

Power Load Flow 101: Basics, Theories & Applications for Engineers & System Operators

An Online Continuing Education Course for Engineers

Course Number: E-3054

Credit: 3 Hours / 3 PDH / 3 CPD

Power Load Flow 101: Basics, Theories & Applications for Engineers & System Operators

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Introduction

We are living in an era where electricity is not considered a luxury, but a necessity that people in developed countries cannot live without for even a short period of time. The existing electric transmission grid has served the country well for many years. However, there is an increase in load growth as a result of population growth and the corresponding construction of new homes and businesses.

As a result, there is pressure on utility engineers and system operators to ensure there are adequate resources to provide secure and reliable power. One of the main tools to perform such function is via the use of load flow programs. There are several software programs available on the market, as well as many that are built in-house.

This course will discuss the key concepts that are crucial to the understanding of load flows from the engineering and system operators' point of view. The fundamental knowledge gained in this course can be applied to any load flow software.

The course will show the important power formulas needed as well as provide numerous load flow examples. You will learn about the electric system, transformers, phase angle regulators, capacitors, shunt reactors, what is a contingency, how to react to a contingency, voltage drop calculations, key aspects of load flows, as well as various tools that help engineers and operators run their systems in an efficient and reliable manner.

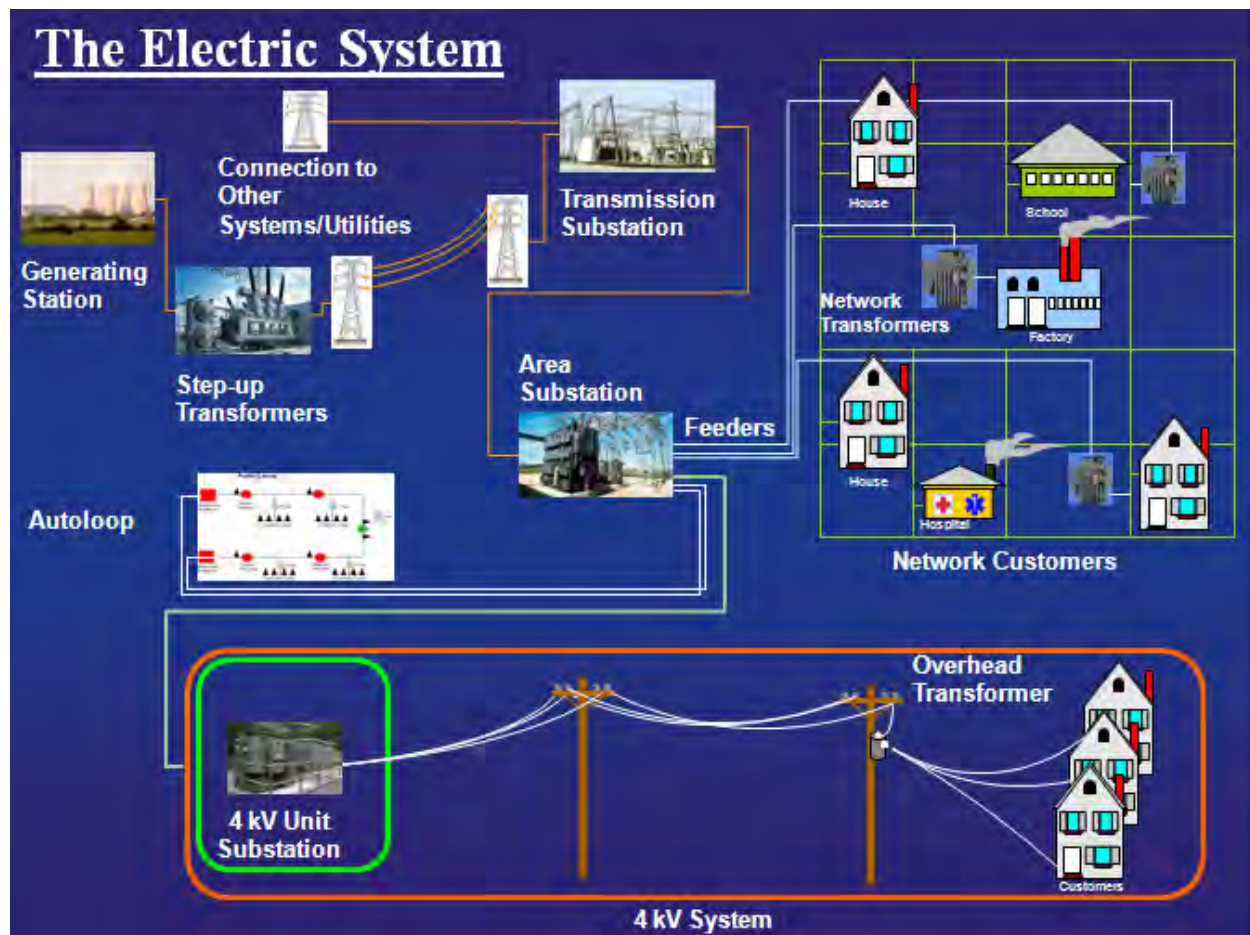
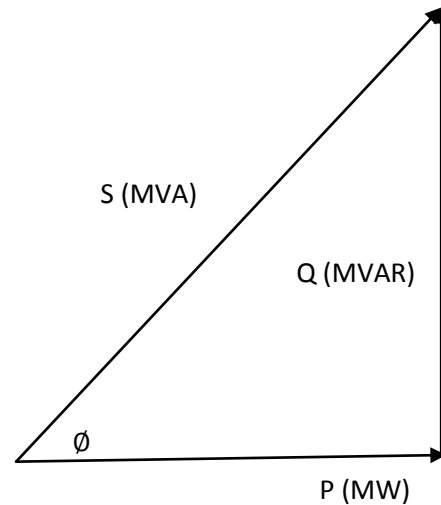
Content:

- This course covers the following topics:
- Power triangle/transfer functions
- The electric system
- Power transfer formula
- Substation load flow
- Load coefficient
- Power factor impact
- Capacitor/shunt reactor impact
- Contingency impact
- Impedance impact
- LTC Impact
- Transformers Vs. Phase Angle Regulators

The Power Triangle

There are many formulas in the power field; however note that the power triangle, Ohm's law and kirchhoff's rules will suffice for this course. There are three main types of loads; real power, P , measured in watts, which is basically what spins the customers' meters; reactive power, Q , measured in VAR (volt ampere reactive) and apparent power, S .

Reactive power is often called useless power; however, in the power field, this type of load is very critical to the livelihood and the stability of the electric system. Reactive power is needed for all motors and other devices, such as air conditioners. The apparent power, measured in VA (volt amperes) is the combination of reactive and real power. In the context of this course and in the utility world, P is measured in MW, Q is measured in MVAR and S is measured in MVA.



The Electric System diagram shows an example of the overall electric system. Although some utilities differ in their electric system design and configuration, this diagram shows most of the utility system components. Everything starts from the generating station; there are several types of power generation, such as nuclear, fossil and hydro (power plant picture below). In the case of nuclear and fossil fuel plants, fuel is burned to create steam that will cause turbines to rotate which is connected to a spinning generator, where three phase electricity is produced.

Generators are mainly placed close to the water far from the city because they use water for cooling. Electric power that is used by consumers, such as household appliances, is generated at the same instant it is needed. Basically, electricity is dynamic. In order to deliver power to the customer's property, power generated by the generators is transmitted via transmission towers/feeders.



Transmission feeders are high voltage lines carrying the power being generated by the generator. The power generated is usually between 11-22 kV.

In order to transmit the power to the load centers, high voltage transmission lines are utilized and a generator step up transformer (GSU) is used (picture below), that steps up the voltage from 11-22 kV to high voltage or extra high voltage, i.e. 345 or 500 kV.



One reason for transmission losses is due to $I^2 R$, where I is the current generated goes through the line. The voltage is stepped down, keeping the power constant for an efficient transmission. A transmission feeder (pictured below) is then usually connected to other transmission feeders. This type of device, capacitor bank, and other equipment. The main purpose is for protection and connecting to other utilities as well as

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Losses are equal to $P = VI$ that is power. The current will be stepped down during the transmission process will allow for a more efficient transmission feeder (pictured below). Transmission feeders are connected to other transmission feeders, switches, metering equipment. The main purpose is for protection and connecting to other utilities as well as

