Artelys

OPTIMIZATION SOLUTIONS

Training Program 2025

Contact: +33 1 44 77 89 00

training@artelys.com

https://www.artelys.com/training/

EDITORIAL

Artelys
OPTIMIZATION SOLUTIONS

The sharing of our skills is a founding element of our company.

At Artelys, we are committed to delivering outstanding training courses.

The strong growth of our activities over the past 25 years has always been accompanied with particular attention paid to our training offer. Our training program is a way of sharing the most advanced and up-to-date knowledge, enabling our customers, partners and employees to acquire and strengthen their skills in our areas of expertise, which are focused on quantitative optimization.

We have developed our training sessions around 3 main themes:

- Mathematical Optimization and Data Science
- Economic optimization of energy systems
- Digital components and optimization tools

Noteworthy among the new features is the fact that the Optimization and Data Science theme has been designed as a Master's level degree course.

These training courses are as always based on the skills and experience acquired by Artelys consultants and researchers in the realization of analysis models and the implementation of operational solutions in companies. They are pragmatic and practice-oriented, without dodging fundamental technical difficulties.

We look forward to welcoming you to our training courses, with a new program and a stronger ambition that will meet your expectations.

Artelys | OPTIMIZATION SOLUTIONS

Artelys is specialized in the modeling of complex systems, notably energy systems, and their optimization. It develops the associated IT tools based on the most suitable numerical technologies and an intensive use of quantitative methods combining statistics and numerical optimization, adapted to the business context of its clients.

Artelys is an approved training institution by the French Ministry of National Education (Training Organization #11754066975). Artelys consultants, who regularly provide training sessions in numerical optimization techniques, statistical computations and energy system management, thus have a solid pedagogical experience.

IN-HOUSE OR CUSTOMIZED TRAINING

- Training programs tailored to your needs
- All courses in the catalogue are scheduled on dates of your choice
- The training organization in your premises everywhere in Metropolitan France and overseas

Our premises are located at 81 rue Saint-Lazare, 75009 Paris, France. They are situated 5 minutes' walk from the Saint-Lazare train station and 2 minutes from the Trinité d'Estienne d'Orves station (metro line 12).

Depending on the sanitary context, we may choose to provide these training courses remotely.

5 REASONS TO CHOOSE US

- Artelys is a **European leader** in optimization and statistical analysis, energy system optimization and IT tools for decision support.
- Artelys has **more than 20 years of experience** in the organization and realization of professional training.
- A **strong commitment** of the company to the quality of the training courses delivered and the adequacy with the expectations of the participants.
- A special attention is paid to the comfort of our trainees: coffee breaks and lunch breaks are included.

Registrations and detailed programs on: https://www.artelys.com/training/

TRAINING ON OPTIMIZATION AND DATA SCIENCE

Operations Research represents one of the major fields of implementation of mathematical optimization techniques and computer science in industry. It is primarily based on the analysis of data and the search for optimal solutions to complex decision-making problems. This area plays a key role in maintaining industrial competitiveness and has made great advances in recent years. The training courses offered here in optimization and Data Science enable to gain and/or update the mastery of theoretical and practical tools in this field. These trainings are devoted to learning statistical analysis and data processing techniques, modeling and solving complex optimization problems (combinatorial, linear, nonlinear and stochastic) and to the design and practical implementation of adapted technologies and computer tools.

Linear programming is an extremely powerful tool to rationalize the use of resources in increasingly complex economic systems. Recent advances in linear programming solvers allow scientists and economists to quickly implement these techniques in many operational and strategic problems. The success of such approaches depends, above all, on the choices made during the modeling phase. This course will allow you to understand the principles behind linear optimization algorithms and to adopt the most efficient modeling approach.

Duration: Two-day training

Training objectives

Ability to model decision problems through linear programming and interpreting results.

Target audience

Engineers, economists, scientists, and developers interested in modeling decision problems and implementing optimization algorithms.

Presentation of trainers

Artelys consultants specialized in modeling and solving large scale optimization models applied to the domains of energy, transport and logistics.

Training prerequisites

Basic skills in linear algebra (vector spaces, linear mapping, matrix operations, basic notions in affine geometry).

The training will be given in English.

Introduction to linear programming

- Introduction: history, set-up.
- Linear programming terminology: definitions, linear program formulation and graphical illustrations, classical reformulations.
- Notion of convexity.

Simplex algorithm

- Simplex method: principle, dictionary form, tabular form, non-degeneration and cycling, initial base. Implementation through simple examples.
- Applying linear programming to scheduling problems. Illustrating the impact of modeling on solver results.

Duality

- Duality: building a dual program, fundamental results (equality constraints and Lagrange multipliers, inequality constraints and Farkas' lemma, KKT conditions, weak duality).
- Economic interpretation of dual variables. Using dual variables to handle transportation and stock management problems.
- Post-optimality and sensitivity analysis.
- Variants of the simplex method: revised form, dual simplex.

Interior-point methods

- Interior-point methods: quality of nonlinear approaches, Karmarkar' algorithm, primal-dual interior algorithm, affine algorithm, complexity and polynomial convergence.

Using a solver

- Taking advantage of a linear programming solver: tips and tricks, and good practices (illustrations with FICO Xpress).

The discrete nature of many decision problems can lead to a so-called combinatorial explosion. Whenever avoiding such phenomena (e.g., by relaxing integrity constraints) proves to be impossible, integer programming (IP) allows to tackle a great number of combinatorial optimization problems such as those found in the domain of logistics, production management or scheduling.

Duration: Two-day training

Training objectives

Handling the discrete aspects of a decision problem with the help of integer programming (IP).

Target audience

Engineers, economists, scientists, and developers interested in modeling decision problems and implementing optimization algorithms.

Presentation of trainers

Artelys consultants specialized in modeling and solving large scale optimization models applied to the domains of energy, transport, and logistics.

Training prerequisites

Contents of the course 'Introduction to linear optimization'.

The training will be given in English.

Integer Linear Programming (ILP)

- A brief reminder of linear programming.
- Formulations: What is an integer program? Formulation of an integer linear program. Combinatorial explosion. IP formulations. Alternatives formulations.
- Optimality, relaxation, and bounds: optimality and relaxation, linear relaxations, combinatorial relaxations, lagrangian relaxation, duality, primal bounds.
- Modeling techniques and illustrations.
- Solving integer linear programs with branch-and-bound.
- Principles of cutting methods and branch-and-cut.
- Numerical examples.

Application

- Introducing, modeling, and solving a travelling salesman problem with the FICO Xpress solver.
- Introducing, modeling, and solving an industrial problem with FICO Xpress.
- Comparison between a naive formulation of the problem and a formulation including cuts.

Introduction to decomposition techniques

- Introduction to decomposition techniques: illustration of the interest of column generation.
- Principles and practical interest of column generation techniques.
- Presentation of an industrial application.

Whenever integer programming (IP) turns out to be unfit for treating a combinatorial optimization problem, it might be necessary to use the problem's attributes in order to overcome it. Based on this concept, constraint programming and local search provide a formal framework for solving difficult combinatorial problems.

Duration: Two-day training

Training objectives

Treating difficult combinatorial optimization problems with the help of constraint programming and local search techniques.

Target audience

Engineers, economists, scientists and developers interested in modeling decision problems and implementing optimization algorithms.

Presentation of trainers

Artelys consultants specialized in modeling and solving large scale optimization models applied to the domains of energy, transport and logistics.

Training prerequisites

Contents of the courses:

- Introduction to linear optimization
- Combinatorial optimization I: integer programming

The training will be given in English.

Detailed program

Constraint programming

- Constraint programming: principles and applications.
- Presentation of a constraint programming solver: Xpress-Kalis.

Practical applications of constraint programming

- A simple staff scheduling example.
- Solving a movie scenes allocation problem.
- Solving a frequency assignment problem.
- Enumeration configuration – Branching strategies – Definition of search strategies for an advanced user.

Local Search

- Intuition (n-queens) - Neighborhood (car-sequencing, magic square) - Optimization (warehouse location) - 2-opt, k-opt
- Optimality vs. Feasibility (graph coloring) – Complex neighborhood (sport scheduling) – Escaping from local minima, connectivity.
- Formalization, heuristics – Introduction to metaheuristics: Variable neighborhood search, Simulated annealing, Tabu search.

Scheduling problems and resource management

- Introduction to scheduling problems.
- Disjunctive scheduling – application to the construction of a sports stadium.
- Multi-machines disjunctive scheduling – Job shop problem.
- Cumulative scheduling – non-renewable resources.

Aside from the attributes, it is possible to get around a problem by using its structure. In such a case, rather than solving a large-scale problem subject to combinatorial explosion, it is better to solve several small problems in a coordinated way: this is the principle of **decomposition**. In some cases, it may even be advantageous to combine combinatorial optimization techniques (IP, CP, local search) to overcome a problem particularly difficult to solve. This is the principle of **hybridization**.

Duration: Two-day training

Training objectives

Mastering the principles of hybridization and decomposition methods in order to solve difficult large-scale problems.

Target audience

Engineers, economists, scientists, and developers interested in modeling decision problems and implementing optimization algorithms.

Presentation of trainers

Artelys consultants specialized in modeling and solving large scale optimization models applied to the domains of energy, transport, and logistics.

Training prerequisites

Contents of the courses:

- 'Introduction to linear optimization'
- 'Combinatorial optimization I: integer programming'
- 'Combinatorial optimization II: constraint programming and local search'

The training will be given in English.

Detailed program

Hybridization techniques

- Linear programming / Constraint programming hybridization. Mixed modeling, common search trees, dialogue among branching schemes. Using reduced cost
- Constraint programming / Local search hybridization. Description of neighborhoods as constrained neighborhoods. Under constraints' neighborhood exploration.

Decomposition techniques

- Principles of price decomposition and resource decomposition. Types of information exchanges. Elementary examples.
- Lagrangian. Duality. Definition and economic interpretation of the dual function. Duality gap. Convex and non-convex cases.
- Price decomposition: coordination algorithms and non-differentiable optimization.
- Bender's decomposition: principles and implementation.

Applications

- Joint gas and electricity assets optimization: introduction, Benders and price decomposition.
- Example of constraint programming and local search hybridization: timetables scheduling, frequency assignment.
- Decomposition and hybridization for maintenance scheduling.

Nonlinear optimization arises in various domains such as energy, economy, finance, machine learning, model predictive model control. This training will enable participants to understand and practice the basics and subtleties of nonlinear optimization and to model and solve problems efficiently.

Duration: Two-day training

Training objectives

Whichever is your application domain, this training will provide you with an introduction to the field of nonlinear optimization and will teach you how to apply nonlinear modeling techniques to industrial applications using Artelys Knitro.

Target audience

Scientists and developers interested in modeling and solving nonlinear programs using Artelys Knitro.

Presentation of trainers

Professional consultants and software developers from Artelys with years of experience in solving large-scale nonlinear problems using Artelys Knitro.

Training prerequisites

Basic knowledge in operations research and programming.

The training will be given in English.

Detailed program

Nonlinear programming (NLP)

- Introduction, presentation of the training.
- Problem statement and optimality conditions.
- Newton method for unconstrained optimization. Globalization techniques.
- Interior-point and active-set methods for constrained optimization.

Solving nonlinear problems with programmatic interfaces

- Presentation, modeling and solving a nonlinear model with Artelys Knitro in Python™.
- Impact of exact versus approximate derivatives. Quasi-Newton method.
- Using Artelys Knitro in R/MATLAB®: a nonlinear least square minimization application.

Solving nonlinear problems with modeling interfaces

- Using Artelys Knitro in AMPL: modeling syntax, automatic differentiation, examples.
- Good practices in nonlinear modeling. Tips and tricks.
- Fine-tuning Artelys Knitro parameters.
- Global optimization using parallel multi-start.

Solving nonlinear models with special features

- Mixed-integer nonlinear programming (MINLP) methods. Practical example.
- Mathematical programming with equilibrium constraints (MPEC). Application to computational economics and game theory.
- Convex non-smooth models.

The decisions to be made over time to manage stocks or financial assets are highly dependent on each other. We often seek a balance between immediate gains and expectations of future gains. This course shows how dynamic programming can be used to model such problems in their entirety.

Duration: Two-day training

Training objectives

This course focuses on the modeling of stochastic optimization problems and their treatment by dynamic programming techniques or techniques derived from them.

Target audience

Those who wish to become familiar with stochastic optimization through dynamic programming.

Presentation of trainers

Experienced Artelys consultants with extensive experience in industrial problem solving and teaching in universities and colleges.

Training prerequisites

Basic knowledge of optimization.

Detailed program

Deterministic dynamic programming

- Deterministic dynamic programming: principles. Transition equation, state, Bellman values. Shortest path problems. Treatment of an example of management of production unit start-ups. Inventory management problems.
- Bellman values and dual variables. Economic interpretation of Bellman values. Application to the case of inventory management. Link with dual variables.

Stochastic dynamic programming

- From deterministic to stochastic. Modeling a dynamic stochastic optimization problem. Non-anticipativity constraints. Dynamic programming on tree-like time-series. Application to option pricing.
- Dynamic stochastic programming. State definition and risk structure. Examples of modeling. Economic interpretation of Bellman values. Valuation of futures contracts.

Stochastic dynamic programming (continued)

- Inventory management and dynamic programming: some examples. Modeling and effects on Bellman functions.
- Large dynamic problems. Limits of dynamic programming for large problems.
- Decomposition methods: dual dynamic programming, scenario decomposition, tree-liked timeseries method.
- Handling of large dynamic problems: application to the annual management of electricity production. Dynamic management modeling of interconnected systems in the energy domain. Resolution by decomposition. Solving by dual dynamic programming.
- Reinforcement learning.
- Sampling and generalization techniques.
- Dynamic learning and optimization schemes.

Synthesis

In the sale of goods or services, demand forecasting is a major issue for operational planning (of production, inventory, teams) and for the sizing of long-term facilities. This training allows you to get to grips with the R software and presents the use that can be made of it in the context of demand forecasting.

Duration: Two-day training

Training objectives

- Increasing your skills on R software, from learning how to use it to deploying forecasting modules.

- Acquiring a proven methodology for data analysis and development of a demand forecasting model.

- Getting to know statistical techniques for forecasting: to know the main kinds of models, their advantages and disadvantages, as well as the link with the business expertise.

Target audience

This training is intended for people who work with data (e.g., business analysts and data-scientists) and who wish to improve their skills with a tool that allows them to perform advanced analyses.

Presentation of the trainers

The speakers are Artelys consultants with a solid knowledge of business issues related to demand forecast and a strong experience of R software.

Prerequisites

Basic knowledge of probability and statistics.

Detailed program

Getting started with R software

- Main features and benefits.
- Description of the most useful syntax and keywords.
- Good programming practices in R.
- Installation of the software and the work environment.

Pre-processing the data and the problem

- Take control of the data by viewing the timeseries.
- From raw data to usable data (data pre-processing methods).
- Identification of the structuring characteristics of the data (numerical and graphic indicators, seasonality, explanatory factors).
- Definition of the problem, the issues and the quality criteria of the forecasts.

Build a relevant demand model

- Which models should be considered given the characteristics of the data? Presentation of several classical models: autoregressive models ((S)AR(I)MA(X), linear models.
- Implementation of the different models with the R software.
- How to choose a good model: analysis of the quality of the forecasting results (fitness performance, generalization).

To go further

- Other types of models are possible (frequency models).
- How to make relevant graphics (ggplot package).
- Code maintenability with R.

Data Science is a discipline born from the convergence of mathematics, statistics, and computer science, which allows to exploit the information contained in the data. The Python language™ provides the Data Scientist with all the tools necessary to do scientific programming. The training puts a special emphasis on the quality of the code.

Duration: Three-day training

Training objectives

- Understanding the problems of scientific programming.

- Enriching your Data Science toolbox.

- Handling the Python libraries allowing to do data mining and scientific computing.

Produce robust and quality Python code.

Target audience

- Analysts, statisticians

- Developer

- Data Scientists

Presentation of the trainers

Engineers and Data Scientists of Artelys working regularly on internal and customer IT projects.

Prerequisites

Basic programming skills.

Basic knowledge of data analysis and statistics.

Detailed program

Efficient programming with Python

- Presentation of the language, first script in Python.
- Presentation of development environments (Anaconda).
- Jupyter notebook: an efficient environment for the presentation and reproducibility of scientific results.

The basics of programming with Python

- Python data structures (lists, tuples, dictionaries).
- List browsing and generation (itertools, iterators, generators, and comprehension lists).
- Good practices (use of exceptions, typing verification, etc.).

Organization and code improvement

- Comments and cleanliness (docstring, linters, pep8…).
- Modularity and reusability of the code (file import, OOP and polymorphism).
- Algorithms and complexity.

Distribution, isolation and package management

Introduction to scientific programming

- Scientific programming vocabulary and statistical analysis.
- Main machine learning algorithms (supervised analysis, unsupervised analysis, classification, and regression).
- The scientific stack: Numpy, Scipy, Scikit-learn, pandas, Sympy, matplotlib.

Descriptive statistics and data structures

- Data management with pandas: import, dataframes, slicing, mapping, (reading, formats, date management).
- Visualization with matplotlib.

Statistical modeling with Scikit-learn

- Presentation, linear modeling and prediction, classification with Scikit-learn.

Scientific computing with Numpy

- Presentation, data structure, indexing, slicing, iterating.

Scientific computing with Scipy

- Presentation, linear algebra, application.

Introduction to Docker, Kubernetes and Serverless

Containers have transformed the way applications are designed, deployed and operated. The service is now the basic unit of measurement for a production application.

Duration: One-day training

Training objectives with containers and K8S cluster:

- Understanding basics of docker, Kubernetes and serverless.

- Introduction of various architectures with new cloud technologies.

- Use command line to interact with containers and K8S.

- Basics on containers, scalability and serverless.

Target audience

The training is intended for people who are interested in virtualization and cloud technologies or who would like to deploy and manage efficiently applications within modern architectures.

Presentation of the trainers

The speakers are Artelys consultants with a solid knowledge of computer and statistical techniques used in Big Data.

Prerequisites

It is preferable to know basics with Unix command line.

Detailed program

Docker

- Main principles.
- My first Dockerfile.
- Introduction to docker-compose and docker swarm.
- Container as a Service principles and implementations in cloud.
- Other container technologies: Introduction to WebAssembly.

Kubernetes

- Main principles.
- My first managed K8S.
- Introduction to scalability and service mesh.
- Kubectl basics: how to control my Kubernetes cluster with command line.
- Brief overview on helm and some CNCF projects.

Serverless

- FaaS: main principles, advantages and drawbacks.
- Developing a high quality FaaS application.
- Available technologies in cloud and comparisons per language.

Software architecture, design and integration of an optimization tool

The technical decisions related to the development, architecture and integration of software have a strong and long-lasting impact on the costs, quality and performance of a software solution. Quantitative decision support modules have their own specificities, in particular by the presence of computational functionalities that are very greedy in terms of machine resources (RAM and CPU time) and the use of complex and voluminous data that require specific skills and a very particular methodology.

Duration: Three-day training

Training objectives

- Understanding the challenges and difficulties inherent to the design and integration of a software dedicated to decision support through practical examples.

- Learning the specific technologies and vocabulary for this need.

Target audience

- Architects, project managers or technical experts wishing to learn about the specificities of solutions based on computational functions (optimization, simulation, statistical calibration).
- Decision support engineers wishing to expand their skills in computer science and software integration.

- Developers working on complex IT development projects.

Presentation of the trainers

Artelys engineers specialized in the implementation of operational solutions for quantitative decision support, experts in design.

Prerequisites

Skills in either software architecture and design, optimization and decision support, or basic knowledge of programming and the Java language.

Detailed program

Software design

- Software quality factors.
- Maintenance and maintainability of the code.
- Unit tests and Test-Driven Development method.

Design Patterns

- General presentation.
- Detailed study of Gang of Four patterns.
- The anti-patterns.

Choice of data structures

- Introduction to complexity.
- Structures of collections and data associations.

Introduction to development tools

- Version management, code review, quality by example (Git, Gerrit, Sonar).
- Continuous integration platform (Jenkins).
- Software integrator (Maven).
- Project Manager (Redmine).
- Know how to use your IDE.
- Additional tools (Meld, unix/grep/, etc.).

Design an integrated decision support solution

- Fundamentals and issues.
- Technological choices.
- Notion of weak coupling and strong cohesion.

Basics and technologies of software architecture

- Architecture (client-server, SOA, etc.), SaaS solutions, remote computing.
- Data exchange methods and dedicated tools.
- Technical foundation of solutions, application containers, hosting.
- Interfacing a calculation engine in synchronous, asynchronous or hybrid mode.
- Create a degraded mode.

Approach to carry out such projects

- V-cycle, agility, spiral walk or iterative development.
- Standard solutions, example architectures and critical analyses.

High performance computing and parallelization

Simulating complex physical systems and solving large problems requires computing power far beyond what can be achieved with a simple desktop computer. Moreover, with Big Data, the computational performance requirement is becoming more important day by day.

HPC (or High-Performance Computing) is thus becoming an essential tool for industry and research today and tomorrow. A large part of the training will be devoted to an implementation work on a virtual distributed infrastructure.

Duration: Two-day training

Training objectives

- Presenting the fundamental principles and best practices of HPC computing on distributed architectures.
- Understanding the new challenges of HPC in the cloud.

Putting knowledge into practice on well-known examples from the scientific and industrial world.

Target audience

This training is intended for engineers and researchers likely to use HPC and wishing to acquire a first experience or cluster users looking to update their knowledge on the latest technologies.

Presentation of the trainers

- Artelys optimization engineers experienced in the use of HPC.

Prerequisites

Basic knowledge of scientific computing, Python and computer systems.

Detailed program

Presentation of High-Performance Computing

- Main issues and need of parallelization.
- Application examples.
- Hardware and software components of High-Performance Computing (processors, memory, applications for the implementation of parallelization on the hardware).
- Performance measurement of calculations and improvement techniques.
- Introduction to parallelism performance indicators.

Architecture of HPC systems

- Shared memory architecture.
- Distributed memory architecture.
- Hybrid architectures.

High performance architecture management systems: Scheduling and Load-balancing with a high-performance infrastructure management system.

- Performance metrics and monitoring.
- Overview of the main systems: SGE, SLURM, OpenPBS, Torque and Celery.
- Scalables cloud Technologies: Container as a Service, K8S and Knative, Azure et AWS Batch, Parallel Cluster - GCP Cloud HPC Toolkit – Azure CycleCloud.

Setting up an HPC cluster:

- Setting up a local cluster with Docker.
- Launching first jobs.
- Installing apptainer.
- Building apptainer images.
- Launching containerized jobs.

ENERGY SYSTEMS TRAININGS

Introduction to the technical and economic analysis of electrical systems and markets

The rapid decarbonization of the electricity sector is a sine qua non condition for achieving the ambitious climate objectives that most countries have set for themselves. This decarbonization must be achieved simultaneously with significant efforts in energy efficiency and the increase in electricity demand due to uses such as electric mobility, heating (heat pumps in particular), electrolysis and the decarbonization of some industrial processes.

Quantitative analysis techniques allow for the analysis of the role different technological options can play, the revenues that players can expect according to the structure of the markets, the risks to which project developers are subject to due to the numerous uncertainties on commodity prices, the strategies of different countries or the evolution of demand.

Duration: Two-day training

Training objectives

- Presenting the challenges of decarbonization.
- Identifying and characterizing the main options for decarbonizing the electrical system and related systems (mobility, heat, hydrogen).
- Describing the structure of the European markets and their potential operational and strategic impacts.

Introducing the fundamentals of the technical and economic analysis of these issues.

Target audience

This course is intended for students, consultants and energy analysts who wish to acquire an overview of the issues.

Presentation of trainers

- Experts in the economics of electrical systems.

Prerequisites

No prerequisites.

Detailed program

Power systems (status, trends, flexibility needs)

- Introducing a few useful concepts
- Status of the European electricity systems
- EU trends, energy and climate objectives on production, consumption and GHG emissions
- Systemic challenges

Introduction to key economic concepts

- From investments to operations - a series of decisions
- Presentation of electricity costs
- Market revenue presentation
- Role of markets
- Cost-benefit analysis methodology, measuring the impacts of an investment project and establishing/analyzing a transition trajectory, synergies and interdependencies between technological options.

Electricity markets in Europe

- Roles of electricity markets
- Sequence of electricity markets
- Brief comparison between US and EU systems

Challenges, hydrogen and wrap-up

- Challenges for the future electricity system
- Interactions between hydrogen and electricity systems
- Wrap-up

Introduction to the operation of power systems

The energy transition is highlighting many upheavals in the electricity system, with the emergence of new forms of generation that are more dependent on the weather and more decentralized, as well as new forms of consumption that are more flexible and satisfy new uses, such as the electric vehicle. At the interface between production and consumption, networks are at the very core of the electrical system, and their operators are also constantly innovating to support the energy transition.

Duration: Two-day training

Training objectives

- Introducing the basics of operating an electrical system.
- Describing the organization chosen in Europe to operate, control and ensure the safety of the system.

Describing the structure of the European markets and their potential operational and strategic impacts.

Target audience

This course is intended for students, consultants and energy analysts who wish to gain an understanding of the operation of power transmission systems.

Presentation of trainers

- Experts in power systems.

Prerequisites

Basic knowledge of physics, mathematics and Python programming.

Detailed program

Introduction to Power Systems Analysis

- General characteristics of power systems
- Main components of power systems
- Power system structure

Power Flow analysis

- Basic principles for circuit analysis
- Power Flow Computation
- Newton-Raphson method

Regional Security Analysis

- Power system security
- Coordinated Security Analysis
- Line overloads
- Cascading effect
- Voltage collapse
- Preventive/curative remedial actions

System security

- Major incidents in France and in the world, typology of network collapses.
- Network protection: N-k, preventive and curative actions, defense plan.

Structure of a generation-transmission-consumption network

- Production, merit order principle.
- Use of electrical energy, characterization of consumption.
- Balance between production and consumption, notion of optimal adapted park.
- Need for an electrical network and structuring.

Interaction with the markets

- Energy Only market model and clearing algorithms.
- Structure of the electricity markets.
- Reserve markets, interactions with setting.
- Market coupling and regional operational security coordination.

Power System Control

- The basics of system control.
- Active power and frequency control: primary, secondary and tertiary control.
- Voltage and reactive power regulation: automatic voltage regulator, on-load regulator, reactive power injection.
- Power transits

Practical work: Power Flow and security analysis in python with PowSyBl / France-Spain capacity sizing with Artelys Crystal Super Grid

In addition to its introductory training, Artelys offers advanced customized training in technical and economic optimization of energy systems based on the international experience of its energy consultants.

- ✓ A training program adapted to your context and faithful to the specifications.
- ✓ Possibility of speaking specifically at conferences and seminars.

To schedule a customized training on any of the following topics, contact us at formation@artelys.com.

Risk management and energy systems

The topics covered are dedicated to forecasting and risk issues specific to the energy sector, as well as the most appropriate methods to deal with them. This course introduces the general concepts of risk management (Value-at-Risk, Stress-Testing) and applies them to the specific case of energy systems, by recalling certain risk hedging tools (long-term contracts, options). This course provides an introduction to the challenges of security of supply in the current context of energy transition. It also provides details on the various aspects of rigorous stochastic modeling and methodological approaches that facilitate the estimation and reduction of risk in an uncertain environment. Practical examples from real problems encountered by practitioners in the energy world will facilitate the understanding and assimilation of the concepts presented.

Operational optimization of energy systems

This course presents the functioning of the energy market and the challenges involved in energy planning. It details the different time horizons considered by energy companies when planning their production facilities (day for tomorrow, next year, 10 to 15 years ahead). The associated optimization methods, as well as the major uncertainties to be considered - electrical demand, fuel prices, weather, energy policies - will be clearly explained and illustrated by application cases.

TRAINING ON NUMERICAL COMPONENTS AND OPTIMIZATION TOOLS

Artelys offers on-demand training sessions on the numerical software solutions, the platforms and optimization tools that its consultants use daily to solve complex issues.

- ✓ A training program tailored to your needs.
- ✓ Possibility of specific lectures during conferences and seminars.

To program an on-demand training on one of our tools or numerical software solutions described below, please contact us at training@artelys.com

1 NUMERICAL SOFTWARE SOLUTIONS

Artelys Knitro

Artelys Knitro is a numerical software component that implements advanced nonlinear optimization techniques. Its 4 algorithms and its numerous options allow it to offer excellent performance and great robustness when solving a variety of optimization problems. We offer on-demand training sessions that will allow you to learn how to solve nonlinear optimization problems, such as portfolio optimization, optimal network power flow, nonlinear predictive control, or Nash equilibrium models. Trusting its efficiency and robustness, hundreds of institutions worldwide have chosen Artelys Knitro to solve highly complex problems.

Artelys Kalis

Artelys Kalis is a software component for modeling and solving large scale combinatorial problems through hybrid constraint programming and mathematical programming techniques. We offer on-demand training sessions that will present the principles of constraint programming and a rapid and efficient implementation of combinatorial problems of different types: tasks and timetable scheduling, resource allocation, equipment or network configuration.

FICO® Xpress Optimization Suite

FICO® Xpress Optimization offers a complete range of modeling and numerical optimization tools. These solutions can be quickly integrated into business problems in order to provide decision-support insights into complex problems. The following are some examples of on-demand courses that we can offer:

- Logistics – Defining master plans in sectors such as transport, manufacturing, etc.
- Personnel planning – Timetabling in sectors such as aeronautics, medical, public transportation, and distribution.
- Networks – Defining investment strategies in sectors such as telecommunications or electricity networks, and establishing a medium-term strategy.

AMPL

AMPL is a complete and powerful algebraic modeling language for solving linear and nonlinear problems with discrete or continuous variables. We offer on-demand training sessions that will teach you how to use generic notation and familiar concepts necessary to formulate optimization problems and to examine the possible solutions. The flexibility and the ease of use of AMPL allow for a very fast prototyping and development of models, whereas its speed and options control make it a very efficient tool for repeated use in production.

2 PLATFORMS

FICO Xpress Insight

FICO® Xpress Insight enables organizations to quickly deploy any advanced analytical model as powerful applications. Xpress Insight enables organizations to work in a collaborative environment with interactive visualizations tailored to business needs. This allows users to work with easy-to-understand models that focus on the impact of decisions on the business problem. They can share results with their peers and collaborate to make optimized decisions by performing what-if scenario analyses and comparing the impact of different strategies.

3 ARTELYS CRYSTAL SUITE

Artelys Crystal City

Today used for the elaboration of the Energy Master Plans of the metropolises of Lyon, Grenoble, Lille, Poitiers, Metz, Tours, Orléans, Toulouse métropole, Artelys Crystal City provides full support to territorial authorities in evaluating, monitoring, and communicating their local multi-energy development plans. At the time of the energy transition, local decision-makers are confronted with new territory planning issues where the energy dimension is a key factor in the decision-making process. We offer on-demand training sessions based on the tool Artelys Crystal City allowing to treat a variety of challenges related to topics such as energy consumption, CO^2 emissions reduction, coordinating the development of distribution networks and valuating local renewable production potential.

Artelys Crystal Super Grid

The energy sector of most countries is currently undergoing a rapid and deep mutation: the development of renewable energy generation technologies, interconnections, energy storage and demand-side response represents at the same time a challenge and an opportunity to rethink the way energy systems are operated and how we plan their evolution. Whether they are energy regulators, network operators, assets owners, researchers, all the actors must evaluate the impacts of strategic choices that integrate this new energy reality. We offer on-demand training sessions based on Artelys Crystal Super Grid, providing quantitative elements to assess the costs and benefits of adding interconnection capacity between two countries or to optimize a national energy strategy using the investment planning module of Artelys Crystal Super Grid.

Artelys
OPTIMIZATION SOLUTIONS

Further information and registration

Tel: +33 1 44 77 89 00

training@artelys.com

81 rue Saint-Lazare

75009 Paris