Fundamentals of power systems and power electronics

❖ *Module Objectives*

- Introduce thefundamental of power system and power electronics, and how power system operation can impact power market activity.
- Explain how to determine the level of reliability, performance and potential bottlenecks or limits on the power system.

❖ *Learning Outcomes*

Students/trainees are expected to:

- Develop initial expertise in the design, modeling, control, analysis of power system.
- Describe the fundamental structure of the micro- grid and distributed generation concept.
- Use simulation tools such as MATLAB and Paladin for power analysis and optimization.
- Describe the communication systems, networking, and telemetering technologies involved.
- Perform computational techniques using decision support tools and optimization.
- Understand various distributed generation sources including working concepts and modeling.

❖ *Module Content*

Part I: fundamental of Power system

Chapter 1: Introduction

- Electric Power system architecture
    - Generation Subsystem
        - Operating principles
        - Fossil fuel power plants
        - Nuclear Power plants
        - Hydroelectric Power plants
    - Transmission subsystem
        - High Voltage transformers.
        - High Voltage transmission lines.
    - Distribution subsystem
        - Medium Voltage substations and transformers
        - Medium voltage cables and headlines.

Chapter 2: Modeling and Simulation of Power system

- Mathematical modelling basics
    - Phasor and per Unit system
    - Zbus method.
    - PQ bus method.
- Simulation of power system in MATLAB/Simulink

Chapter 3: Power system analysis

- Load flow.
- Fault analysis.
- Transient and Fast transient stability.
- Power Quality and Harmonics.

Chapter 4: Power System control

- Control techniques
    - Demand side management.
    - Optimization of source scheduling.
- Control tools:
    - Tap changing regulator
    - Power electronics applications
        - AC/DC converters
        - AC/AC inverters
        - Flexible Alternating Current Transmission System (FACTS)

Part II: Renewable Energy Sources integration

Chapter 5: Integration of Photovoltaic Systems in SG

- Basics of solar energy.
- Photovoltaic system architecture.
- Photovoltaic system design.
- Photovoltaic system economic calculations.
- Integration legislation (standards and utility code) technics (HF transformer, transformerless)

Chapter 6: Integration of Wind energy systems in SG

- Energy of wind.
- Wind energy system architecture.
- Wind energy system design.
- Wind energy system annual production estimation.
- Integration legislation (standards and utility code)

Chapter 7: Integration of Fuel cell systems in SG

- Basics of Fuel Cell
- Architecture of fuel cell.
- Fuel cell electricity production estimation.
- Integration standards and utility code.

Part II: Communication technics and telemetering in Power system

Chapter 8: Power system measurements

- Standards of measurements
- Fundamental measurement techniques
  - Root mean square
  - Average response measurement
  - Peak response measurement
  - Meter accuracy.

Chapter 9: Digital measurement Instruments and protocols

- Data acquisition techniques (DAQ)
- Power Line carrier communication (PLCC)
- Telephone-based systems (ISDN, DSL)

Chapter 10: SCADA in Power systems

- Advantages of SCADA in power systems
- SCADA basic application and functions in Power systems.
- Intelligent Electronic devices IEDs
- SCADA protocols (Modbus, DNP3…)