EEN-206: Power Transmission and Distribution

Lecture -03

Chapter 1: Introduction

- Overhead vs. Underground Systems
- Distribution Systems: Primary & Secondary and Radial & loop

Symbols in Power System Network

Line, cable or busbar (three-phase)

M — Rotating machine-general

Synchronous machine

Two-winding transformer

Auto transformer

Two-winding transformer (alternative symbol)

Three-winding transformer

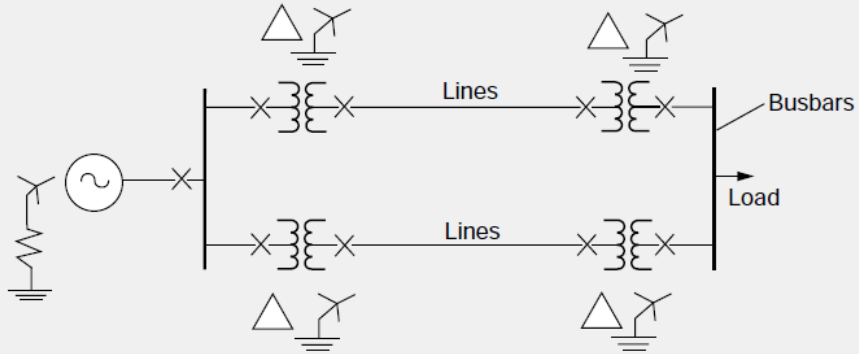
Circuit breaker – alternative

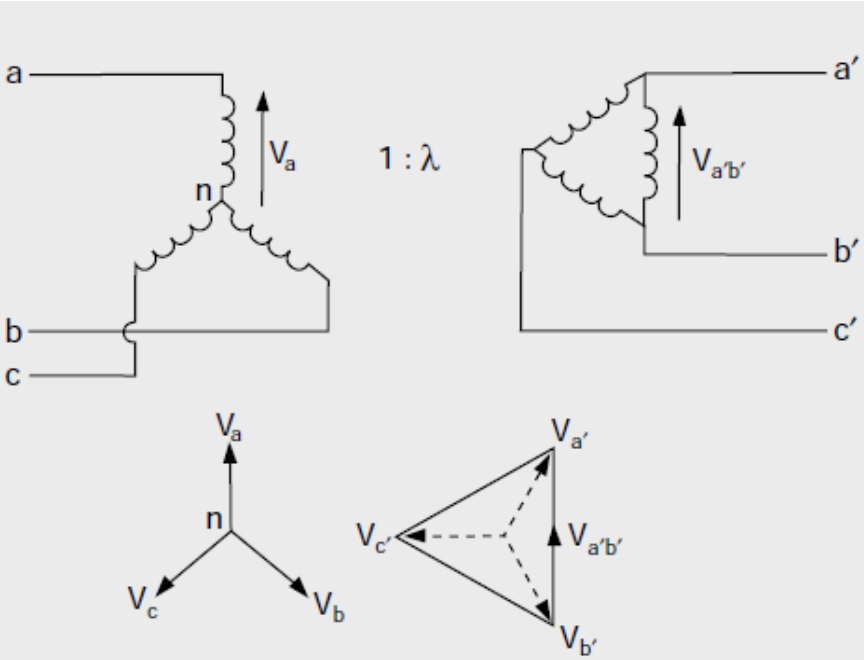
Isolator

Three-phase wye or star connected with the star point solidly connected to an earth or ground electrode

Delta connected

Current transformer

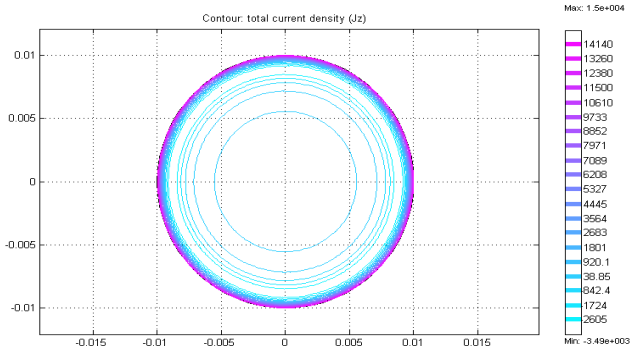




B. M. Weedy, B. J. Cory, N. Jenkins, Janaka B. Ekanayake, Goran Strbac, "Electric Power Systems", 4th Ed., John Wiley and Sons, 2012

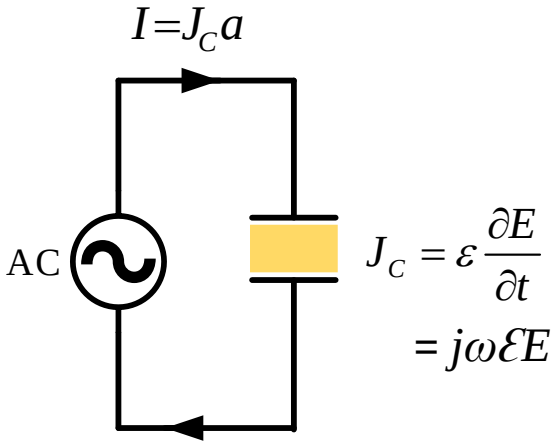
Comparison of AC and DC Systems

- **Advantages of DC Lines**
  - There is no skin effect in DC transmission. Therefore, small cross sectional area conductor required or Lower losses,
  - In High Voltage DC Transmission lines, there are no Dielectric losses,
  - There is low voltage drop,
  - No charging current, best suitable for undersea cable transmission,
  - lower tower clearances, require less insulation,
  - Lower switching overvoltages,
  - No problem of stability and synchronism,

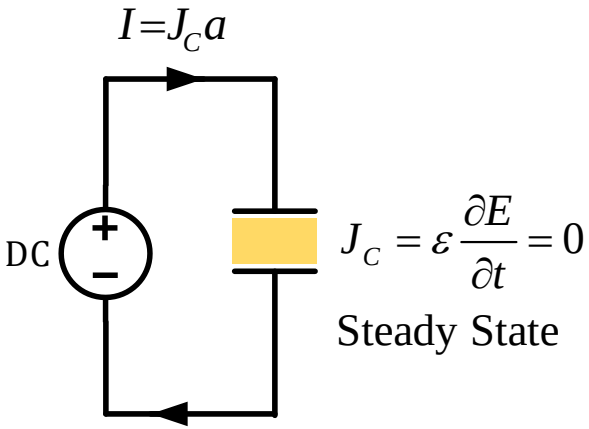


- **Disadvantages of DC Lines**
  - Transformation of voltage levels
  - There are problems in breaking DC current.

Charging Current



AC Systems

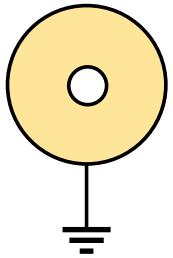


Steady State

DC Systems

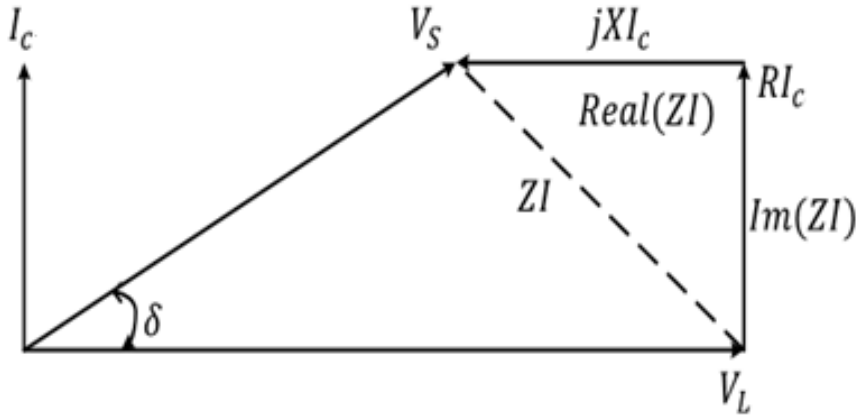
Overhead line

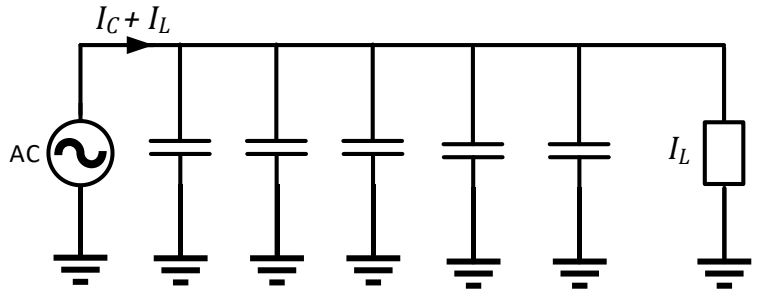
$$C_o = \frac{2\pi\varepsilon_0}{\ln\left(\frac{2H}{r}\right)} \text{ F/m}$$

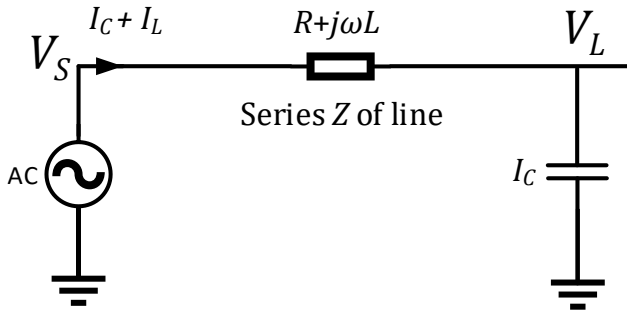


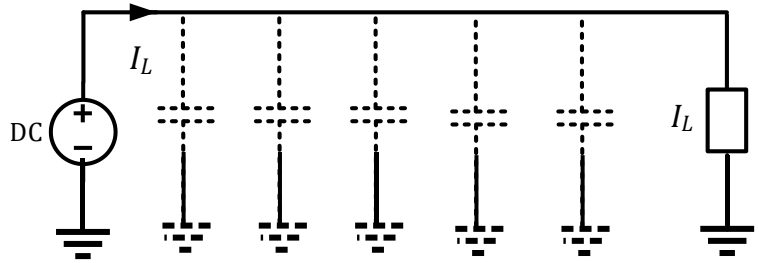
Underground Cables

$$C_c = \frac{2\pi\varepsilon}{\ln\left(\frac{R}{r}\right)} \text{ F/m}$$





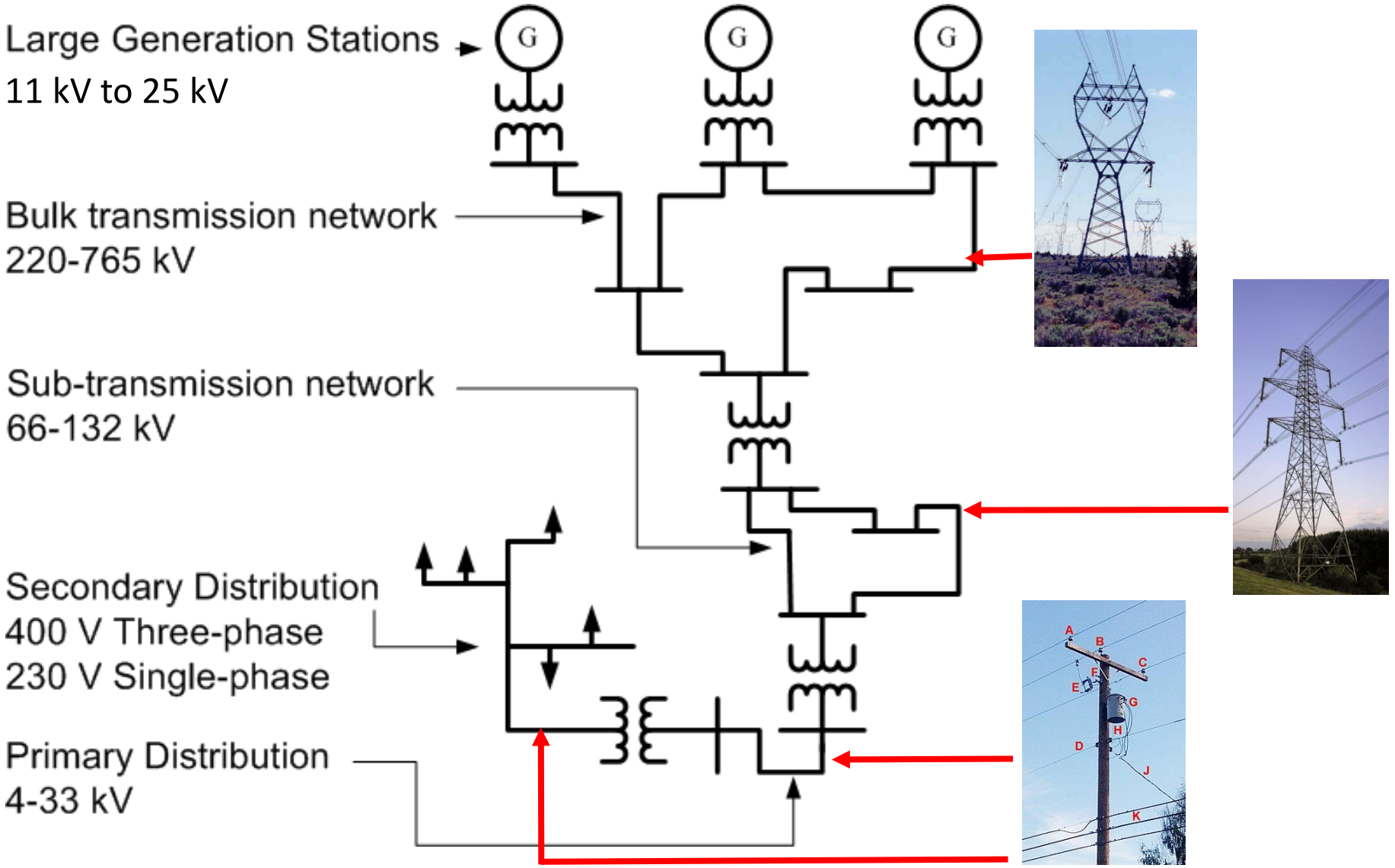




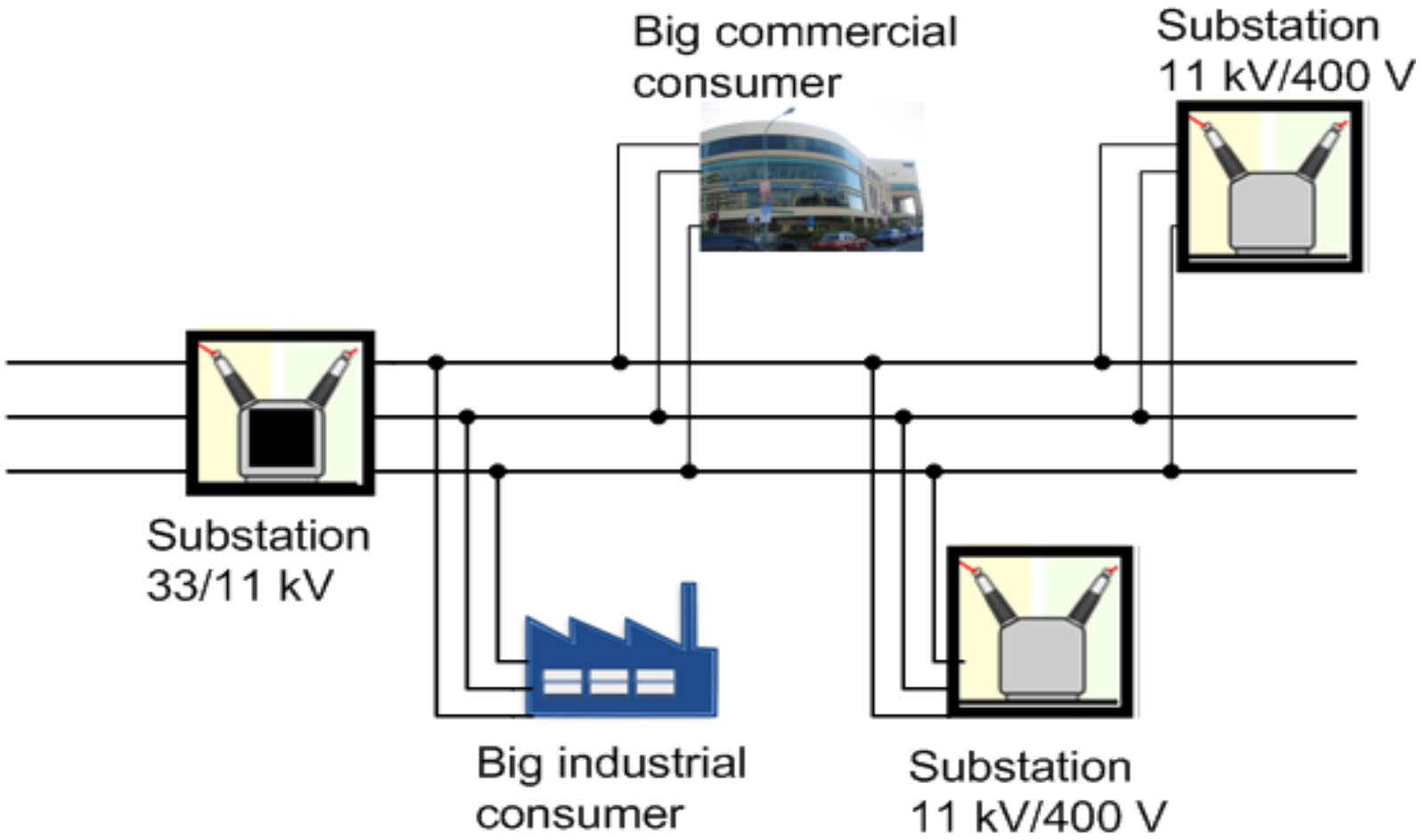
Overhead vs. Underground Systems

- **Advantages of cables:** less maintenance, less accidents/interruptions, higher safety, less voltage drop, less electromagnetic interference, higher life, preserve aesthetic beauty, theft free.
- **Disadvantages of cable:** High initial cost, longer time for restoration, capacitance is predominant.
- Therefore long distance transmission overhead lines are preferred for AC transmissions.
- Cables are mainly used at distribution levels.
- Cables are preferred in following conditions:
  - Public safety involved and low interference is required
  - Large populated cities
  - Scenic beauty of city is important
  - DC transmission through cable in sea
  - Substation and transformer connections

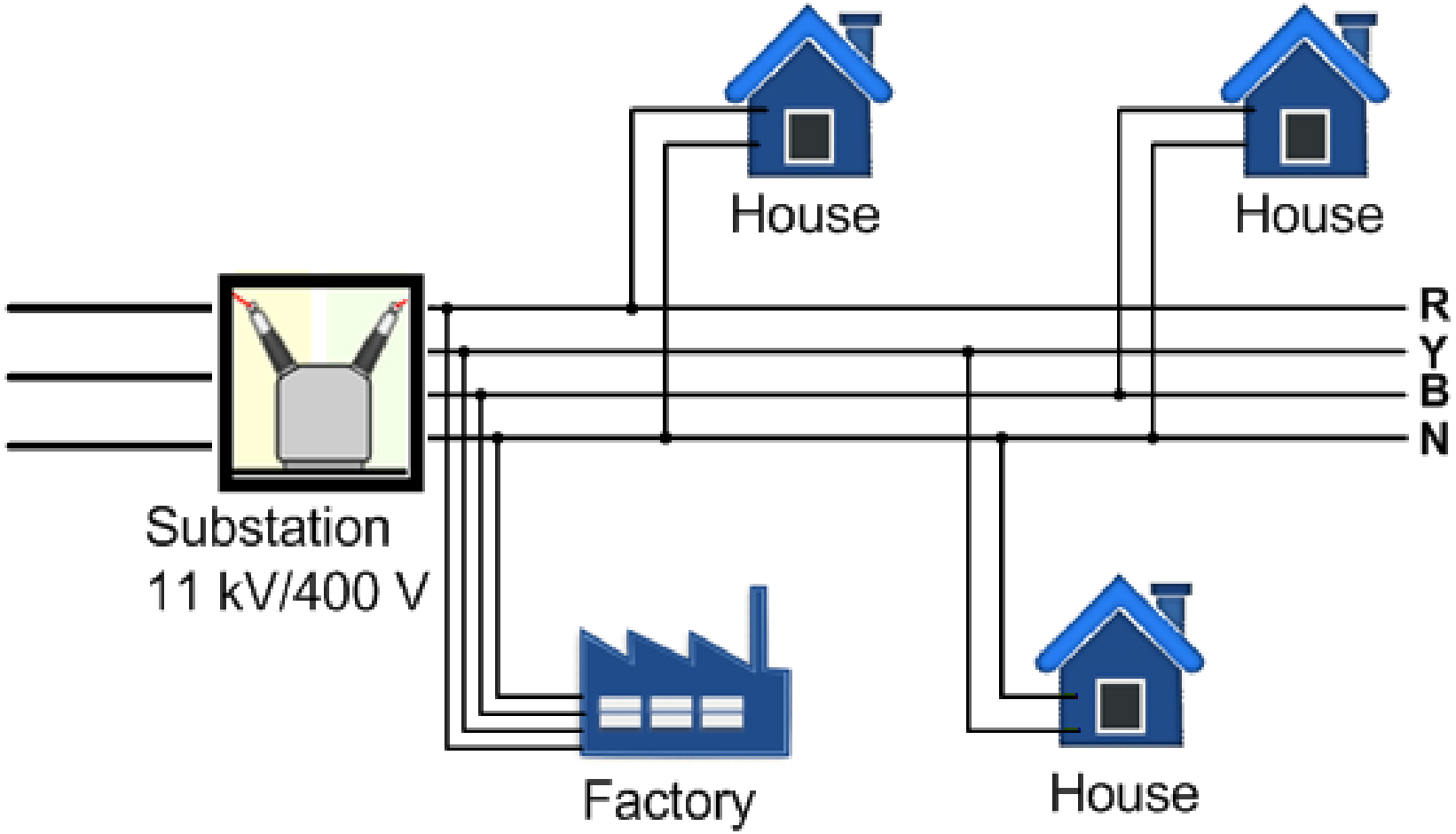
Structure of Power System



Primary Distribution System

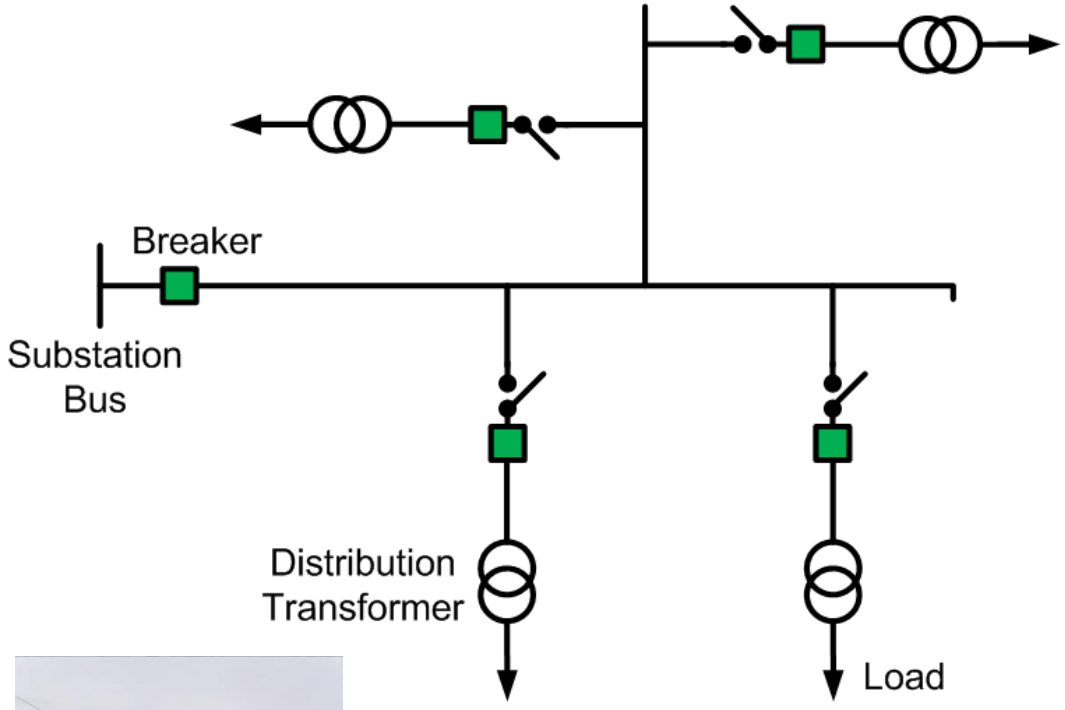


Secondary Distribution System



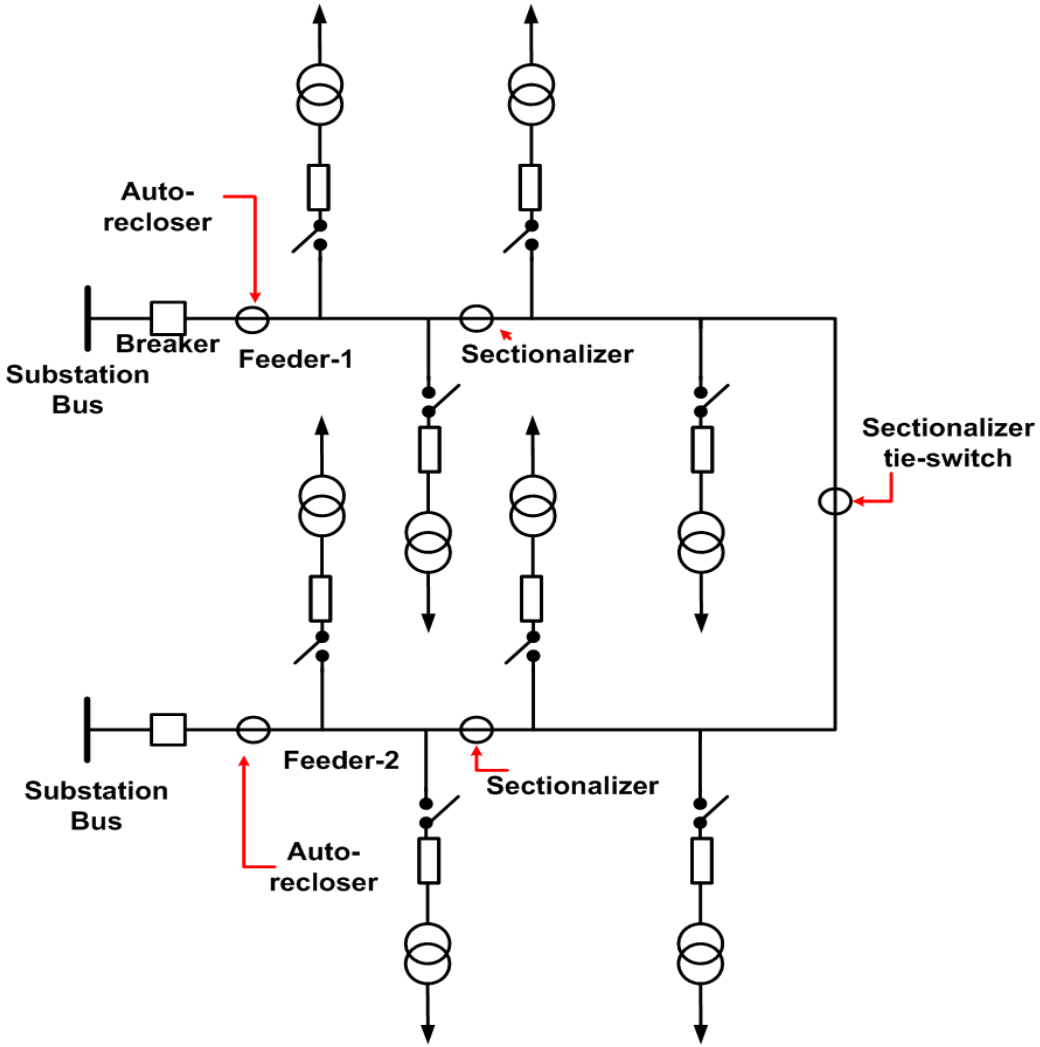
Distribution System Topology

- **Advantages**
  - Simple in Planning, Design and Operation
  - Lower cost
  - Simple Protection
  - Easier voltage control
  - Easier prediction and control of power flows
- **Disadvantage**
  - Poor reliability

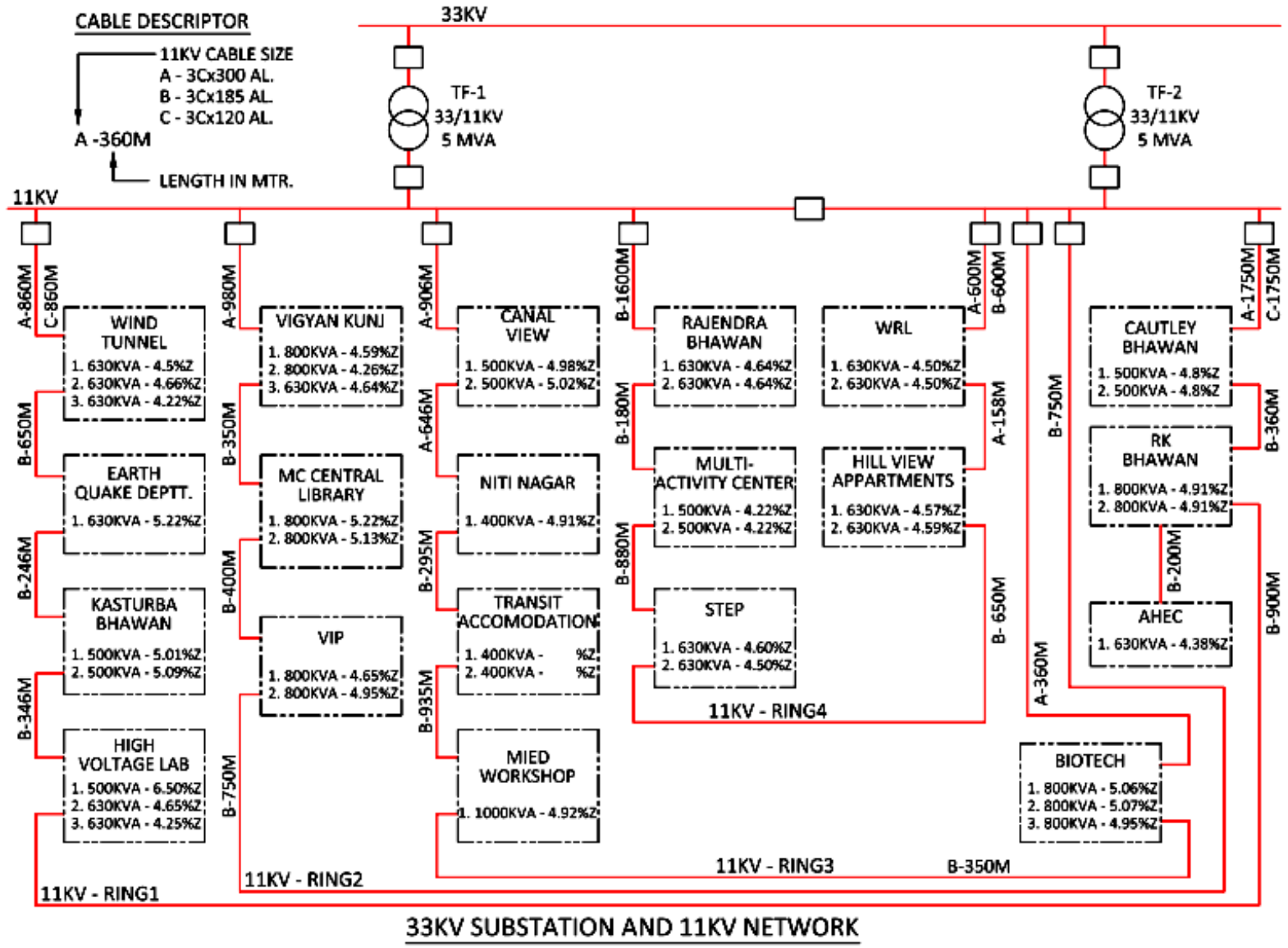


Loop System/Ring Main

- More reliable than a radial system
- Larger conductor and more number of switches
- The loop should meet all power and voltage drop limits from both sides
- Cost is more
- Protection is more complicated than radial systems.

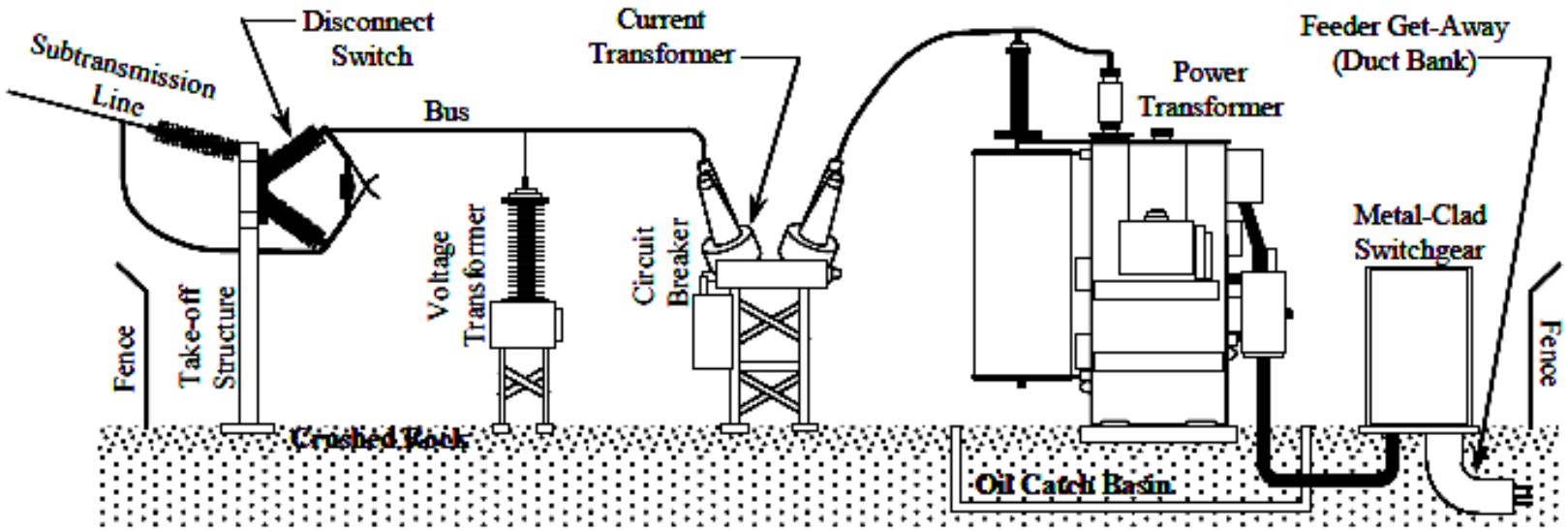


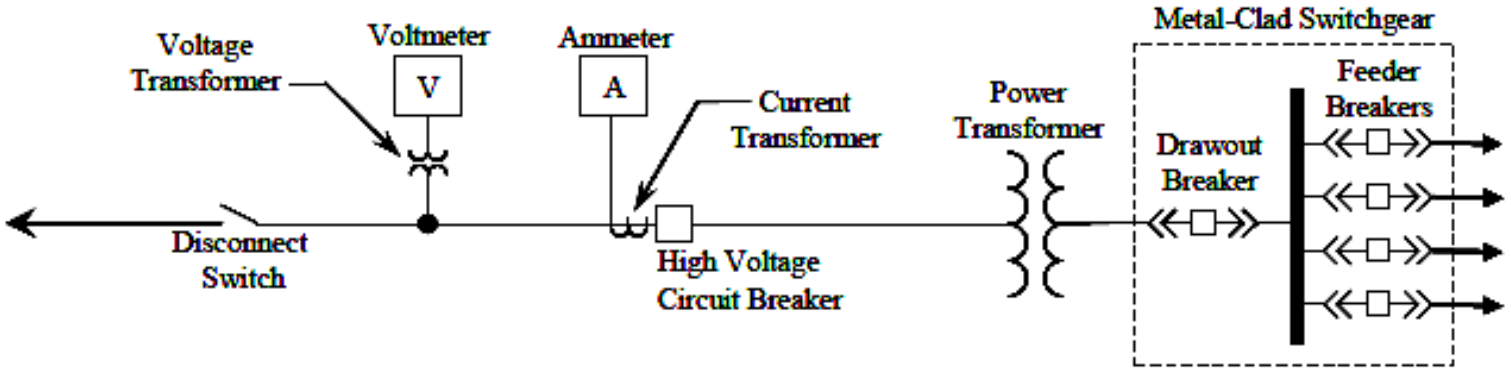
IIT Roorkee Ring-Main System



33KV SUBSTATION AND 11KV NETWORK

Distribution Substation





Source: Brown, R., Willis, H. . *Electric Power Distribution Reliability*, Second Edition. Boca Raton: CRC Press, 2008.


Thank
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