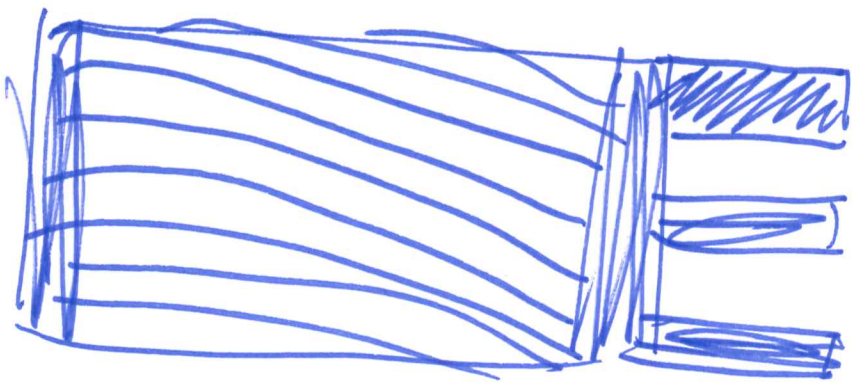
- less cooling at start up



- start up (or stall)
  no cooling

- inertia impacts starting time
  acceleration ⇒ heating

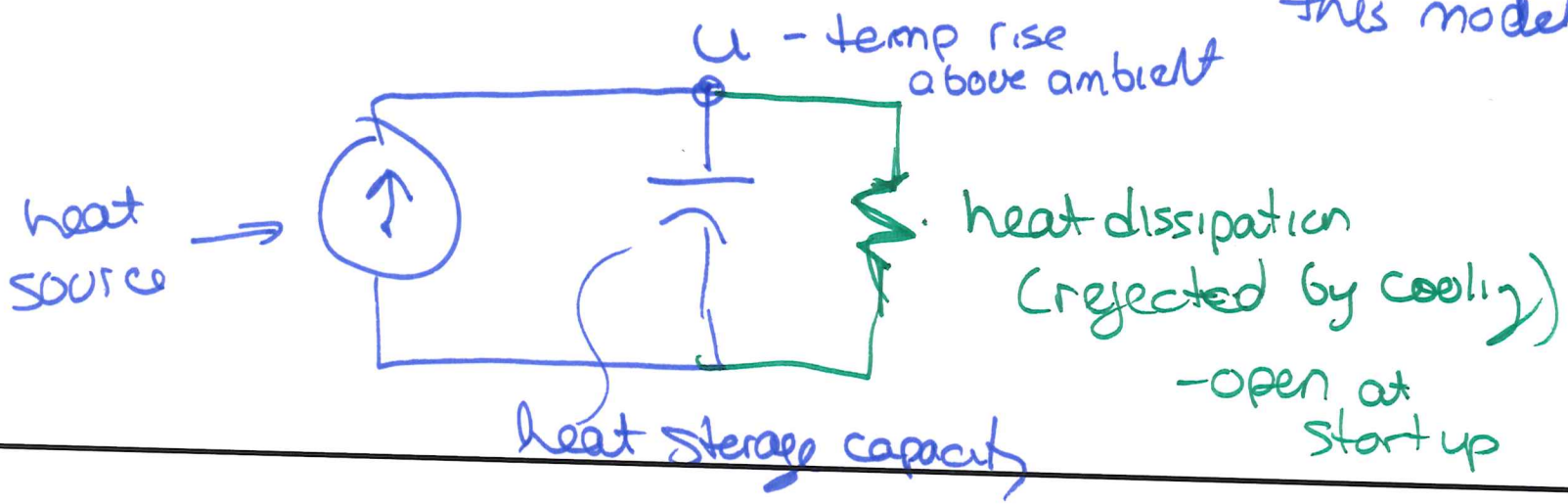
- Modern motor relays have thermal models for ~~Mo~~ motors

2 thermal models

① Start up / locked rotor model)

- uses measured current

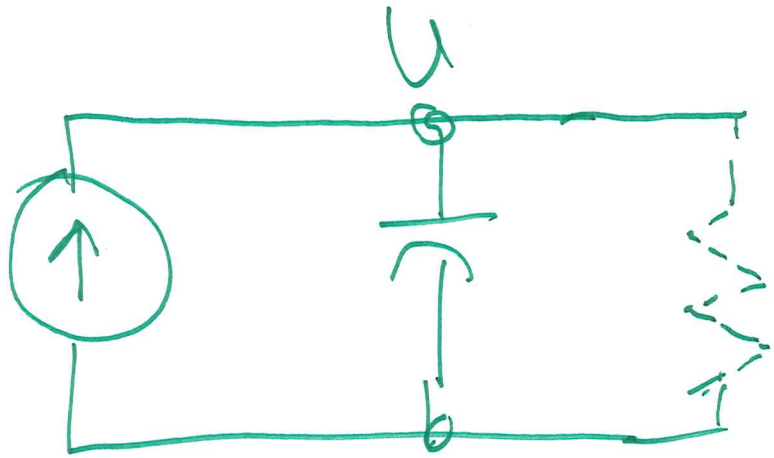
- If $I_1 > 2.5 * I_{nom}$ changes to this model



Startup

$$\frac{R_1}{R_0}\left(I_1^2 + I_2^2\right)$$

pos neg

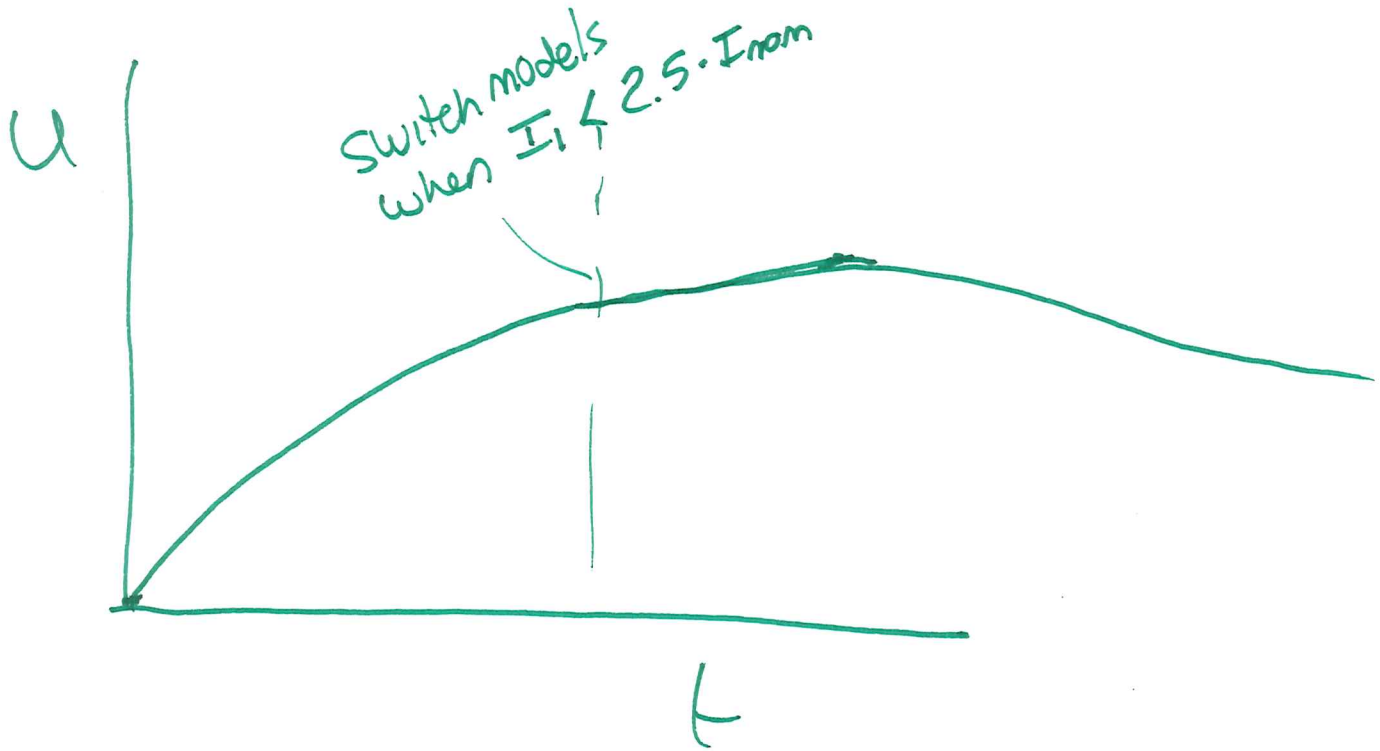


where:

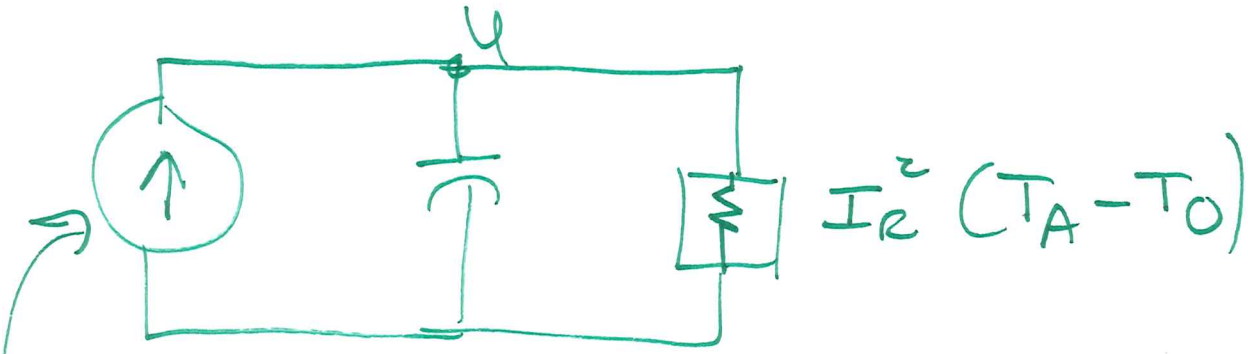
$R_1 \equiv$ rotor resistance under startup

$R_0 \equiv$ Rotor resistance at rated speed

plot of u vs time for normal start up



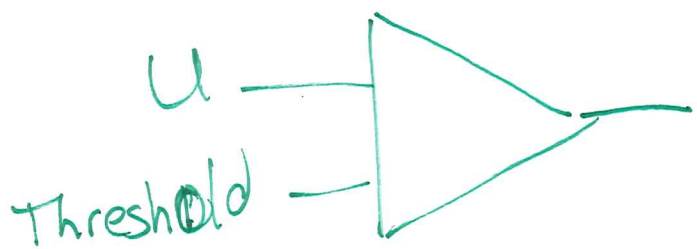
Run model



$I_1^2 + 5 I_2^2$

↑

assuming an effect of I_2 on heating



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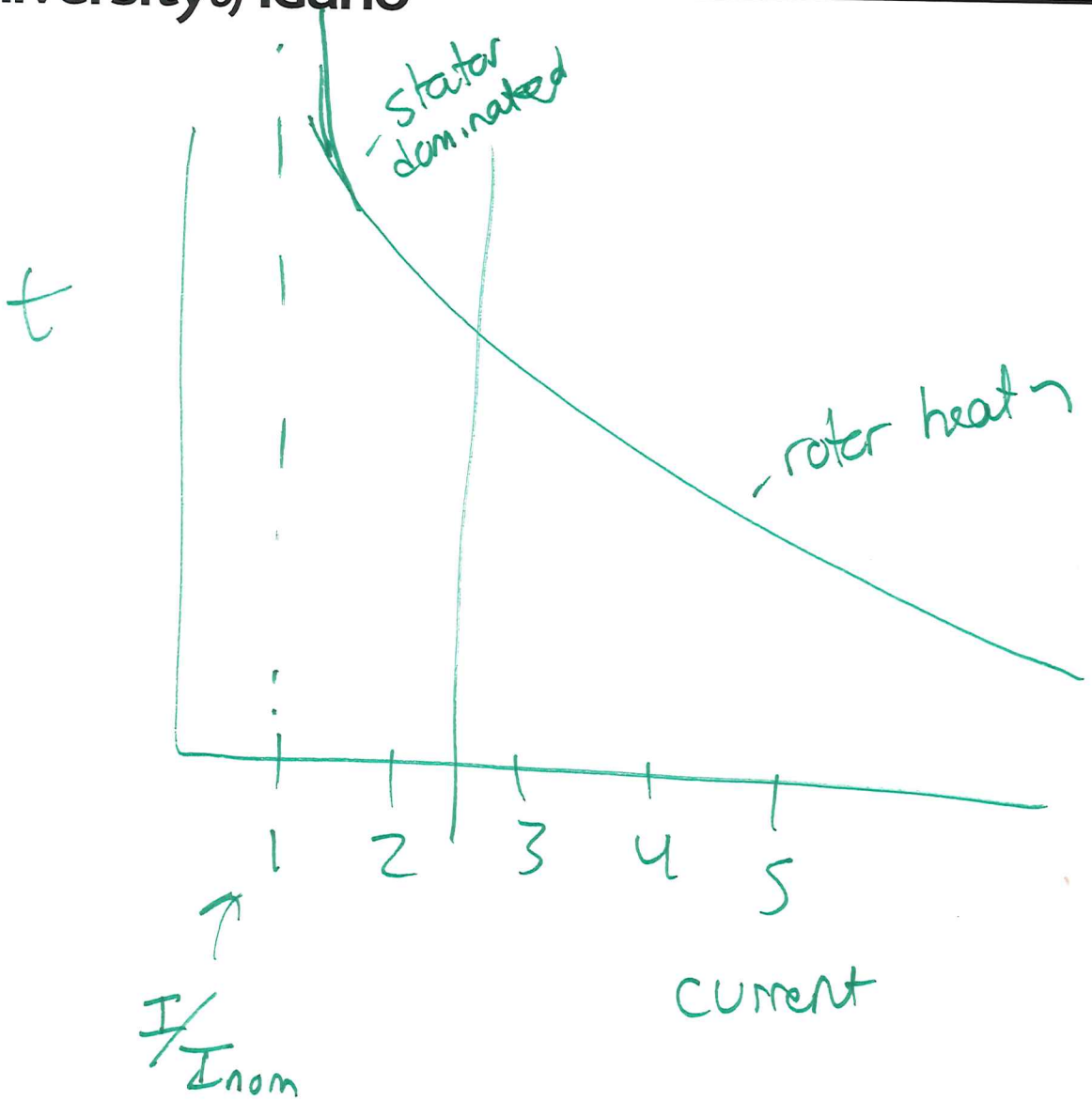

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Other concerns with motor protection

- faults
  - in the motor itself
  - on the system
    - voltage sag.
      - draws ~~motor~~ more current
        - slows down -
        - Stalls
- motor bus transfer
- Power system impact of ~~to~~ higher Q draw.

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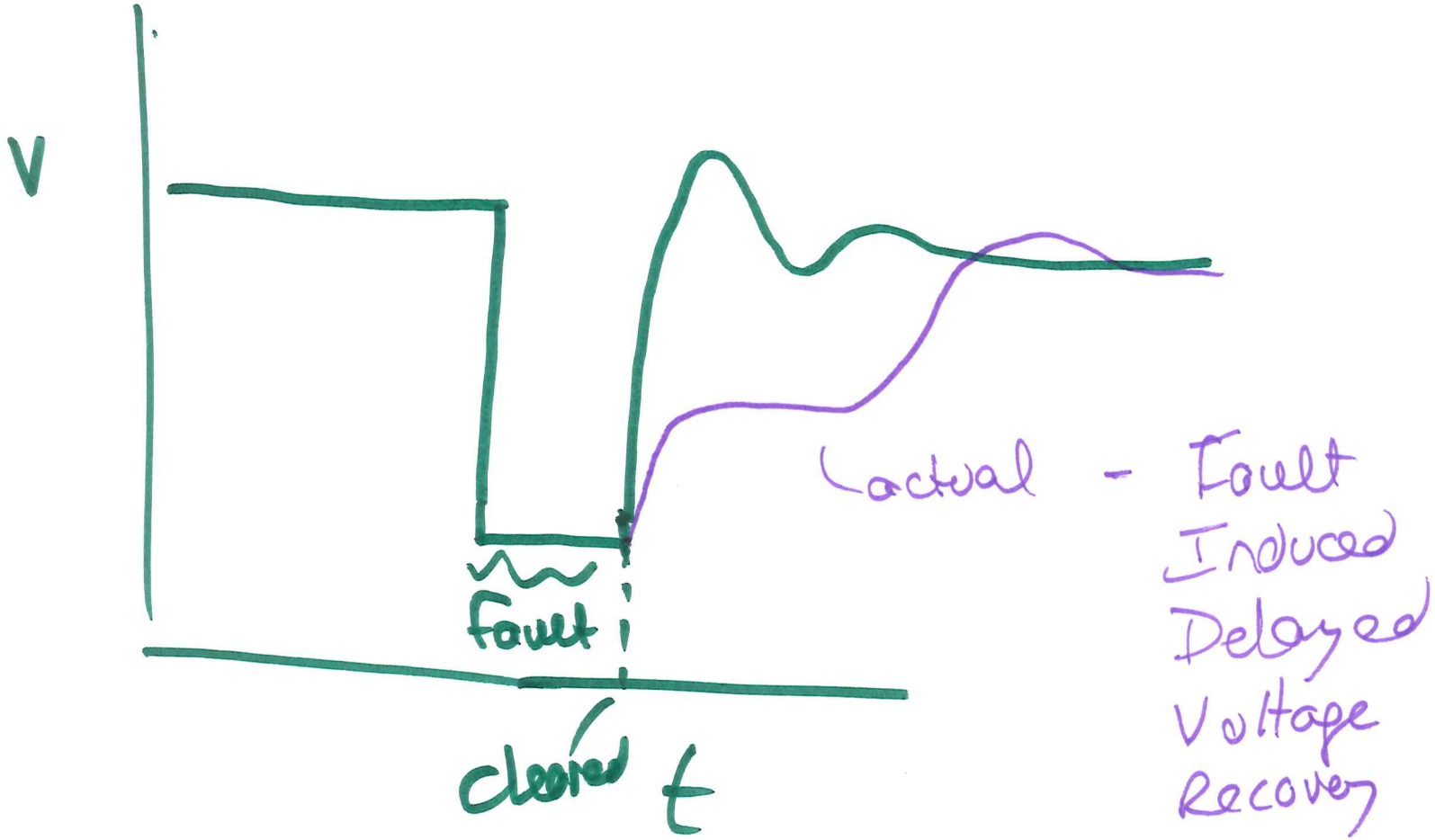
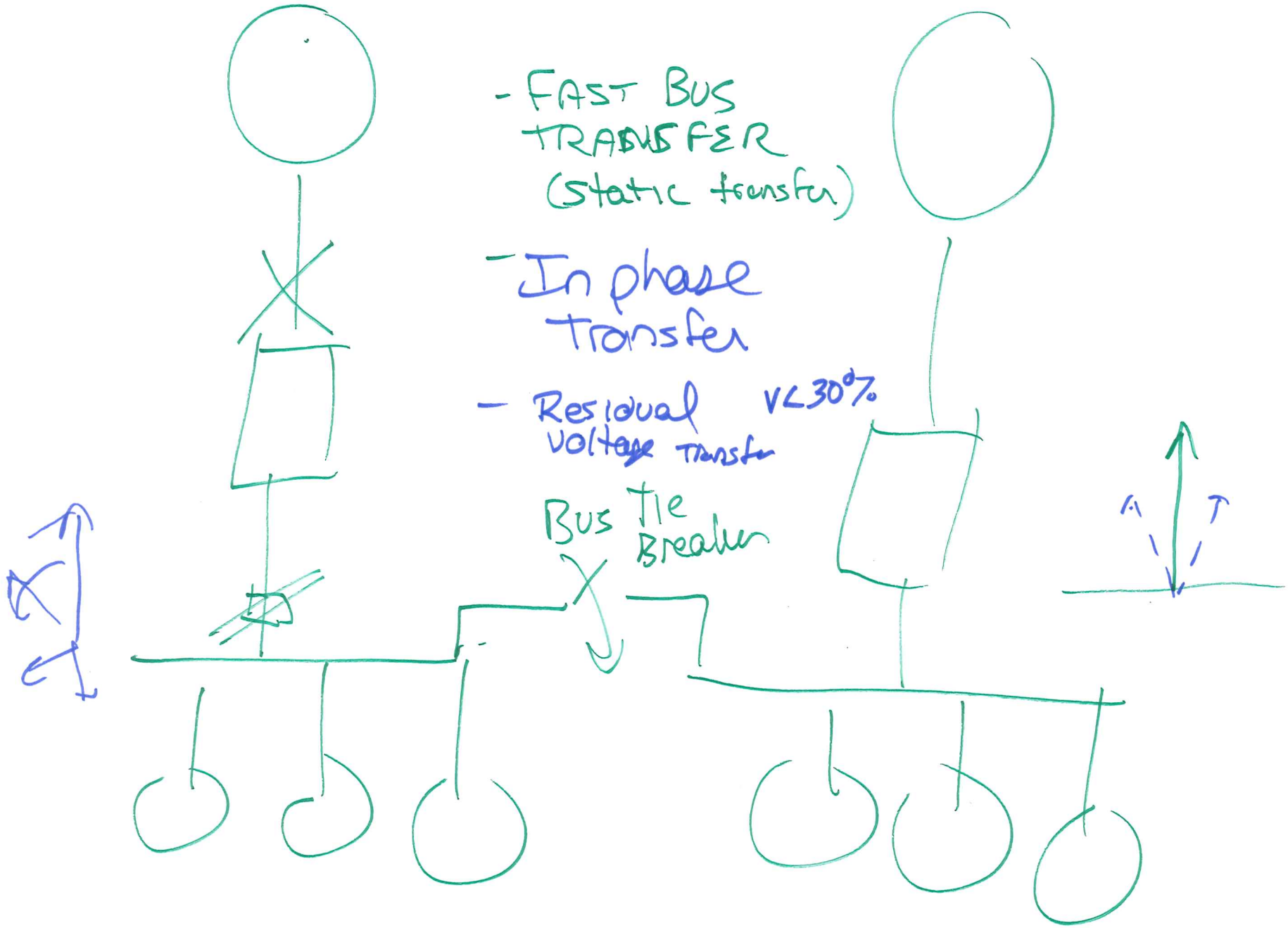


FIDVR


- FAST BUS TRANSFER (static transfer)
- In phase Transfer
- Residual Voltage Transfer
V<30%
Bus Tie Breaker