Course description

INTCV374
Power System Studies, Planning and Analysis

Course goal
The goal of the course is to increase the proficiency of power system engineers to do the Power system studies, planning and analysis of power system by using current state-of-art technologies practically.

Learning objectives
Upon completion of this course, students will be able to understand
- Modeling of Power System and concepts of power flow studies,
- Mathematical modeling of power system components and network
- Load flow studies, Optimal power flow studies, static security assessment and improvement
- Balanced and unbalanced short circuit studies based on IEEE, IEC and G74 standards
- Voltage Stability Studies
- Transient Stability Studies
- Distribution System in Industry.
- Dynamic Stability / Small Signal stability Studies
- Power system protection: protection of generators, motors, transformers, cables, and transmission lines.
- Transient studies using NEPLAN®
- Reliability evaluation of practical
- Composite power systems
- Harmonic analysis & Filter Design
- Real-Time control: Energy management concepts
- General Power System Engineering Topics.

Participant profile
Personnel from Power Utilities, Power Generation, transmission companies & industries and Consultants responsible for system design, planning and engineering of power system

Prerequisites
Degree or diploma in engineering, basic knowledge of power system, Protection & Substation Automation and PC operations

Topics
- **Mathematical Modeling of Power system components and network**
  - Static, transient and dynamic models: Elements of transmission, distribution networks and generation system: Phasor notation. Symmetrical components transformation; Per unit system; (Network admittance and impedance matrices), Overhead transmission line representation; Transformer representation; Synchronous machine representation; Representation of cables: Induction motor representation: Types of loads and their representation; Representation of relays, CT, saturation, outages and other disturbances and CVT.

- **Load Flow studies, optimal power flow studies, Load Flow analysis and Load Forecasting**

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- **Voltage Stability Analysis**: Incidents of voltage collapse and factors leading to them: Solutions adopted by utilities to avoid such incidents: Methods of detecting, evaluating static voltage stability by means of indices: The PV curves: Minimum singular values: L indices: C indices: Case studies using software tools.

- **Transient Stability Analysis**: Examination of stability for different types of single or multiple disturbances such as faults, load rejection/recovery, motor starting, line/transformer switching, loss of generation, Designing under frequency and undervoltage based load shedding schemes, Study of load rejection, dynamic over voltage phenomena.

- **Dynamic Stability Analysis**: Concepts and application areas: Concept of damping and synchronizing torque: Component modeling such as generator, motor, AVR, Prime mover-Governor: Effect of system loading, transmission strength, excitation system parameters etc. Case studies using software tools.

- **Power System Studies Related to Power System Protection & Relay Coordination**

  - **Current Transformer**: Introduction: Current Transformer error, CT winding arrangements: construction, Secondary winding impedance, selection Parameters, Open circuit secondary voltage

  - **Capacitor Voltage Transformer**: Errors, secondary load protection, selection parameters, construction

  - **Distribution**: Feeder protection: Introduction, principles of time-current grading: IDMT overcurrent relays: Inverse overcurrent relays: Extremely inverse and voltage controlled over current relays: Directional overcurrent relays: Unit protection, Primary and backup relays and their grading.

  - **Protection of Transformers and Reactors**: Over Current and ground fault protection, Application of differential protection to transformers, Thermal overload protection, Restricted Earth fault protection, Buchholz relay, Tank Protection Overpressure Protection, Winding temperature and oil temperature devices, Over voltage protection of transformers, Sample Setting Calculations

- **Protection of Transmission Lines**: Auto Reclosing, Distance Protection, Carrier Aided Distance Protection, Time delayed Overvoltage and Under Voltage protection, Power System Supervision - Broken conductor check (BRC), Loss of voltage check (LOV), Load supervision, Dead line detection, Synchrocheck and energizing check & Autorecloser (AR), Sample Setting Calculations

- **Protection of Motors & Generators**: Differential protection, Reverse power, stator ground, out-of-step, loss of field, field ground, over excitation, inter-turn, Over-frequency, under frequency, over voltage, under voltage, Under impedance, Negative phase sequence or phase unbalance, over current & under current protection, stator overload, rotor overload protection, Synchronizing systems, synchro-check relays, Sample Setting Calculations

- **Busbar Protection**: Introduction, Busbar faults, Causes of bus faults, Protection requirements, Effect of CT saturation, Stability with saturated CTs, Circulating current busbar protection stabilizing on an external fault, Circulating current busbar protection operating on an internal fault, Circulating current protection for double busbars, Circulating current duplicate line of defense busbar protection.

- **Transients Studies**

  - **Introduction**, Solution methodology, modeling power system components, Network representation, Branches, Switches, Sources, Linear elements, Non-linear elements, time varying elements, solution with compensation methods, Time controlled switch, Voltage dependent switch, Piecewise linear resistance or surge arrester, Piecewise linear inductance, Voltage and Current sources, Current controlled DC voltage source, Initial conditions, Transformer representation, Saturation effects, Switching surges, Fault transients, Dynamic overvoltages,
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Ferro resonance etc. Case studies using software tools.

- **Distribution System Analysis & Improvement**
  - Associated problems and considerations Case studies using software tools.

- **Reliability Studies of Composite Power Systems**
  - Basic probability and statistics. Load point indices calculation and evaluation of reliability in conjunction with optimal power flows. Case studies using software tools.

- **Harmonic Analysis & Filter Design**

- **Real-Time Control**

  - EMS functions. Automatic Generation Control (AGC), Operation without AGC, Parallel operation of generators.

Course type and methods
This is an instructor led seminar Lectures, demonstrations, design, application and calculation exercises. The language of the course is English. This course gives about 50% time for demonstration and practical exercise on power system studies software’s for each participant on individual PC.

Course duration
The duration of the course is Two Weeks (10 days)