AUTOMATIC VOLTAGE REGULATOR (VAR)

TRAINIT ACADEMY

EPE125
Electrical & Power Engineering

COURSE TITLE

AUTOMATIC VOLTAGE REGULATOR (VAR)

COURSE DATE/ VENUE

12– 16 September 2022

Dubai, UAE

COURSE REFERENCE

EPE125

COURSE DURATION

05 Days

DISCIPLINE

Electrical & Power Engineering

COURSE INTRODUCTION

When the first power systems were introduced more than a hundred years ago the controls used were very primitive and undeveloped. These systems were usually rather small, and the requirements regarding quality and stability were not as high as they are today, so the control could be performed manually in most cases. Fairly soon the end users started to put higher demands on the quality of supply, that is, on the voltage profile and the frequency, so optimized automatic controllers and regulators had to be introduced to meet these requirements.

One of the main power control systems is the Automatic Voltage Regulator (AVR) system. The role of an AVR is to force the generator terminal voltage to be at a specified level via the excitation system, and is to control the reactive power flow. However, the stability would seriously influence the security of the power system. Hence the designed controller of the AVR system should be robust to load change.

Design of optimal controllers is a crucial point and obviously a fundamental aspect in optimization of system global performances. Tuning of a proportional integral derivative (PID) controller is investigated. Indeed, it is well known that such controllers are the most used controllers in industry. This is mainly due to two major advantages:
From a theoretical point of view, the structure of this controller naturally allows us to take into account the usual trade-offs in the design of a control law: the proportional action tunes the bandwidth and the rapidity of the system, the integral action allows choosing the level of precision and the steady-state behavior, and the derivative action enhances the stability and robustness of the closed loop.

From a practical point of view, the tuning of the parameters is facilitated by their strong and intuitive links with the closed-loop behaviour. Due to the uncertainties and nonlinearities of some industrial plants, the tuning of PID parameters becomes difficult. Several heuristic tuning methods have been considered, among which the classical Ziegler and Nichols methods. Ziegler-Nichols is mainly proposed to design a controller when no specifications are given, but its optimization to get a good behaviour is generally not done.

In this program, we propose to implement a metaheuristic particle swarm optimization (PSO) algorithm, first introduced by Kennedy and Eberhart, in order to evaluate the PSO-PID performance criteria in time and frequency domain applied to the AVR system. Compared to this traditional approach, the use of this design method allows optimization and tuning of controllers. Indeed, initial specifications expressed, for instance, in terms of time responses, maximum overshoot or control energy corresponding to functions that can only be computed using simulation. Thus, PSO which only requires the possibility of evaluating cost and constraint functions appears as a good candidate method.
From an optimization point of view, some attempts to optimize these difficult cost functions have been performed, but the proposed method remains a local search method and so is strongly dependent on the initial point. Metaheuristic PSO methods, with the different topologies, will also be tested to solve the controller tuning and optimization problem.

COURSE OBJECTIVE

Upon successful completion of this course, the delegates will be able to:

- ✓ Identify the parts of AVR, adjust output voltage on AVR and maintain AVR
- ✓ Describe AVR principle operation
- ✓ Know how to install an AVR and
- ✓ Perform AVR troubleshooting

COURSE AUDIENCE

This program is excellent for training technicians, operators and engineers as well as for the multi-craft training needs of process and manufacturing facilities.

COURSE CONTENT

Chapter 1: Automatic Voltage Regulation System

- Introduction
- Power System Control
- Voltage and reactive power control
- Excitation system
- Automatic Voltage Regulation Concept
- Automatic Voltage Regulator
- The simplified model of an AVR system
- Linearized model of an AVR system
- Block diagram of an AVR system
- PID controller
- Amplifier Model
- Exciter Model
- Generator Model
- Sensor Model
- Phase And Phase Regulation
- The need for Automatic Voltage Regulation
- Conclusion

Chapter 2: Particle Swarmoptimization

- Introduction
- PSO Principle
- Main parameters of PSO
- Personal and global best
- Particle’s Velocity
- Acceleration Factors
- Topologies and Structures
- PSO Implementation
- Initialization
- Velocity Clamping
- Boundary Conditions
- Stopping Criteria
- Advantages and Drawbacks
- Conclusion

Chapter 3: PSO Based PID Controller Design

- Introduction
- The Proportional-Integral-Derivative Control Theory
- The Proportional Term
- The Integral Term
- The Derivative Term
- The Characteristics of PID Controller
- Tuning of a PID Controller
- The Ziegler-Nichols Tuning Method
- Stability Study
- PID Parameter Design using ZN Rule
- Simulation Results
- Disadvantages
- PSO-PID Algorithm Implementation

- Performance Specification
- Fitness Function
- Conclusion

Chapter 4: Simulation Results Analysis

- Introduction
- Uncontrolled AVR Performance
- Optimized Controlled AVR Performance
- Impact Of Acceleration Profiles and Topologies
- Comparison with Recent and Reference Work
- Robustness Analysis
- Conclusion

COURSE CERTIFICATE

TRAINIT ACADEMY will award an internationally recognized certificate(s) for each delegate on completion of training.

COURSE FEES

$4,150 per Delegate. This rate includes participant's manual, Hand-Outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

COURSE METHODOLOGY

The training course will be highly participatory and the course leader will present, guide and facilitate learning, using a range of methods including formal presentation, discussions, sector-specific case studies and exercises. Above all, the course leader will make extensive use of real-life case examples in which he has been personally involved. You will also be encouraged to raise your own questions and to share in the development of the right answers using your own analysis and experiences. Tests of multiple-choice type will be made available on daily basis to examine the effectiveness of delivering the course.

- 30% Lectures
- 30% Workshops and work presentation
- 20% Case studies & Practical Exercises
- 10% Role Play
- 10% Videos, Software or Simulators (as applicable) & General Discussions