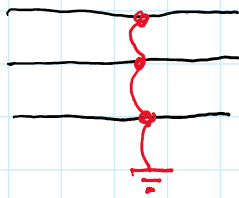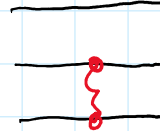# Types of Faults
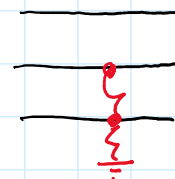
3- Phase

3 - Phase to Ground

SLG
(A-G)
(B-G)
(C-G)

LL
(A-B)
(B-C)
(C-A)

LLG
(ABG)
(BCG)
(CAG)

SLG — 70 - 80% ✓
LLG — 10 - 17%
LL — 8 - 10%
3ϕ — 2 - 3% ✓
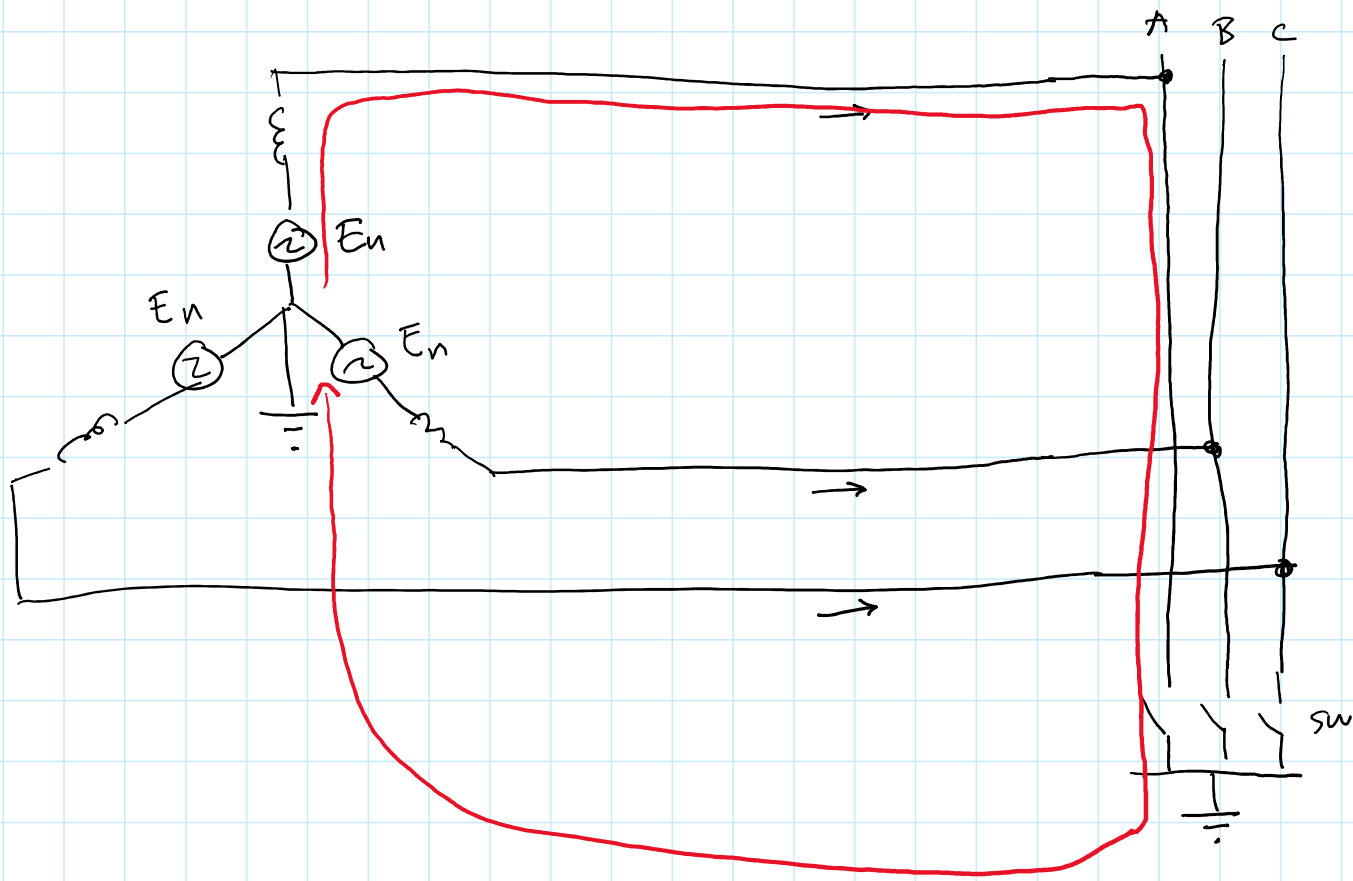
Fault Contribution
✓ Grid (Collections of N generators)
✓ Generators (Synchronous)
✓ Motors (Induction, Synchronous)
↓ ↓
1-2 cyc   4 cycles

Why Calculate?
① Maximum Fault — Circuit breaker ratings, Relay Coordination
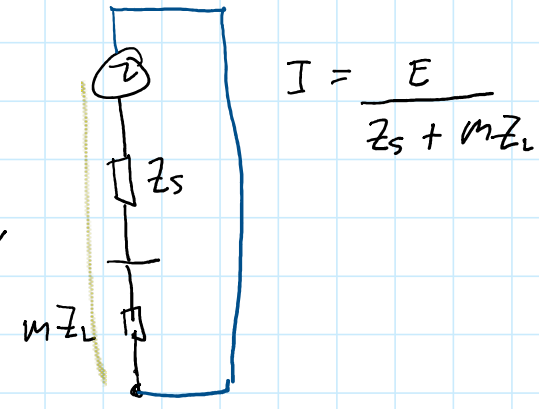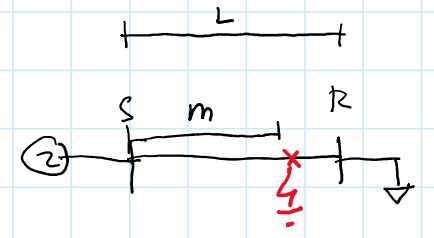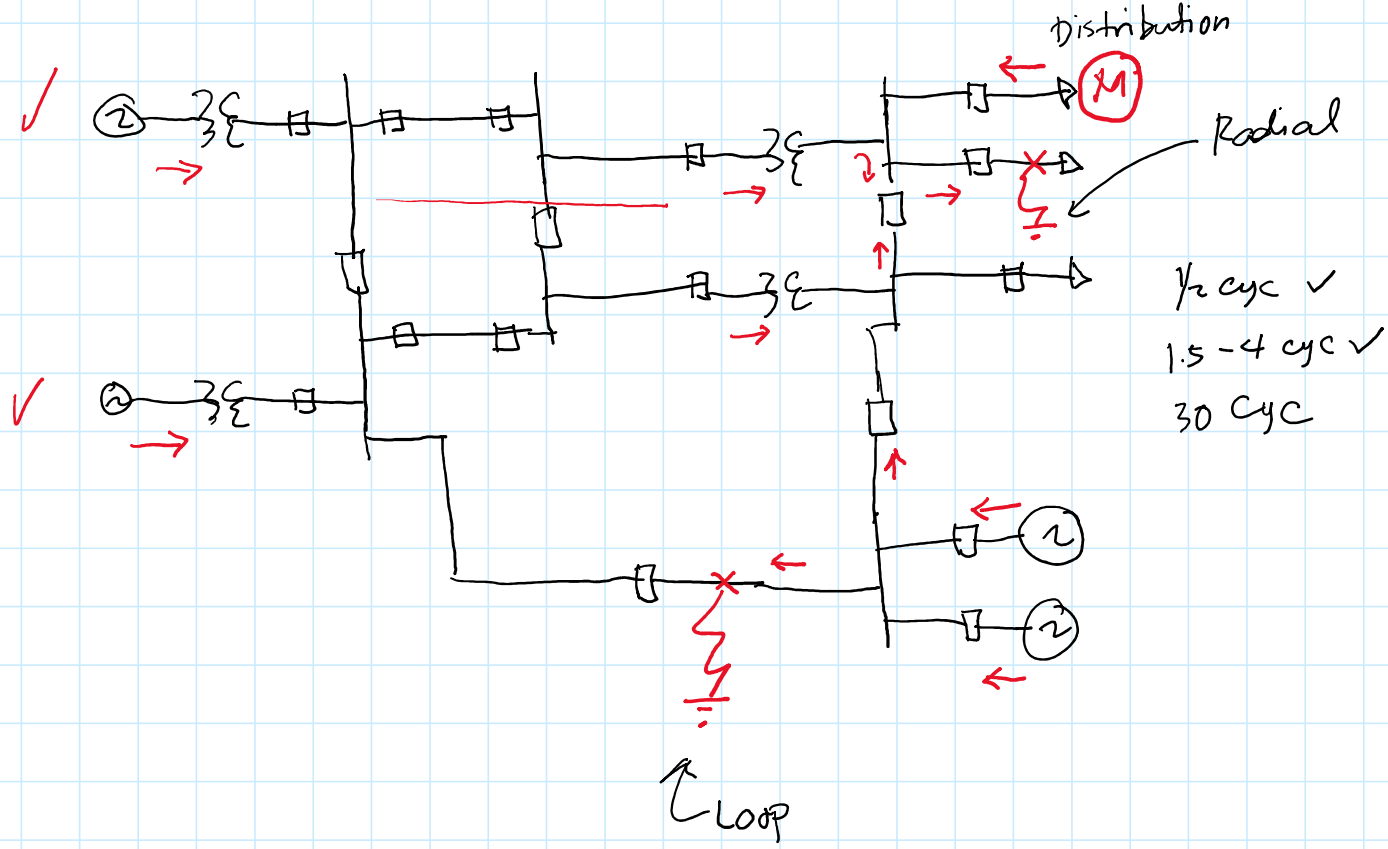② Minimum Fault — Relay sensitivity, coordination

$$I_A = E_{An}/Z_G = I \angle \phi$$

$$I_B = I \angle(\phi - 120)$$
$$I_C = I \angle(\phi + 120)$$

A B C

En

En

En

En

sw

Radial Vs Loop System

Distribution

Radial

½ cyc ✓

1.5 - 4 cyc ✓

30 cyc

Loop

$$I = \frac{E}{z_s + m z_L}$$

Faults on Radial Line

Faults on Loop System

$$L$$

$$Y_{\frac{1}{2}} \quad S \xrightarrow{m} \quad R \quad Y_{\frac{1}{2}}$$

Z_S

S

$m Z_L$

Z_R

R

$(1-m) Z_L$

$1pu$ $1pu$

Z_S $j0.1pu$ Z_R $j0.2pu$

S R

$m Z_L$ $j0.6pu$ $j0.4$ pu $(1-m) Z_L$

$$I_S = \frac{1}{j0.7} = 1.43 \, pu$$

$$I_R = \frac{1}{j0.6} = 1.67 \, pu$$

$j0.7 pu \quad\downarrow\quad j0.6 pu$
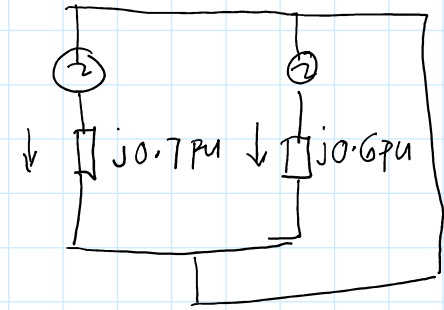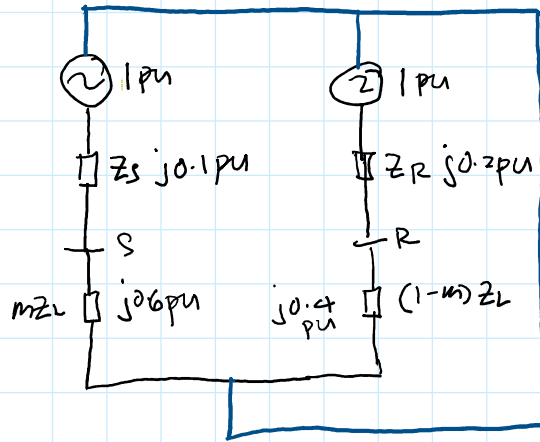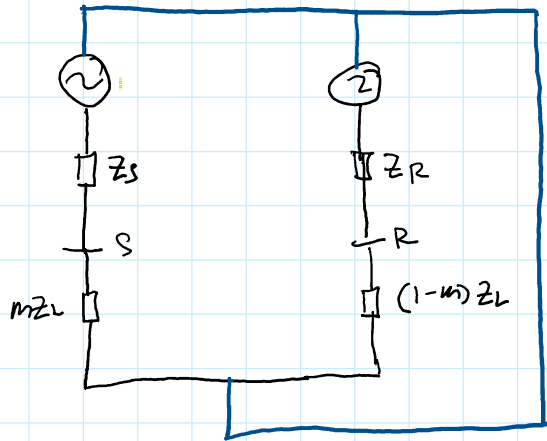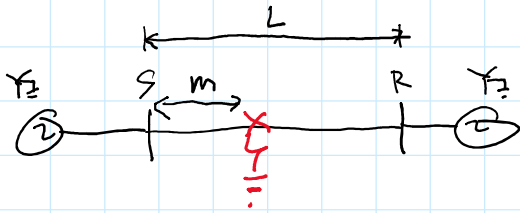
$$Z_{TH} = \left(\frac{1}{j0.7} + \frac{1}{j0.6} \right)^{-1} = j0.32 \, pu$$

$$I = \frac{E}{Z_{TH}} = \frac{1}{j0.32} = 3.125 \, pu$$

$$I_S + I_R = 1.43 + 1.67 = 3.1 \, pu$$

Voltage Profile During Fault

Va   φ
Ia
Ic
Ve   Ib   Vb

Normal Operation

Ic   Va
φ
Ve   Vb
Ia
Ib

Fault Condition
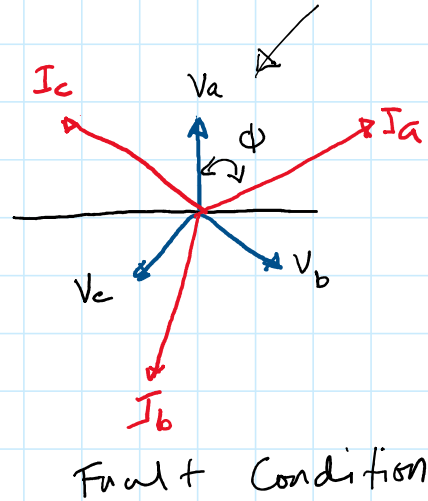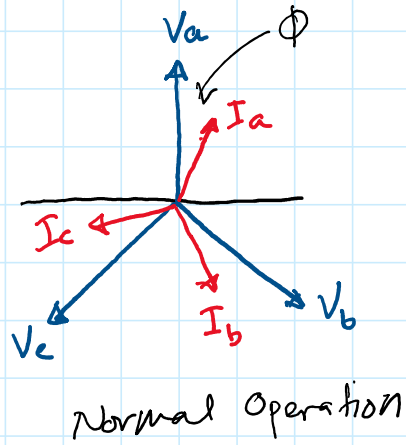
① Voltage collapses
② Current magnitude increases
③ Current angle increases

Val   No Load   Val