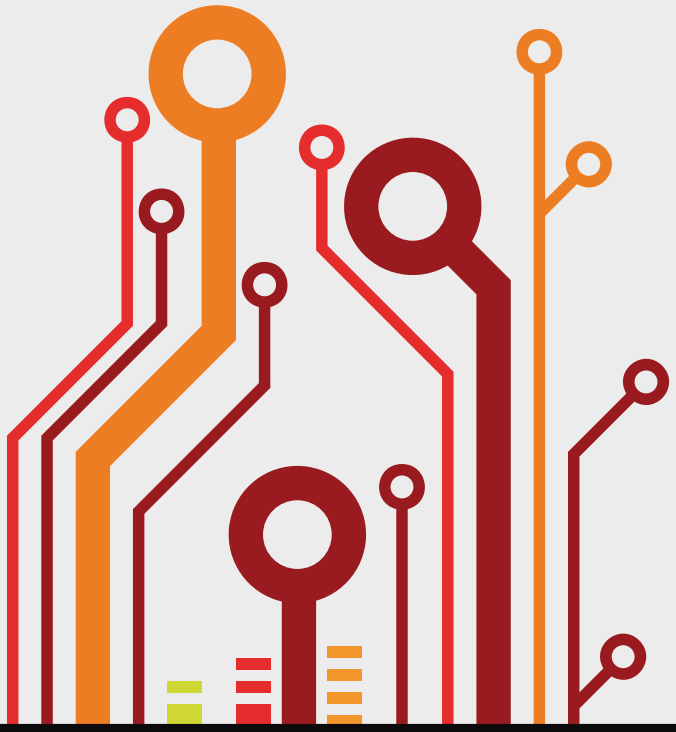
Energy School | Automation
Substation Automation Systems
2011 - 1st Semester



Academy

efacec

Training Contents

Architectures

March / April
36 hours

Substation Primary Equipment
- Introduction to power systems and substations
- Power transformers
- Circuit breakers
- Interrupters
- Current and voltage transformers
- Substation bus-bar configurations
- Gas insulated switchgears
- Hybrid systems
- Others

Communications in Power Systems
- Introduction to communications
- The role of communications in power systems
- Communication media support used in power systems
- International standard communication protocols
- Communication infrastructures in power systems

Integrated Substation Command, Control and Protection
- Definition and examples of intelligent devices (IED)
- Integration levels in power systems
- Conventional architectures based on RTU
- Examples of conventional architectures
- Distributed architectures based on IED
- Examples of distributed architectures
- Integrated systems in distribution and transmission networks
- Phasor Measurement Systems (PMU)
- Technological aspects of substation LAN

Substation LAN Architectures
- Overview of IEC 61850
- Virtual LAN
- LAN topologies
- Introduction to redundancy and fault tolerance mechanisms
- Fault tolerance and redundancy – best design practices
- Building networks for IEC 61850 requirements
- Time synchronization
- Network synchronization design – IEEE1588-V2
- Networks Beyond Substations
- Introduction to Cyber Security

Protection Features

April / May
32 hours

Basic Concepts
- Electrical quantities in power systems (current, voltage, power)
- Phasors (theory and practice)
- Introduction to symmetrical components (theory and practice)
- Calculation of symmetrical short-circuits

Introduction to Protections
- Why protections in power systems?
- Causes and statistics of network faults
- Historical evolution of protections
- Protection principles – which faults to eliminate and how fast
- Concepts on selectivity and sensibility
- Over-current protection – applications and how it works
- Differential protection – applications and how it works
- Digital protection description – hardware and features, including oscillography and watchdog

Over-current Protections
- Working principals
- Definite time and reverse time characteristics
- Phase faults detection versus earth faults detection
- Introduction to earth connections
- Phase-earth fault detection – high level earth currents
- Phase-earth fault detection – low level earth currents

Distance Protections
- Distance protection reach definition
- Protection zones
- Operational characteristics
- Power swing blocking / out of step protection
- Distance protection systems implementation

Differential Protections
- The differential protection concept
- Introduction to transformers differential protection
- Restricted earth fault protection for transformers
- Transformer differential protection systems implementation
- Introduction to bus-bar differential protection
- Bus-bar differential protection systems implementation
- Overhead lines differential protection

Generator and Motor Protections
- Protection of conventional synchronous generators – stator faults protection
- Protection of conventional synchronous generators – rotor faults protection
- Protection of conventional synchronous generators – loss of excitation protection
- Protection of distributed generation – general concepts
- Protection of distributed generation – anti-islanding protection
- Protection of AC motors

Protections Coordination
- Coordination of protections in distribution networks (theory and practice)
- Coordination of protections in transmission networks (theory and practice)

Performed by

RUGGEDCOM INDUSTRIAL STRENGTH NETWORKS™

KEMA

Automation Features

May / June
16 hours

Introduction to Automation
- The role of automation in substations
- Interlocking
- Intertripping, substation or network reconfiguration
- Automatic reclosing concept
- Automatic reclosing in distribution and transmission networks
- Load management – voltage/frequency shedding
- Transformers supervision – on load tap changer control
- Human-machine interfaces – alarm grouping, event recording, oscillography

IEC 61131-3 Standard for Automation Design
- Introduction to IEC 61131-3 (theory and practice)

IEC 61131-3 Hands on
- Hands on Efacec Engineering Tools

Substation Model and Intra-communications

June / July
28 hours

IEC 61850 Introduction
- Trends and general requirements for a substation communication protocol
- ISO model briefing
- Structure of IEC 61850 standard
- Introduction to the IEC 61850 approach – separation between data model and communications
- Advantages of IEC 61850

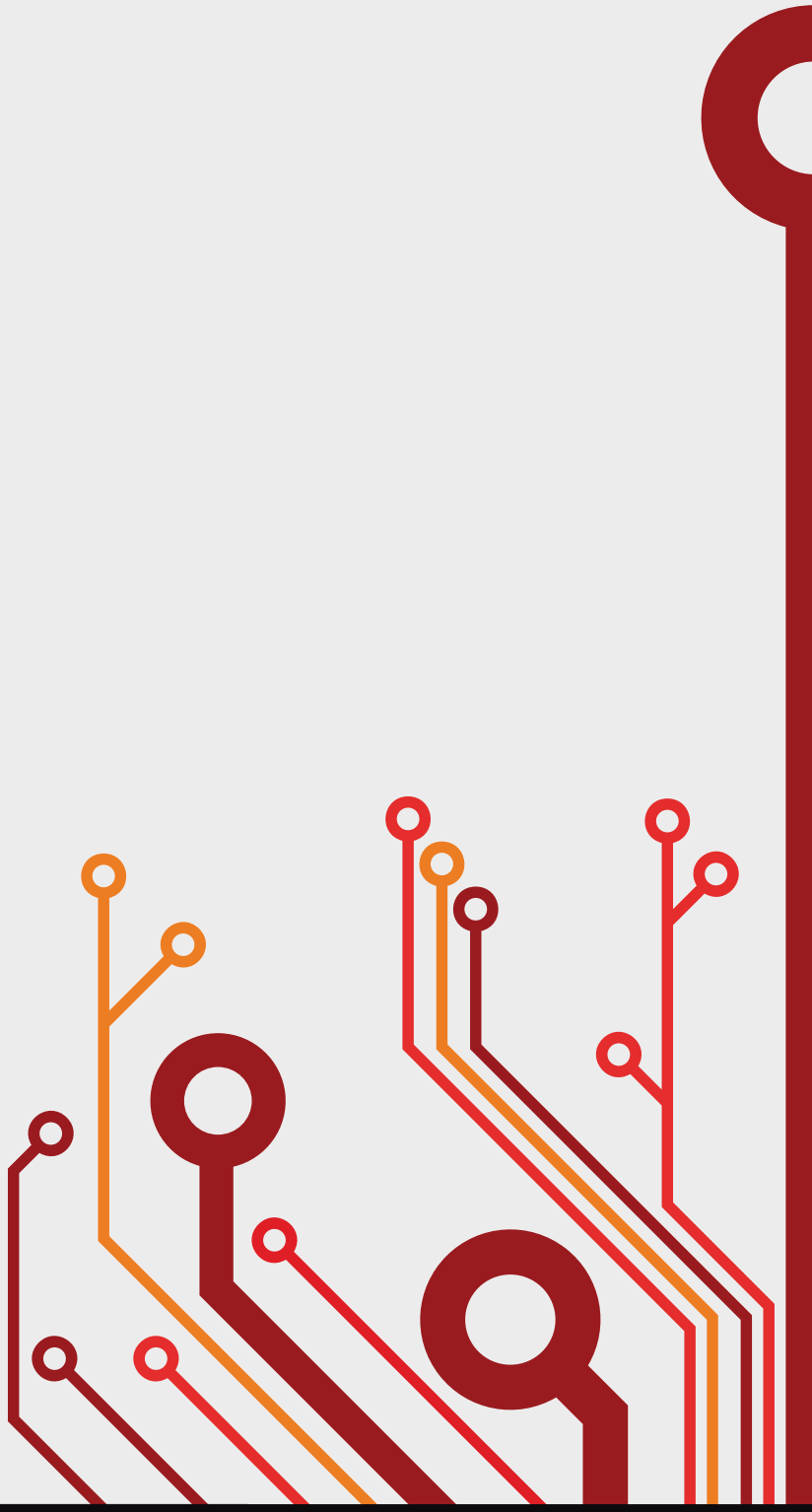
Details on IEC 61850
- Data modelling details – objects, data and attributes, communication services
- Communications – mapping to MMS, TCP/IP, Ethernet
- Substation Configuration description Language (SCL) – theory and practice
- Introduction and migration strategies
- The specification according to IEC 61850
- Quality control and tests

IEC 61850 Hands on
- Hands on Efacec Engineering Tools

Legacy Protocols
- Legacy protocols in substation intra-communications

Performed by

KEMA efacec



efacec

esautomation@efacec.com