

SAARC Training Workshop 'Power System Studies for Synchronization of Multiple Systems'

Balanced 3-Phase Fault Close to Generator

Day-2-B

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Generator under 3-Phase Symmetrical Fault

Post Fault Scenario

Sub-Transient period

- Lasts few cycles
- Current amplitude decays rapidly, say with a time constant of 20 ms (1 cycle)

Transient period

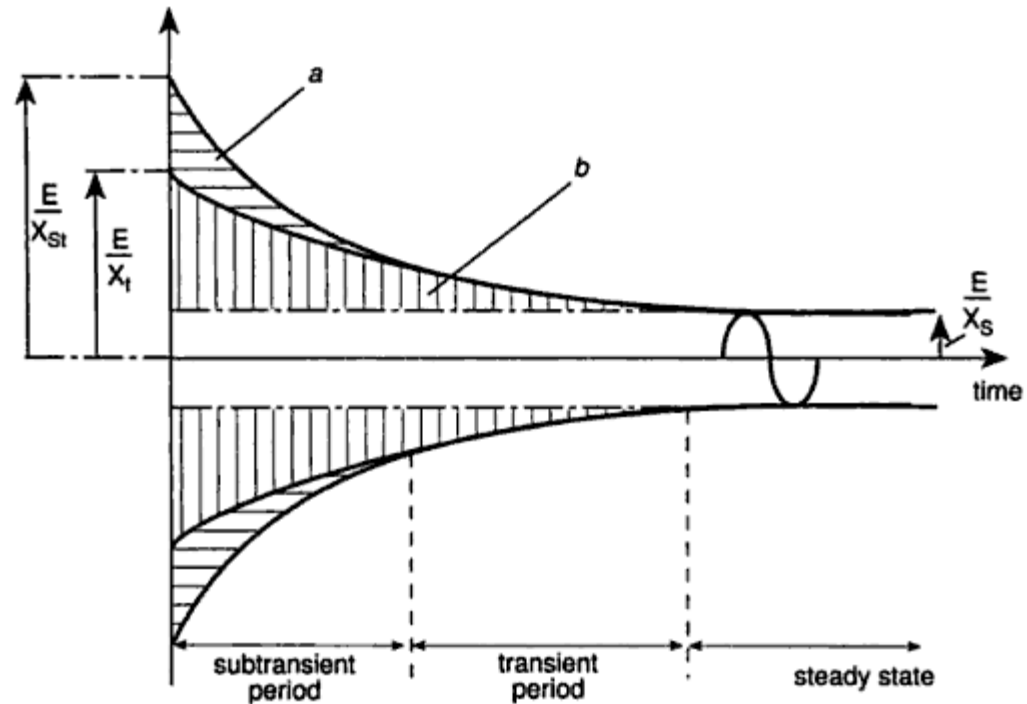
- Lasts 2-5 seconds
- Current amplitude decays slowly, say with a time constant of 1 second

Steady state period

- Current amplitude remains constant
- Symmetrical current envelop for 3-Phase fault as shown in Figure.

Shaded area a = subtransient current decay

Shaded area b = transient current decay



Generator under 3-Phase Symmetrical Fault

At the instant of fault occurrence, the fault current is limited by subtransient reactance X_{st} or X'' or more appropriately X''_d

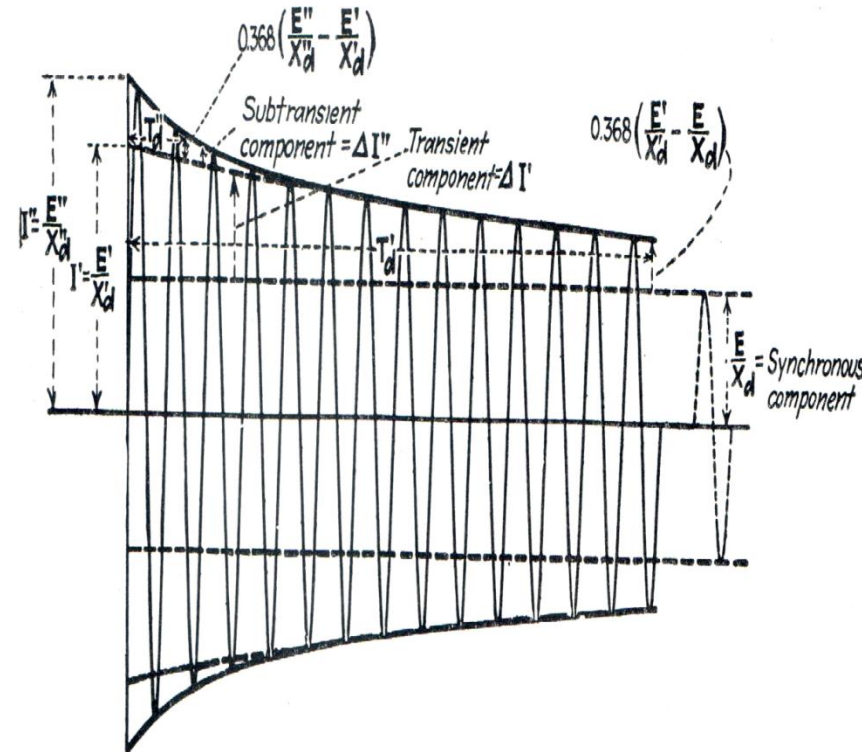
$$I_{sc} = I'' = \frac{E''}{X''_d}$$

During transient period, the transient current is limited by transient reactance X_t or X' or X'_d

$$I' = \frac{E'}{X'_d}$$

During steady state the current is determined by synchronous reactance X_s or X_d

$$I = \frac{E}{X_d}$$



Modeling System for 3-Phase Symmetrical Fault

Generator model

- Generator rated MVA (Own base MVA)
- Sub-Transient Reactance = X''_d P.U. at Generator rated MVA (Own base MVA) or system common base (100 MVA)

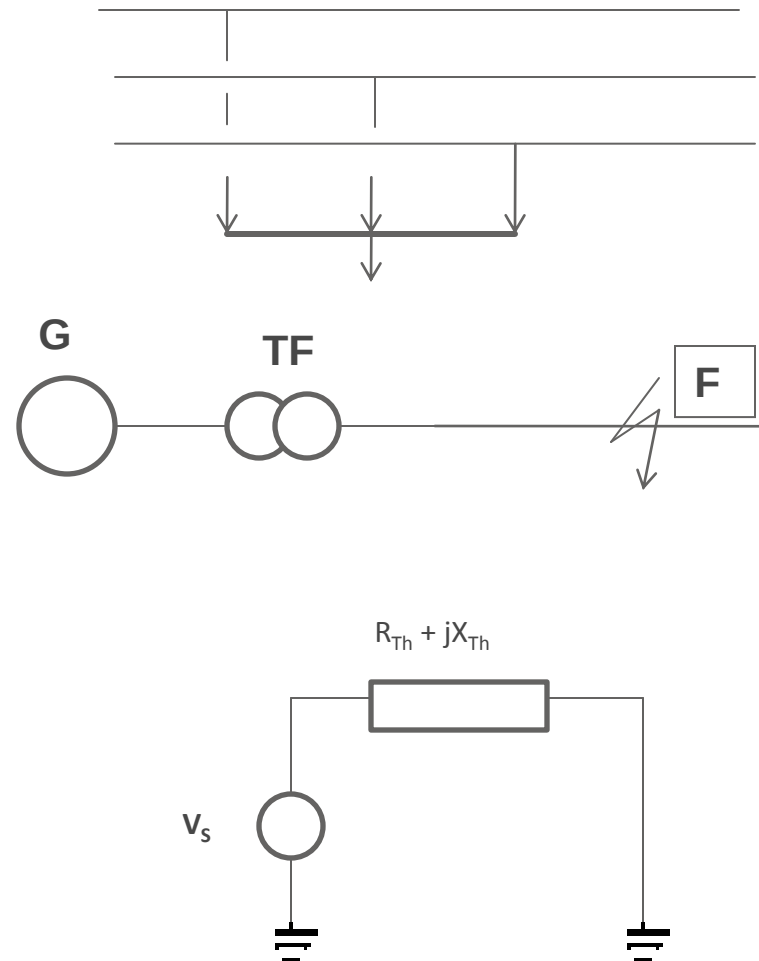
Step-up Transformer

Reactance = X''_d at rated MVA (Own base MVA) of GSU or system common base (100 MVA)

Transmission Line

R, X and B at system common base (100 MVA)

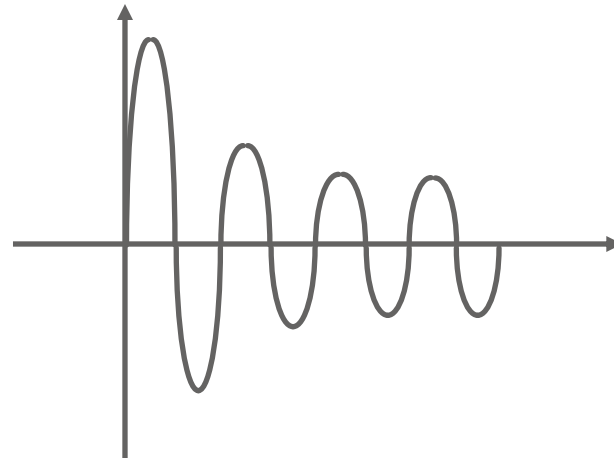
R, X and B of balanced 3-phase symmetrical system are +ve sequence components



Generators and Fault levels

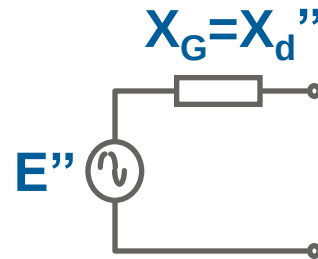
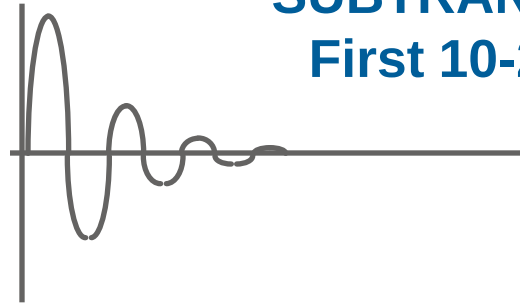
Faults Close to Generators

- For close-up faults the current supplied by the generator decays exponentially
- Generator is represented by different equivalent circuits depending on time elapsed since fault occurred



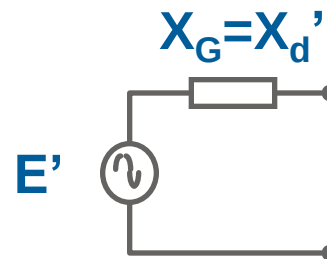
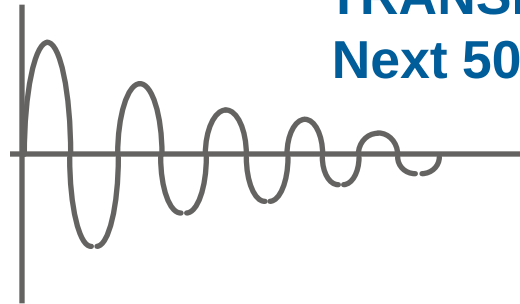
Faults Close to Generators

SUBTRANSIENT
First 10-20ms



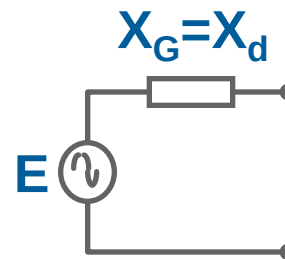
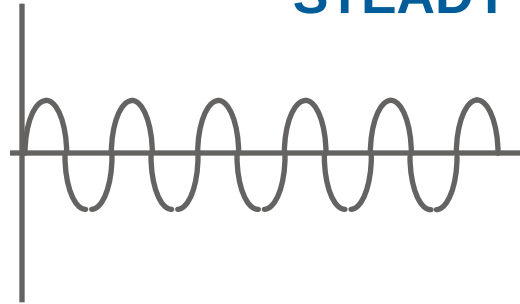
$X_d'' =$
SUBTRANSIENT
REACTANCE

TRANSIENT
Next 500ms



$X_d' =$
TRANSIENT
REACTANCE

STEADY STATE



$X_d (X_s) =$
STEADY STATE
(SYNCHRONOUS)
REACTANCE

Faults Close to Generators

- Equivalent circuit used depends upon instant after fault for which analysis is required
- For initial (peak) value of fault current (10ms) use subtransient reactance (X_d'')
- For break fault current (60-120 ms) calculations, use the transient reactance (X_d')

Faults Close to Generators

- Typical impedance values for synchronous machines :

X_d''	X_d'	X_d
15-25%	25-35%	70-120%

- Steady state reactance may be greater than 100%