# Home Automation/Distribution Automation

## ❖ *Module Outline*

Power engineering is the oldest and most traditional field in Electrical engineering. The power grid considered to be the most complex system ever made by human beings. It is the driver behind our modern world. The traditional model of power generation, transmission and distribution is becoming obsolete. Modernizing the grid or in other words rendering it automated is the key to overcoming a plethora of challenges that the grid faces nowadays. Challenges are multiple and to name a few:

- The ever increasing electricity demande
- The public and the offcials awareness about the impact of fossil generation on the envirenment
- The introduction of renewable energies in the energy mix
- The introcution of distributed generation
- The lack of visibility at the level of the distribution
- And so on

## ❖ *Module Description*

This module aimes at introducing the concept of distritution automation. It will tackle distribution automation from two angles. The first one consists of explaining distribution automation from the low voltage grid side. From introducing the history of the grid low voltage distribution automation, to reviewing all the components and devices that render grid distribution automated. Various senarios will be introduced to familiarize the reader with the advantages of automating the distribution side of the grid. In the second angle the reader will be introduced to home/building automation, a series of laboratories with low cost of the shelf components readily available will be available for the reader to exerice to give him/her an idea on how one can make a home benefit from automation.

## ❖ *Module Objectives or interned learning outcomes*

**Part I: Distribution automation**

At the end of this section of the module, trainees/students will be able to:

- To recall the history of power systems and describe in general the differences between the conventional distribution systems and the automated ones.
- To identify the major components of a distribution system and list various equipment components that make up the system.

- Define the function of distributed automation, Station design, and automation schemes
- Demonstrate how to model individual components in a distribution system
- Model and solve classic power flow in a simple distribution system in an unbalanced system
- Examines the first operation issues in a distribution system, how to maintain voltage control on a distribution system, and how the model active devices.
- Define major types of automation and control systems available and illustrate how they work.
- Expand on the functions of the system through reliability, power quality, protection and voltage regulation.
- Demonstrate awareness of the drivers of change in how networks are designed and operated.
- Understand How to operate a Volt VAR optimizing scheme.

**Part II: Home Automation**

At the end of this section of the module, trainees/students will be able to:

- Understand the concept and the advantages of home automation
- Understand the components needed to render homes automated
- Be able to design and implement a basic home automated system based on cost efficient of the shelf components.

### ❖ *Module general content and brief description per lecture*

**Part I: Distribution Automation**

- **Chapter I: Development of the modern distribution systems**

  An overview of power system and emphasis on distribution systems at the low voltage and medium voltage distribution system will be tackled. The components, terminology used, feeders, distributers, feeders' configuration and their use will be covered.

- **Chapter II: Modeling of distribution level components**

  The following topics will be discussed in detail in this chapter:

  - The network analysis functions and goal
  - Fundamentals of distribution system analysis
  - Distribution system modeling

- Distribution Power Flow
- Fault Isolation and System Restoration
- And, Fault Location

- **Chapter III: Distribution level power flow**

  In this chapter, the Need for load flow analysis will be explained. The reader will be introduced on how to use the power flows to analyze a network and the metrics to use to assess a power network. Bus classification, algorithms used, Bus Example Design Case study will be covered in this chapter.

- **Chapter IV: Voltage control devices/Volt-VAR optimization**

  This chapter presents various approaches used to improve the distribution system's overall voltage.

- **Chapter V: Distribution automation (switching and reconfiguration)**

  In this chapter, power automation in general will be covered and its benefits, structure, substation automation, and distribution automation architecture will be introduced. Furthermore, substation energy management systems will be introduced along with the various functionalities they offer. The following topics will be discussed during this chapter:

  - Computerize automation systems
  - Function, classification, and functionalities of the components making the distribution automation will be discussed.
  - SCADA and Distribution Management System (DMS)
  - Geographical Information System (GIS)
  - Automatic Meter Reading System (AMR)
  - Outage Management System (OMS)
  - Billing and Business Process Automation
  - Enterprise Resource Planning (ERP) Systems
  - Operational problems and Potential Applications of DAS
  - Some scenarios will also be analyzed at the end of the chapter

- **Chapter VI: Demand response**

  The new approach of demand response will be discussed in this chapter. The conventional grid approach of managing the supply to meet demand proves to be inefficient. The demand response approach will

be discussed in details and how it enables the grid operator to be able to manage the grid in a more flexible and efficient manner.

**Part II (Chapter 7): Home Automation**

- **Laboratory I: Introduction to home automation**

This chapter will introduce the reader to the basic concepts of home automation, its components, and the advantages that one can benefit from when making a home automated. Available technologies and solution currently available in the market will be introduced. A bill of material is also included and it contains the components needed to perform that labs presented in this module.

- **Laboratory II: Raspberry Pi Applications**

In this laboratory experiment, all the steps needed to install and set up the hardware and software needed to build a home energy management system will be presented.

- **Laboratory III: Arduino Nano Applications**

This laboratory experiment explains in detail how to set up the Arduino Nano that contains all the sensors and controls for smart appliance. The system set up and how to use it will be explained in details.

- **Laboratory IV: Wireless communication via Xbee**

In this laboratory experiment you will learn about the Xbee and the Zigbee hardware and software involved and differentiate between the major Xbeeoperation modes. You will be tutored on how to configurate the Xbee modules and how to interface between an Arduino and a computer via Xbee, between a Raspberry Pi and a computer via Xbee, and finally, Interface between an Arduino and a Raspberry Pi via Xbee.

## ❖ *References*

1. Juan M. Gers (2013) **Distribution System Analysis and Automation**. Stevenage, United Kingdom: Institution of Engineering and Technology.
2. Quentin Wells (2013**), Smart Grid Home**, Delmar, USA: Cengage Learning
3. Mahmoud Al-Qutayri (2010), **Smart Home Systems**, intechopen.com

4. B.Zhou, W. Li, K. Chan, Y. Cao, Y. Kuang, X. Liu, X. Wang, “Smart home energy management systems: Concept, configurations, and scheduling strategies,” Renewable and Sustainable Energy Reviews 61 (2016) 30–40.
5. A.M. Vega, F. Santamaria, E. Rivas, “Modeling for home electric energy management: A review” Renewable and Sustainable Energy Reviews 52 (2015) 948–959.
6. K. R. Tan, T. Logenthiran, W. L. Woo, R. T. Naayagi, “Smart home demonstration on LabVolt Home Energy Production Training System” 2016 IEEE Region 10 Conference (TENCON)