PiControl Solutions LLC

Industrial Process Control and Engineering Training Courses




Novel & New, Voted as "The Best"

Industrial Process Control and Engineering Training Courses

Practical, Designed for Control Rooms

Many new technicians, operators and engineers enter the chemical plant control rooms every year. Responding to the needs of the industry all over the world, PiControl Solutions LLC has developed practical, proven and effective training courses on several industrial process control and engineering topics. PiControl Solutions LLC is a process control, engineering software vendor and industrial training company. PiControl develops and provides software for advanced process control (APC), PID tuning, OPC and training for both industry and colleges.

For more information, please visit www.PiControlSolutions.Com or send an email to Info@PiControlSolutions.Com.

PiControl offers the training courses using several different convenient options– Classroom, Online (using Vimeo and live instructors available for immediate assistance)using GoToMeeting and Self-Paced (using computer- based training Software modules).

The new courses are very practical; they avoid unnecessary and complicated academic material (not useful in the practical control-room environment) and are aimed at fast learning and immediate application. The courses will benefit operators, technicians, engineers, supervisors, managers - both new and experienced, and also college students.

Unlike other training techniques, PiControl's new approach is far simpler, more effective and easier to learn and master. The simplicity and ease of use of the training products are because of PiControl's powerful and user-friendly software user interface, software product design and modern-style training material and approach.

A complete list of all PiControl training courses and their description are shown on the following pages.

Software, Training, Services

APC (Advanced Process Control)

Control Scheme Implementation

PID Tuning

Online Control Quality Monitoring

Model Based Control

DCS Training

Transfer Function System Identification

Online Oscillation Detection

PLC Training

OPC Communications

DMC (Dynamic Matrix Control)

Industrial Statistics

Process Control Training for Plant Personnel

Process Control Security

Plant Operations Safety

COURSE LIST

Classroom and Online

PID100: PID Tuning Certification and Primary Process Control
APC200: Advanced Process Control, PID Tuning and Beyond
APC275: Advanced Process Control Scheme Implementation in DCS or PLC
MON300: Control Quality Performance Monitoring and Adaptive Control
DCS400: DCS Training for Control Room Personnel
DCS450: Function Blocks for APC Implementation in DCS or PLC
PLC475: PLC Hardware, Programming and Design
OPC500: Industrial OPC Software for Communications and Control- Overview
OPC515: Industrial OPC Software for Communications and Control- Hands-On
SEC600: Process Control Software, Hardware Security & Cyber Security
MPC700: DMC Maintenance
STA100: Industrial Statistics, SQC and SPC
STA200: Transfer Function Dynamics Identification
PLT100: Industrial Safety – Plant Operations and Process Control

Self-Paced CBT (Computer-based Training) Software

CHE100C: Basic Chemical Technology and Stoichiometry
CHE200C: Material Balances
CHE300C: Thermodynamics - Gases, Vapors and Liquid
CHE400C: Energy Balances
CHE500C: Industrial Process Control - Primary and Advanced Process

Course Times and Format Options (Online, Classroom and Self-Paced CBT

The classroom courses are conducted at your plant site, training center or at our training facility or in a hotel or some alternate training venue. Local times every day are typically 8:30 AM to 4:30 PM with one-hour lunch break.

PiControl is very flexible and selects training options, venues and locations to best fit the customer need.

Online sessions are based on using Vimeo platform and GoToMeeting for answering student's questions. You can join in from any location anywhere in the world. Broadband internet with at least 1 MBPS speed or higher is required.

Online courses are completely flexible, students can join sessions anytime based on their availability; the sessions can be started, paused, stopped, rewound, or fast-forwarded. During specific time windows every day, students can ask questions to an experienced live instructor for assistance on the theory and software.

Self-Paced CBT (computer-based training) is using software that you install on your computer and then you go through all chapters, sessions and take tests and quizzes. The CBT comprises of several chapters, lab sessions and tests. This is great for people who are currently very busy and are having a difficult time to participate in a classroom or online course with fixed times.

Courses consist of theory (based on classroom sessions or Vimeo/GoToMeeting), software and homework lab and practicals and a final review test. If the student gets 75% or more questions correct, then the student can print a course completion certificate automatically.

PID100:
PID Tuning Certification and Primary Process Control

Duration:	**2 Days Classroom or 15 hours Online**
Audience:	**DCS Technicians, Plant Operators, Instrument Engineers, Process Engineers and Process Control Engineers.**
Prerequisites:	**Control room experience as technician, operator or engineer is desirable, but not required.**
Course Material:	**Software Products used in Course - Pitops, Simcet and Training Slides.**

Course Description:
This course addresses needs of control room operators, DCS technicians, process control engineers, applications engineers and anyone else responsible for PID tuning in the plant. Many new personnel enter the control room these days; there are numerous types of processes and different DCS and PLC systems.

This course starts with the basics of process control, explains the PID equation in the time domain and then trains using three powerful PID tuning, real-time simulation/ optimization and grading software products.

In a remarkably short 2-day time, students learn to optimally tune PIDs and make process changes on distillation columns, reactors, tanks, compressors, flow controllers, heat exchangers using modern real-time simulator software.

The software also has automatic grading capability, so at end of the course, the software generates a report card on the PID tuning skills of each attendee.

This course provides good foundation, skills and knowledge for all DCS/PLC related tag building, control scheme design in a DCS/PLC and the ability to calculate tuning parameters not only for PIDs but other control schemes without the old trial-and-error method but scientifically.

Learning Outcomes:
After completing the course, attendees will be able to tune PIDs in any DCS/PLC, troubleshoot problems, dampen/eliminate oscillations, improve controller performance, all of which helps maximize rates, directly increasing the plant's bottom-line profits.

Through practice on a real-time PID tuning simulator, attendees will gain tremendous confidence in PID tuning on live DCS/PLC's in actual operating plants. This confidence that would otherwise have taken several years on the job now can be achieved in just two days. Attendees will also learn many important and practical concepts about DCS/PLC operations. The following topics are covered in this course:

- Introduction to Industrial Process Control Process Control Terminology and Definitions
- Manipulated Variables, Controlled Variables, Disturbance/Feedforward Variables Process Control Dynamics and Process Transfer Functions
- Open Loop Dynamics
- PID Equation in Time Domain and Laplace Domain
- PID Examples in Time Domain with Calculation Illustrations Process Control Schematics
- Positional and Velocity Forms of PID Equation PID Simulations using Pitops and Simcet

- Advanced Forms of PID Algorithms Simulating Noise and Process Disturbances Filter Action and Filter Time Constant
- Estimating Correct Filter Time Constant in DCS or PLC
- Hands-On Lab (Practical) Sessions Using Real-Time PID Simulator Software
- Optimal Tuning Theory and Calculations
- Error Criteria for PID Tuning and Quantifying Control Quality Typical PID Tuning Parameters for Various Types of Processes
- Optimal Tuning using Pitops Simulator with Disturbances, Noise and Setpoint Changes Estimating Process Dynamics from DCS Trends and Operator Knowledge Transforming Process Operating Information into Controller Tuning
- DCS Attributes and Features Controller Modes
- PV Tracking
- Importance of Derivative Action, When to Use/Not to Use Derivative Estimating Derivative Tuning Parameter Scientifically
- Procedures for conducting Step Tests in the Plant
- Continue Hands-On Lab (Practical) Sessions Using Simulator Software Cascade Control Basics
- SP/OP Tracking, Bumpless Transfer
- Timed Tests using Training Simulator for Testing

APC200:
Advanced Process Control, PID Tuning and Beyond

Duration:	**3 Days Classroom or 21 hours Online**
Audience:	**Process Control Engineers, Advanced Process Control Engineers, Instrument Engineers, Lab Technicians, DCS/PLC Technicians, Managers and Supervisors.**
Prerequisites:	**PID100, 2-year or 4-year degree in engineering or operations. A few months of plant/ engineering experience is desirable, but not required.**
Course Material:	**Software Products used in Course - Pitops, Simcet and Training Slides.**

Course Description:
The DCS and PLC have many powerful features that still remain under-utilized. This course shows you how to tune PIDs and build powerful optimizing controllers inside the DCS or PLC. During the course, we use several industrial process control software products - Pitops, Simcet, Process Control CBT and ACSSI.

The course assumes that attendees have completed PID100 course (PID100 is a prerequisite for this APC200 course).

Attendees use real time-series plant data and identify multivariable closed-loop/open-loop dynamics. Then they build various control schemes all inside Pitops software – cascade, constraint override, maximizing and minimizing constraint controllers, selectors, model-based controllers, dead-time compensators and many others.

This course is designed more for engineers but also will offer tremendous value to operators, technicians and supervisors. PiControl software products used in this course are so very easy to use that the course can be comfortably followed by even new and inexperienced technicians. This course also covers advanced functions of PID controllers in more detail.

Learning Outcomes:
At the end of the course, attendees will be able to study a process and its P&IDs and talk to the right people in the plant or control room and then design and build powerful controllers in the DCS/PLC. Attendees will become skilled in PID tuning, feedforward implementation, and parameter specification for all types of controllers in the DCS/PLC.

Further, using scientific process control methods and software products they will be able to calculate tuning and other DCS parameters precisely, thus eliminating guesswork and generating precise, optimized control action.

The course also trains attendees how to be careful while activating and commissioning new control schemes, avoiding mistakes and starting up a control chain in the right sequence.

This course is all you will ever need to use the full potential of the DCS or PLC and build powerful new controllers to stabilize plant operation, push against economic, market, process and equipment constraints. Attendees will also learn when to use traditional advanced control and when to use multivariable model- predictive control, a very practical and useful skill. The following topics are covered in this course:

- Process Control Hierarchy
- Advanced Process Control (APC) Options and
  Strategies Need for Automatic Process Control
- Benefits of Process Control
- How to Maximize Throughput and Minimize Utilities using
  APC Feedforward Control Theory and Calculations
- Feedforward Lab Session using Pitops
  Decoupler Strategies
- Advanced Cascade Control
- Cascade Control Lab Session Illustrating an AC-TC Triple
  Cascade Cascade Control Tuning Guidelines
- Constraint Override Selector Control Procedures and Calculations
- How to build correct DCS Configuration for Long Chain Control
  Schemes Startup and Chain Activation Procedures in the DCS
- Practical Rules and Tips for PID and APC Schemes
- Model-based Control
- Bias Update for Automatic
  Control Closed-Loop
  Dynamics
- GC-based Online Correction, PV Sample Hold
- Using Rigorous Models for Closed-Loop Advanced Control with PID
  Integration Dead-Time Compensation
- Internal Model-Based Control and Lab Session Internal Model-Based
  Control Identifying Process Dynamics based on Operator Experience
  and Knowledge Identifying Process Dynamics based on DCS Trends
  and Historical Data
- Continue Lab (Practical) Sessions on System Identification and Tuning Optimization
- Identification of SISO Closed-Loop Process Transfer
  Functions Multi-Input Closed-Loop Transfer Function
  Identification
- Identifying Process Dynamics based on analyzing actual Time-Sampled Data
- Lab Session using Pitops to identify first and second order transfer functions using real
  plant data Use Pitops to identify multivariable transfer functions using real plant data in
  closed-loop mode Model-Predictive Control
- When to use PID, Cascade PID, Advanced Regulatory, DMC, RMPCT, Rule-Based
  Control Identifying, Debugging and Troubleshooting PID Tuning and Process
  Control Problems Online PID/APC Control Quality Monitoring and Reporting
- Online Oscillation Detection and Online Control Sluggishness Detection
- PID Control Quality Alerting to Smartphones for Improved Proactive Maintenance

APC275:
Advanced Process Control Scheme Implementation in DCS or PLC

Duration:	**3 Days Classroom or 21 hours Online**
Audience:	**Process Control Engineers, Advanced Process Control Engineers, Instrument Engineers, DCS/PLC Technicians, Managers and Supervisors.**
Prerequisites:	**2-year or 4-year degree in engineering or operations. A few months of plant/ engineering experience is desirable, but not required. PID100, APC200 are required, DCS450 is nice to complete also.**
Course Material:	**Training Slides.**

Course Description:
This course continues the knowledge and skills building from PID100, APC200 and DCS450. PID100 and APC200 are required courses and it is nice to complete DCS450 before taking this course. This course covers the design of control schemes and implementation inside a DCS or PLC. The course covers how to design and implement various advanced control schemes using real plant examples. The course shows you how to conceptualize the design of APC schemes for maximizing production rates, minimizing utilities, developing schemes to improve the plant's operating efficiencies, protecting equipment from overloading and avoiding shutdowns. The course discusses how to build both standard and custom function blocks inside any DCS or PLC. This includes batch control, continuous control and sequence control. The course takes specific examples of how to build complex and advanced control schemes using a variety of standard and custom blocks in the DCS or PLC that were covered in APC200 and DCS450.

Learning Outcomes:
At the end of this course, students will have the skills to design and build continuous and batch control schemes inside any DCS/PLC. They will have the ability to look at a process flow diagram or P&ID and based on operations goals and objectives, design and implement the appropriate control schemes inside any DCS or PLC. Students will also have the skills to mathematically compute the various tuning parameters and control parameters for the control schemes. The course teaches how to provide automation to stabilize the process operation, how to maximize production, minimize cheaper byproducts, minimize utilities, minimize environmental emissions, increase the profit margins and improve key performance indicators. You can develop many powerful APC schemes in any DCS or PLC with the knowledge from this course and achieve the goals and objectives of plant management. The following topics are covered in this course:

- Using PV transforms for linearizing nonlinear processes
- Ratio control for pure mixing versus complex processes
- Adaptive tuning - as function of PID Output
- Median temperature controller in a reactor
- Average temperature controller in a distillation column
- Distillation reflux mass balance controller
- Signal validation for use in closed loop control
- Analyzer validation logic
- Constraint override control for limiting equipment
- Rate maximizer - with delta temperature and characterizer on valve
- Online heat balance control
- MW power feedforward control scheme
- Cross firing limiting control
- Lab update bias correction
- Online mass balance controller

<u>MON300</u>:
Control Quality Performance Monitoring and Adaptive Control

Duration:	**2 Days Classroom or 20 hours Online**
Audience:	**Process Control Engineers, Advanced Process Control Engineers, Instrument Engineers, Lab Technicians, DCS/PLC Technicians, Managers and Supervisors.**
Prerequisites:	**2-year or 4-year degree in engineering or operations and/or a few months of plant/ engineering experience is desirable, but not required.**
Course Material:	**Software used: Apromon and Pitops. Also custom training slides.**

Course Description and Objectives:
Chemical plants can have anywhere from about 50 PIDs in small plants to over 2000 PIDs in large refineries and integrated petrochemical complexes. In addition to simple PIDs, there are cascades, override controllers, model-based controllers and multivariable controllers.

As time goes by, even well-tuned PIDs and other controllers can slowly start to deteriorate. As deterioration progresses, process oscillations can start with small amplitudes and can grow large over time costing the plant significant monetary and/or quality losses. Or conversely, PIDs could become sluggish because of changes in process and operating conditions, once again causing the control quality to deteriorate.

This course covers the technology and application of a control performance monitoring software (Apromon) that identifies poorly controlling PIDs (includes single, cascade, override and complex PIDs). Apromon runs online using OPC and calculates several control criteria and generates control quality reports. Integrated with Apromon is a novel, breakthrough algorithm called TAD (True Amplitude Detection) that accurately isolates oscillating or sluggish controllers. This course shows how to improve and maintain the plant's primary and advanced control system and increase the plant's profits.

This course explains how to identify control problems in an online/real-time manner and take immediate corrective action using online adaptive control. The course also shows how to implement true adaptive control inside the DCS by connecting the control quality monitoring software using OPC technology to the DCS/PLC and by designing special DCS/PLC-resident logic for triggering automatic control action.

Learning Outcomes:
At the end of the course, attendees will be skilled in understanding process control quality monitoring criteria and statistics. They will be skilled in the application, installation and use of real-time software products for process control quality monitoring at any plant.

Attendees will also be skilled on the application of online adaptive control technology using the control quality monitoring software and then linking it with closed-loop DCS based-adaptive control schemes. Using the knowledge, attendees on their own can build closed-loop adaptive control schemes at their plant inside the DCS/PLC using OPC connectivity.

Attendees will be able to significantly improve control quality at their plants, move the plant more stably and reliably in the direction of increasing profits with fewer shutdowns and fewer abnormal events. The plant will also see a reduction in the number of alarms and a reduced need for operator intervention. The following topics are covered in this course:

- Modern process control in plants
- Process interactions because of mass balance and heat balance integration Potential for process cycling and sustained oscillations
- Causes of process oscillations
- Pitops simulations illustrating different oscillation cases
- Pitops simulations illustrating excessive control valve movement Pitops simulations illustrating sluggish control
- Definition of various process control quality performance criteria Explanation of special new terms – crimp, cheat, vacillation, rope length etc. Component breakdown of PID contributions
- Use of process control monitoring software - Apromon-Excel Run example cases on Apromon-Excel
- More explanation of process control quality performance monitoring criteria
- Conduct what-if studies on example using Apromon-Excel
- Adjust and understand oscillation tuning parameters
- Set up online OPC servers to simulate real-plant environment Use of Apromon-OPC
- Run example cases on Apromon-OPC
- Implement Apromon-OPC using OPC simulation server
- More explanation of process control quality performance monitoring criteria Procedure and tips on implementing Apromon-OPC in a plant environment
- Need for detection of online oscillation in an industrial process Need for detection of sluggish control in an industrial process. Precise determination of oscillation
- Practical challenges of detecting oscillations reliably Understanding of true amplitude detection) algorithm
- Setting up Apromon-OPC and configuring it in online/real-time mode
- Implementing online adaptive control using DCS, Apromon and a OPC server-based computer

<u>DCS400</u>:
DCS Training for Control Room Personnel

Duration: **1 Day Classroom or 6 hours Online**
Audience: **Plant Operators, Process Engineers, DCS technicians, Instrument Engineers**
Prerequisites: **Some control room exposure is desirable, but not required.**
Course Material: **DCS screens and slides**

Course Description and Objectives:
Many new and inexperienced control room operators enter plants every year. This course is aimed at training both new and experienced operators. The course focuses not only on the mechanics of how to use the DCS but also covers many of the intricate details necessary for skilled and high quality operation.

This course covers important DCS operational details, including DCS tag attributes, parameters and fields, how to start up complex control schemes. We cover procedures for how to detect control problems and tackle them quickly and effectively. The course covers DCS graphics.

The course helps to prevent careless mistakes that could potentially cause shut-downs and encourages safe habits. The operators also learn to fully utilize features like alarms, trending, event monitoring, history and other advanced features that can make the operators' time more effective. The course also covers the meaning and use of various types of DCS tags – PV, analog, digital, input/output, numerics, summers, multipliers, timers, sequence programs, continuous programs and many other tags.

Learning Outcomes:
At the end of the course, operators will be skilled on all basic, advanced and practical concepts on DCS operations. They will understand DCS tag attributes and variables. They will know how to activate control schemes correctly, troubleshoot process and control problems and identify tuning problems. They would have learnt tag ranges, tuning parameters, alarm system, alarm limits, rate of change limits, trending in the DCS, event history, logs, reports and security.

The course also teaches safety and important good habits recommended for operators. This course is a must for any operator or technician and will be of great value to engineers and supervisors too. The following topics are covered in this course:

- Distributed Control Systems (DCS) Introduction
- DCS Architecture and Control Network
- Analog and Digital Signals
- DCS Tagnames and Graphics
- PID Control Tags and Attributes
- Other Types of DCS Tags
- Custom DCS Tags and Calculations
- Activating Long Cascade and Complex Control Schemes
- Continuous versus Sequence Control
- Online Analyzers and Discrete Signals
- Control Valve Characterization and Nonlinear Transformations
- Alarms, Events and Alerts

- Trends
- Remote Access
- Safety and Recommended Procedures
- Advanced Process Control
- Management of Change Procedures

DCS450:

Function Blocks for APC Implementation in DCS or PLC

Duration:	**3 Day Classroom or 20 hours Online**
Audience:	**Process Control Engineers, DCS Maintenance Technicians, Instrument Engineers**
Prerequisites:	**Some control room exposure is desirable, but not required.**
Course Material:	**PowerPoint Slides, DCS screens, Industrial Data, Calculation Procedures and Data Analysis**

Course Description and Objectives:

This course teaches you how to conceive, design and implement process control schemes inside a DCS or even a PLC. There are many DCS and PLC vendors and this course builds skills that are useful for all types and models of any DCS or PLC. Whether you work in a chemical, petrochemical, pharmaceutical, polymer, electric power, paper or really any manufacturing process, this course will teach you the skills to come up with new advanced process control ideas and schemes. The knowledge will also help in the design of controls for safer and smoother plant operation and to run the plant better, smoother and with reduced chance of mistakes, shutdowns and human error. The knowledge will help to maximize production rates, minimize utilities, speed up product grade transitions and improve key performance indicators. In an era of a lot of approaching retirees in industry and the entry of new personnel in the control room, this course is a must for any process control engineer, DCS engineer, PLC engineer or process control technician.

Learning Outcomes:

This course teaches the main components of a DCS and even a PLC. It describes the DCS and PLC architecture. It explains all DCS and PLC control functions. It teaches standard and custom DCS logic blocks. It covers batch, sequential, continuous and semi-batch control schemes. It teaches how to design and implement control schemes. It explains how to design and implement various standard function blocks available in most DCSs and PLCs. The various standard function blocks are listed below. With knowledge from PID100, APC200, this course is a perfect continuation to build the process control skills and knowledge and be more in the realm of what is available in DCSs and PLCs. After completion of this course, the student will be ready to build new APC tags inside a DCS or PLC. The following topics are covered in this course:

- Process Control Nomenclature and Basic Definitions
- SAMA Standard Diagrams and Symbols
- PID Control
- PID Related Peripheral Algorithms
- PIDFF - PID with Feedforward
- Transfer Function
- Nonlinearity
- SMOOTH Filtering for Noisy Signals
- Dead Time and TRANSPORT Algorithm
- LEADLAG Algorithm
- Monitoring Algorithms
- Boolean Logic Algorithms
- Timers and Counters
- Input and Output Algorithms
- Multiple Signal Algorithms
- Calculation Algorithms and Programs

- Smith PREDICTOR Algorithm
- PID Tuning Procedures
- Procedures for Testing, Commissioning & Troubleshooting
- DCS/PLC algorithms covered:

PID	AND	COMPARE
MASTATION	OR	TRANSFER
MAMODE	NOT	SELECTOR
BALANCER	XOR	MEDIANSEL
FUNCTION	FLIPFLOP	2XSELECT
FIELD	PULSECNT	GAINBIAS
FACEPLATE	COUNTER	SUM
KEYBOARD	ONDELAY	INCREMENTAL SUMMER
SETPOINT	OFFDELAY	MULTIPLY
PIDFF	ONESHOT	DIVIDE
SMOOTH	RESETSUM	RATIO CONTROL
TRANSPORT	TOTALIZER	RAMP AND SOAK
LEADLAG	AVALGEN	SQUAREROOT
LOWMON	DVALGEN	CALCBLOCK
HIGHMON	ASSIGN	CALCBLOCKD
HIGHLOWMON	PACK16	CALCULATION PROGRAMS
QUALITYMON	UNPACK16	POLYNOMIAL
DBEQUALS	TRANSLATOR	RUNAVERAGE
RATECHANGE	FLOW COMPENSATION	QAVERAGE
RATELIMIT	LOSELECT	DIGCOUNT
RATEMON	HISELECT	PREDICTOR

PLC475:
PLC Hardware, Programming and Design

Duration: 5 Day (Classroom) or 24 hours Online
Audience: Process Control Engineers, PLC Engineers and Technicians, Instrument Engineers
Prerequisites: Some control room exposure is desirable, but not required.
Course Material: PowerPoint Slides, PLC slides, PLC Simulation Software and Industrial Examples

Course Description and Objectives:
This course teaches you software, hardware and programming skills in using PLCs (programmable logic controllers). The course is designed to build skills in such a manner that upon completion, the student will have the skills needed to work with any PLC. This course like other PiControl courses is not vendor specific. The course starts with basics of PLC, covering both hardware, software and architecture. It teaches ladder logic, function blocks, input/output cards. It explains all basic, standard and custom functions and capabilities of a PLC. With this knowledge, a student will have the skills to design ladder logic, function blocks and safe habits to work in any manufacturing unit. Various real industrial examples are used to illustrate the concepts and with the incorporation and usage of all commonly used PLC functions.

Learning Outcomes:
At the end of this course, students will have strong skills on PLCs. They will be exposed to hardware, software, ladder logic and function blocks. They will have learnt all common PLC blocks and schemes. The course is hands-on and allows students to design and build PLC schemes on their personal computers. With this knowledge, it is possible to design and build PLC logic and control schemes in an industrial environment. The course places significant emphasis on safety, reliability and maintenance for the safe and improved operation of any process. The course covers discrete control, continuous control, adaptive control, safety shutdowns and also the design and implementation of APC inside the PLC. The following topics are covered in this course:

- Programmable Logic Controller (PLC) Overview
- PLC Hardware and Components
- PLC Communication
- Number Systems – Binary, Decimal and Hexadecimal
- PLC Input and Output Cards
- How to read P&IDs and design control schemes
- Relays
- Relay Logic Diagrams
- PLC Programming
- Logic Gate Functions
- Motor Starter Logic
- Timers
- Counters
- Setting up PLC software on personal computers
- PLC Lab Hands-On Project 1-3
- PLC Math Blocks and Functions
- Compare and Jump Instructions
- PLC Lab Hands-On Project 4-6

- Subroutines for Repetitious Calculations and Logic
- Bit Shift Instructions
- Data Handling Instructions
- Sequence Design and Implementation
- Sequence Instructions
- PLC Lab Hands-On Project 7-10
- Troubleshooting and Maintenance of PLC systems
- PLC Networks in Industry
- Safety Procedures
- PID and cascade control design inside the PLC
- Developing APC inside the PLC
- Starting up APC schemes
- Safe operating practices and design to avoid making mistakes and process upsets
- Procedures and practices for improved user interface
- Designing PLC schemes for improved GUI and assisting the job of the operator

<u>OPC500</u>:
Basic Industrial OPC Software for Communications & Control

Duration:	**1 Day Classroom or 6 hours Online**
Audience:	**Process Control Engineers, Application Engineers, Analyzer Technicians, DCS technicians, Instrument Engineers and Supervisors.**
Prerequisites:	**Some plant experience and/or a 2-year associates diploma in technical field.**
Course Material:	**OPC training slides, various OPC software products - OPC Servers, OPC Clients, OPC Explorers and OPC Browsers.**

Course Description and Objectives:
OPC (OLE for Process Control) is now the latest, most modern and powerful communications protocol for the industry. Using OPC, many data transfers can be quickly and effectively facilitated. In addition, many powerful, custom applications can be developed and implemented on an OPC server-based computer connected to the DCS.

This course shows you how to use OPC for many important DCS connected applications, e.g.: bringing online data from gas chromatographs into the DCS, allowing operator entered data on an operator HMI screen to get downloaded into the DCS.

This course also shows you how to connect two independent OPC servers together easily with special software. The course covers how to pull/push data to and from DCS/PLC to host computers. It teaches how to use signal processing and validation for increasing safety and reliability in chemical processes.

The course teaches how to conceive, design and implement new process control, advanced control and communications-related applications using OPC, level-3 computers and DCS/PLC.

Learning Outcomes:
At the end of the course, attendees will clearly understand important concepts about OPC and its use in the industry.

Attendees will be able to connect any OPC server together, transfer data two-way to DCS/PLC, perform custom calculations directly on an OPC server and then talk to the DCS, decipher, troubleshoot and solve OPC problems.

Attendees will understand COM, DCOM, DA, HDA, UA, AE and all commonly used OPC concepts.

Attendees will have the skills and knowledge to develop new applications using OPC, save costs using modern OPC technology and implement new APC and primary control schemes faster and with lower costs. The following topics are covered in this course:

- History and Vision behind OPC technology Basic Concepts of OPC
- OPC Specifications Benefits of OPC Solutions
- Connection Parameters in OPC Servers Configuration of OPC Clients
- OPC Redundancy OPC DA and HDA
- OPC Client and Server Architecture OPC Tunneling Technology

- OPC Alarms and Events
- Windows Security
- OPC options and industry vendors XML Overview
- COM and DCOM Troubleshooting DCOM Problems
- Systematic Detailed Procedure for Correctly Setting DCOM Configuration OPC Diagnostics
- SCADA applications using OPC OPC Alarms and Events
- Server-Client-Server (SCS) OPC Applications OPC UA (Unified Architecture)
- Overview of connecting OPC clients to OPC servers

OPC515:
Advanced Industrial OPC Software for Communications & Control

Duration:	**1 Days Classroom or 8 hours Online**
Audience:	**Process Control Engineers, Application Engineers, Analyzer Technicians, DCS technicians, Instrument Engineers and Supervisors.**
Prerequisites:	**OPC500 course or equivalent OPC software knowledge**
Course Material:	**OPC training slides, various OPC software products – PiOPC Server, PiBridge, PiLogger, PiConect and PiLims.**

Course Description and Objectives:
This course is an advanced course and continues the OPC500 course. The OPC500 is a must prerequisite for this course.

This course OPC515 is very hands-on. You install various real OPC servers and real OPC clients. You run the OPC servers and OPC clients in full real-time mode. You will witness real-time data transfer and two-ways data communications.

You will get complete real industrial hands-on experience since you are installing and configuring real industrial grade software products.

OPC-related software includes the following:

- PiOPC server (complete industrial grade real-time OPC server with built-in PID control loop simulator, giving a real-plant feel in the training room).
- PiBridge is a dual OPC client capable of connecting to two OPC servers.
- PiLogger is a fast data monitoring, trending and logging OPC client.
- PiConect is an OPC client connecting to MS Excel, collecting real-time data.
- PiLIMS is an OPC client based laboratory information management system.

You will not only see these products during the online session but you will install these products yourself on your own computer for training, learning and hands-on practice. The experience is full industrial grade and the same principles you learn will be applicable in a real industrial plant environment.

Learning Outcomes:
At the end of this course, you will be able to install, configure and activate real industrial grade OPC servers and clients. You will be familiar with both COM and DCOM configuration. You will be configuring both COM and DCOM on your own computer(s).

You will understand how to connect two different devices or OPC clients together. You will install and activate both fast data logging and historizing OPC client and also a LIMS OPC client. You could use the concepts for connecting online analyzers to any DCS/PLC using OPC. You could connect online vibration monitoring sensors to another device. The number of applications and opportunities are diverse and wide-spectrum.

With this knowledge, you will be able to select the right OPC tools (servers and clients) for any industrial application. The following topics are covered in this course:

- PiBridge OPC Client Connector Connecting different OPC servers together PiConect Human-to-Excel/DCS Interface
- Building powerful custom process applications using OPC
- Converting any Excel spreadsheet from office/control room and make it online using OPC
- Online Analyzer Signals in Chemical Processes
- Using validated signals for closed-loop advanced process control Laboratory Information Management Systems (LIMS)
- Using OPC as a modern, new method for implementing LIMS Overview of PiLIMS Laboratory Data Information Management System
- Fast Data Monitoring for Debugging Process Problems and Equipment Shutdowns OPC Product PiLogger for Fast Data Monitoring
- Expert-System Rule-Based Advisory using OPC Additional Industrial Applications using OPC Online process optimization using OPC Fieldbus, Ethernet, OPC comparisons
- Practical industrial communications case studies

SEC600:
Process Control Software, Hardware Security and Cyber Security

Duration:	**1 Day Classroom or 4 hours Online**
Audience:	**Process Control Engineers, Supervisors, Managers, DCS/PLC Technicians/Operators and Laboratory Technicians.**
Prerequisites:	**None**
Course Material:	**Training slides and hand-outs.**

Course Description and Objectives:
Modern-day process control systems need to be secured and protected against unauthorized personnel, hackers and potentially malicious attackers. Cyber security understanding, needs and a defensive plan is increasingly important these days. Plant and process data must be protected from competitors or contractors having temporary access to the control systems. Viruses, worms etc., can infect and bring-down an entire process control network if the control system is not adequately and appropriately protected. User IDs, access control for new employees, leaving employees, contractors etc. need to be properly implemented and enforced. Control room access, magnetic card access, DCS/PLC access etc., need to be properly enforced in the modern control room and process control environment. This course is a must for process control management and staff in order to protect data, protect the entire control system and ensure safe and reliable operation.

Learning Outcomes:
This course focuses on important process control system security concepts. It helps to staff the control systems team correctly to ensure that control systems security is properly enforced at the plant. The course discusses security forms that can be used to get signatures from various staff members for facilitating securities enforcements. Forms you get from the course can be directly used immediately at the plant. The course provides information to make the plant control system safe and secure. The following topics are covered in this course:

- Industrial process control network architecture
- The concept of L0 – L4 (levels of industrial process control networks)
- Process control system security
- Password, user IDs and handling of shared passwords Passwords, user accounts and automatic password expiration Protecting non-24-hour manned process control consoles
- Control room access controls, DCS/PLC configuration access controls, Personnel security
- Preventing unauthorized access
- Protecting proprietary data and intellectual property, attorney reviews
- Sharing control room with different competing technologies
- Satisfying licensor requirements regarding patents and proprietary technology Virus patches and updates
- Remote access security and control, remote process control support and monitoring Developing securities and control forms for management approval
- Developing the required management approval authority for security and controls Protecting proprietary data from offices and control rooms
- Developing teams to manage process control systems and audits
- How to conduct formal process control audits to ensure control system reliability

MPC700:
DMC Maintenance

Duration:	**2 Days Classroom 18 hours Online**
Audience:	**Process Control Engineers, DCS Technicians and Supervisors.**
Prerequisites:	**Knowledge of primary process control, PIDs etc. and preferably a few months of plant experience especially on a DCS.**
Course Material:	**Training slides and DMC software.**

Course Description and Objectives:
This course trains on the use of DMC (dynamic matrix control) software. It starts from the fundamentals: the history behind DMC, the need for DMC, how DMC is superior when used right and where other control methodologies could be more appropriate. The course covers how to conduct step tests and identify DMC models, designing and building the DMC controller, startup and commissioning. The course also covers DMC maintenance, how to modify and improve DMC models after years of operation or after significant process changes. It covers automated step testing, PRBS and other new techniques.

Learning Outcomes:
At the end of the course, attendees will be equipped with the skills to design, maintain and troubleshoot DMC controllers. They will be able to use the modern 3G closed-loop dynamics identification technology to improve DMI models using Pitops-TFI. They will have the skills to observe plant trends and troubleshoot the DMC controller and discuss with operations and control engineers on how to improve the control. The following topics are covered in this course:

- APC and MPC
- Dynamic Models
- Components of an MPC System
- Step Response Coefficients
- Slave PID Control Optimization
- Conducting Step Tests
- MPC Control Matrix
- How MPC Works
- MPC Tuning Parameters
- LP Costs and Optimization
- Lets Build a New MPC System
- When to Use and When Not to Use MPC
- Choose MPC or APC for this Process
- MPC Monitoring and Troubleshooting
- MPC Commissioning and Good Practices

STA100:
Industrial Statistics, SQC AND SPC

Duration:	**6 hours Online Only**
Audience:	**Process Engineers, Research Engineers, Laboratory Personnel, Analyzer Technicians, Instrument Engineers and Supervisors.**
Prerequisites:	**None**
Course Material:	**Training slides and various statistical software products.**

Course Description and Objectives:
Train engineers, technicians and supervisors on the latest statistical tools, methods and practices. Apply statistical methods to analyze process and plant data. Understand statistical quality control, statistical process control, six sigma and related topics. Understand customer quality needs and implement monitoring and statistical methods to improve control.

Learning Outcomes:
At the end of the course, attendees will understand all practical concepts on statistics. They will be able to apply statistical principles and theory to their practical plant data and control problems. They will be able to use modern statistical tools and apply them to actual plant data. The knowledge will help directly to improve statistical control at the plant and achieve more customer satisfaction. The following topics are covered in this course:

- Analyze, interpret and present data in a meaningful way and Descriptive statistics Histograms, Pareto charts, Scatter Plots, Confidence Intervals, T-tests and F-tests. Sampling strategies, transformations, power and sample size calculations Analysis of variance (ANOVA), Non-parametric tests and Regression
- Determine when a real problem exists and if process improvements, changes are required X and mR, Xbar and R, c, u, np, p, CUSUM and EWMA charts
- Capability indices Cp, Cpk, Pp and Ppk, Time series plots, Trend analysis and Decomposition
- Moving averages and other smoothing methods Statistical hypothesis tests - equivalence testing
- One-way analysis of variance and confidence intervals showing their application to validation Problem definition, selecting responses and factors
- Scoping studies, Screening designs, Taguchi methods, fractional and full factorial designs Response surface methodology (RSM)
- Product design, semantic scales, questionnaire design Factor analysis and Principal components analysis (PCA)
- Gauge repeatability and reproducibility studies
- Gauge linearity and bias studies and attribute agreement analysis
- Estimate relationships between independent variables and dependent variables
- Understand and explain relationships among variables and use them to predict actual responses Understand product and system lifetimes. Product reliability and failure modes Manufacturer's methods to inform warranty periods
- First-time failure rates, terminal failure rates, non-repairable devices, repairable systems, test plans and the Weibull distribution.

STA200:
Transfer Function Dynamics Identification

Duration:	**4 hours Online Only**
Audience:	**Process Control Engineers, Process Engineers, Research Engineers, Laboratory Personnel, Instrument Engineers and Supervisors.**
Prerequisites:	**None**
Course Material:	**Training slides and Pitops-TFI software product.**

Course Description and Objectives:
Identification of transfer functions using industrial process data is both an art and a science. Industrial data comprises of fast noise, drifts and disturbances; these result in special challenges while trying to accurately estimate the transfer function parameters. We use the most modern, advanced and sophisticated 3G dynamics identification technology (Geometric, Gradient and Gravity components) to isolate fast and slow disturbances to accurately determining the true transfer function. The technique used works remarkably well even for multivariable inputs using closed-loop data. Another unique feature is the successful transfer function identification with relatively short-duration data (where other techniques are commonly unsuccessful). The new method used in the course is far simpler and more powerful than other currently practiced methods. It can be easily learnt and applied by new personnel without advanced educational degrees or prior experience.

Learning Outcomes:
At the end of the course, attendees will be able to identify multivariable (multi-input) transfer function parameters using closed-loop data, open-loop data or a mixture of both. Attendees will learn skills to help isolate disturbances and identify the true transfer functions. The skills will be useful in all fields dealing with transfer functions – chemical, mechanical, electrical and industrial engineering, all branches of science (particularly chemistry), medical fields, population studies, statistics and related fields. The modern techniques are both revolutionary and novel; they produce successful results even with challenging data sets comprising of significant levels of complex, unknown and unmeasured disturbances. The following topics are covered in this course:

- Transfer function definition Fast and slow processes
- Different methods of characterizing process dynamics Characterizing high order transfer function models Step response coefficient models
- ARMA models
- Pros and cons of various dynamic models
- Open loop step tests, closed-loop tests, gradual changes in input
- 3G disturbance rejection technology- Geometric, Gradient and Gravity options Isolating noise from process data
- Dead time estimation tips
- Model prediction and correction procedures Industrial examples using real plant/process data
- Identification examples using many real and simulated conditions Zooming on the real transfer function in cases of multiple solutions Practical tips for successful closed-loop transfer function identification

PLT100:
Industrial Safety–Plant Operations and Process Control

Duration: **1 Day Classroom or 8 hours Online**
Audience: **Operators, Technicians, Engineers, Supervisors and Managers.**
Prerequisites: **None**
Course Material: **Training slides and hand-outs.**

Course Description and Objectives:
Despite advances and improvements on safety in modern-day plant operation, injuries, illnesses and fatalities on-the-job still happen. The course covers most common areas of safety related to plant operation, startup, commissioning and maintenance. A unique aspect of the course is that it also discusses how process control schemes and strategies may be used to increase operational safety. The course also aims at increasing safety awareness and reducing both on-the-job and off-the-job safety-related incidences.

Learning Outcomes:
After completion of the course, attendees will be familiar with important safety concepts relevant to chemical plants. They will be more aware of hazards and will be more cognizant of imminent dangers. Course attendees are likely to operate and work safer than ever before and contribute to improved company safety records. This course is a must for operators, technicians, engineers and managers. The following topics are covered in this course:

- Safety in perspective, causes of accidents, psychological and human nature
- What employees, management and personnel can do to mitigate accidents and improve safety
- Accident examples and what could have been done to avoid them
- Industrial safety, working safely with chemicals, safe handling of pressurized gases
- Welding safety
- Electrical and lighting safety Material handling
- Machine shop safety Powered hand operated tools
- Back safety, correct lifting technique
- Asbestos awareness, ammonia, H_2S, and other hazards Asphyxiation dangers
- Blood-borne pathogens
- Fire safety, different types of fires and fire extinguishers Hazard communications
- Hazardous materials transportation
- Lock-out and Tag-out procedures Material safety data sheets Office ergonomics
- Personal protective equipment Scaffolds
- Slips, trips and falls, fall protection Forklifts
- DOT training
- Using DCS/PLC control schemes and advisories for increased safety
- Online analyzer – GCs and other analyzers and how to use them in process control strategies
- Incorporating safety in design of process control strategies and online closed-loop advisories

<u>CHE100C</u>:
Basic Chemical Technology and Stoichiometry

Duration: Self-Paced Training Software
Audience: Control Room Operators, Process Engineers, Technicians, Application Engineers, Instrument Engineers and Supervisors.
Prerequisites: None
Course Material: CBT (computer-based training) software

Course Description and Objectives:
This course is an excellent refresher for process engineers, control engineers and managers – those who took college classes but now need a refresher to review and remember important concepts. This course is also an excellent introduction and knowledge-booster for operators and technicians who want to learn more about the academic theory and principles of basic chemical technology and stoichiometry.

Learning Outcomes:
Master the concepts of basic chemical technology and stoichiometry. Use the knowledge to perform calculations and interact more intelligently during design and troubleshooting meetings at the plant. The knowledge and skills will be of immediate value and use on the job in the control room or a design office.

Course Chapters:
1. Basic Information and Stoichiometry
2. Units, Dimensions, and Conversions
3. Dimensional Homogeneity and Analysis
4. Dimensionless Groups and Analysis
5. Pressure and Temperature
6. Process and Process Units
7. Mass, Density, Volume and Mole
8. Chemical Equations and Stoichiometry

CHE200C:
Material Balances

Duration: Self-Paced Training Software
Audience: Control Room Operators, Process Engineers, Technicians, Application Engineers, Instrument Engineers and Supervisors
Prerequisites: None
Course Material: CBT (computer-based training) software

Course Description and Objectives:
This course is an excellent refresher for process engineers, control engineers and managers – those who took college classes but now need a refresher to review and remember important concepts. This course is also an excellent introduction and knowledge-booster for operators and technicians who want to learn more about the academic theory and the principles of material balances.

Learning Outcomes:
Master the concepts of material balances which are so critical and useful in the plant operation and process design. Use the knowledge to perform calculations and interact more intelligently during design and troubleshooting meetings at the plant. The knowledge and skills will be of immediate value and use on the job in the control room or a design office.

Course Chapters:
1. General Balance Equation
2. Material Balances without Chemical Reaction
    a. Distillation
    b. Mixing/Settling
    c. Drying/Evaporation
    d. Absorption
    e. Extraction
    f. Crystallization
    g. Adsorption
3. Material Balances without Chemical Reaction - With Recycle, Bypass, Purge
    a. Distillation
    b. Drying/Evaporation
    c. Combination of Units
4. Material Balances with Chemical Reaction
    a. Recycle
    b. Purge
    c. Multiple Equipment
    d. Combustion

CHE300C:
Thermodynamics - Gases, Vapors and Liquids

Duration: Self-Paced Training Software
Audience: Control Room Operators, Process Engineers, Technicians, Application Engineers, Instrument Engineers and Supervisors
Prerequisites: None
Course Material: CBT (computer-based training) software

Course Description and Objectives:
This course is an excellent refresher for process engineers, control engineers and managers – those who took college classes but now need a refresher to review and remember important concepts. This course is also an excellent introduction and knowledge-booster for operators and technicians who want to learn more about the academic theory and principles of practical industrial thermodynamics.

Learning Outcomes:
Master the concepts on thermodynamics. Use the knowledge to perform calculations and interact more intelligently during design and troubleshooting meetings at the plant. The knowledge and skills will be of immediate value and use on the job in the control room or a design office.

Course Chapters:
1. Pure Components
    a. PVT Relations
    b. Ideal Gases
    c. Real Gases
    d. Vapor Pressure
2. Mixtures
    a. Ideal Gases
    b. Real Gases
3. Ideal Solutions
    a. Phase Rule
    b. t / P-x-y Diagrams
    c. Raoult's & Henry's Laws
4. Humidity And Saturation
    a. Air + Water System
    b. Air + Solvent System

CHE400C:
Energy Balances

Duration: **Self-Paced Training Software**
Audience: **Control Room Operators, Process Engineers, Technicians, Application Engineers, Instrument Engineers and Supervisors**
Prerequisites: **None**
Course Material: **CBT (computer-based training) software**

Course Description and Objectives:
This course is an excellent refresher for process engineers, control engineers and managers – those who took college classes but now need a refresher to review and remember important concepts. This course is also an excellent introduction and knowledge-booster for operators and technicians who want to learn more about the academic theory and principles of energy balances.

Learning Outcomes:
Master the concepts on energy balances which are so critical and useful in process design and plant operation. Use the knowledge to perform calculations and interact more intelligently during design and troubleshooting meetings at the plant. The knowledge and skills will be of immediate value and use on the job in the control room or a design office.

Course Chapters:
1. Heat Effects
    a. Without Phase Change
    b. With Phase Change
    c. With Water & Steam
2. General Energy Balance Equation
    a. First Law of Thermodynamics
    b. Application To Processes
    c. Mechanical Energy Balance
3. Energy Balances With Reaction
    a. Enthalpy of Formation
    b. Enthalpy of Reaction
    c. Enthalpy of Combustion
    d. Adiabatic Flame Temperature
    e. Application To Processes
4. Enthalpy of Solution & Mixing
5. Application To Processes

6. Heating Values of Fossil Fuels
    a. Coal
    b. Petroleum
    c. Gas

CHE500C:

Industrial Process Control -Primary and Advanced Process Control (APC)

Duration: Self-Paced Training Software
Audience: Process Control Engineers, DCS/ PLC Technicians, Operators, Process Engineers, Contact Engineers, Supervisors, Managers, Project Engineers
Prerequisites: None
Course Material: CBT (computer-based training) software

Course Description and Objectives:
Process control courses in universities are still too academic and the training is not adequate for the industrial control room environment. This course covers the practical industrial aspects of process control like no other textbook or course available currently. What would take a typical engineer or technician numerous years of hands-on experience in the control room now can be mastered by this modern, powerful CBT in just an amazing span of a few hours. This course will benefit both new and experienced engineers, operators, supervisors, managers, professors and students. It covers modern industrial process control theory - both primary process control and advanced process control (APC) and can be used by both technicians and engineers without need for advanced math and other background or skills.

Learning Outcomes:
After completion of the course, the students will understand the concept of DCS and PLC architectures and networks. They will understand process control schematics, basic process control theory, system identification, step testing, dynamics characterization. The course teaches PID control, cascade control, feedforward control, constraint control, override control, model-based control, model-predictive control, and other forms of APC (Advanced Process Control). The course teaches how to design and implement primary and advanced process control schemes inside a DCS or a PLC. It teaches skills on when to use PID and APC and when to use a DMC (dynamic matrix control) or other forms of multivariable model-predictive control. It teaches how to design and implement closed-loop controllers in the practical control room environment. It also teaches concepts typically not covered in universities and concepts that take a long time to learn on one's own on-the-job time and effort. The course helps to convert both new and experienced personnel into skilled process control experts in a remarkably short time.

Course Chapters:

Part I: Primary Process Control (Study Time » 25 Hrs.)

1) Overview of Modern Industrial Process Control
   a. Overview
   b. Need For Process Control
   c. Distributed Control System
   d. Choice of DCS or PLC
   e. Laboratory Information Management System (LIMS)
   f. Safety Interlocks and Shutdowns
   g. Permissives

2) Process Control Variable Definitions

a. Controlled Variables (CV)
b. Manipulated Variables (MV)

c. Process Variable (PV)
d. Setpoint (SP)
e. Process Dynamics
f. Transfer Function
g. Transfer Function Parameters
h. Linear and Nonlinear Processes
i. Identifying Process Dynamics
j. Dynamics Identification Procedure
k. Dynamics Identification With Multiple Inputs
l. Rules For Conducting Pulse Tests

3) Primary Control and The PID Algorithm
   a. Manual Control
   b. Automatic Control
   c. The PID Algorithm
   d. Sign of the three terms
   e. Offset
   f. Primary Control

4) PID Algorithm - Additional Options and Parameters
   a. Process Noise
   b. Filter Time Constant
   c. Direction of Control Action
   d. Direct and Reverse Action
   e. Other Forms of The PID Algorithm
   f. Nonlinear PID
   g. Output Sponge PID
   h. Split Range PID
   i. PID Faceplate
   j. PID Detailed Screens

5) Cascade PID Algorithm
   a. Level-To-Flow Double Cascade
   b. Temperature-To-Temperature Double Cascade
   c. TC-FC Double Cascade
   d. AC-TC-FC Triple Cascade
   e. AC-TC-QC-FC Quadruple Cascade

6) Override Control Strategies
   a. Dual Level Control
   b. Dual Temperature Control
   c. Low Level Override Constraint Control
   d. Distillation Reflux Flow Override
   e. Compressor Override Controls
   f. High and Low Override Constraint Control
   g. Maximization of Production Rates
   h. Need For Constraint Override Control Strategies

7) PID Modes and PID Activation Procedure
   a. PID Controller Modes
   b. Summary of Different PID Modes and States
   c. How To Change PID State
   d. Ranges of A PID Controller
   e. Setpoint Tracking and Output Initialization
   f. The "Track" Flag
   g. Bumpless Transfer
   h. Cascade Chain Activation Sequence
   i. Chain Activation Sequence For A Constraint Override Loop
   j. PV Tracking
   k. How To Enable PV Tracking
   l. Benefits of PV Tracking
   m. When To Use PV Tracking
   n. PV Tracking In Case of Master PIDs

8) PID Tuning Procedures and Control Quality
   a. Open-Loop and Closed-Loop Mode
   b. Engineering Units of PID Tuning Parameters
   c. PID Tuning Procedures
   d. Effect of Range Change on PID Tuning Parameters
   e. Advanced Control PID Control
   f. PID Tuning and Control Quality
   g. Comparison of The Criteria

9) Process Control Schematics

Part II: Advanced Process Control (Study Time » 30 Hrs.)

10) Disturbances, Feedforwards and Decouplers
   a. Disturbance
   b. Feedforward Control
   c. Feedforward and Feedback Control Examples
   d. Feedforward Strategy Implementation In DCS or PLC
   e. LEAD and LAG Action
   f. Final Steady State Value From Feedforward
   g. Cases where Feedforward Control may not be effective
   h. Distillation Column Feedforward

11) Process Signal Filtering and Control Valve Checkout
   a. Signal Noise
   b. Effect of excessive noise on control quality
   c. Filter Constant
   d. When To Use Filtering
   e. Selecting Filter Constant
   f. Optimal Filtering
   g. Adding Filtering During PID Tuning
   h. Impact of Noise Band on Open-Loop Test Procedure
   i. Identifying Valve Problems

j. Effect of Noise on PID Control Action

12) Dead Time Compensation and Model-Based Control
   a. Dead Time in Control Loops
   b. Effect of Dead Time On Control Quality
   c. When Dead Time Is Really Harmful In A Control Loop
   d. Methods to combat dead time
   e. Dead Time Compensation Implementation in DCS or PLC
   f. Model-Based Control
   g. Pure Transfer Function-Based Models
   h. Rigorous Predictive Models
   i. Steps In Implementing A Rigorous Model-Based Control Scheme

13) Control Schemes Using Discrete Signals
   a. Continuous Signals
   b. Discrete Signals
   c. PV Sample Delay
   d. Discrete Signals
   e. Distillation Control With PV Sample Delay
   f. Distillation Cascade Control With PV Sample Delay
   g. Analyzer Multiplexing
   h. Inferential Model-Based Control
   i. Spike Rejection ii) Frozen Value Check
   j. PID Scan Time

14) Model Predictive Control and Rule-Based Control
   a. Types of Process Control Strategies
   b. Characterizing Process Dynamics In MPC
   c. Control Matrix
   d. MPC Algorithm
   e. Feedback Correction
   f. Rate of Change
   g. Multivariable MPC System
   h. Priority of Controlled Variables
   i. Local Optimization
   j. When To Use MPC and When To Use TAC
   k. When To Use MPC and When To Use TAC
   l. Analyzing the criteria to select TAC or MPC
   m. Benefits Due To Advanced Control
   n. Pros and Cons of MPC Versus TAC
   o. Operating Zones
   p. Rule-Based Control and Fuzzy Control
   q. Types of Advanced Control Tools

15) Handling Nonlinearities
   a. Linearity
   b. Valve-To-Flow Nonlinearity
   c. Gain Scheduling
   d. Valve Characterization

e. Constraint Control
f. Reflux-To-Product Impurity Nonlinearity
g. Average Temperature Control

Part III: Lab Session (Study Time » 20 Hrs.)

16) Lab Sessions (Practical Exercises)

The various simulation exercises will be conducted with PITOPSÔ industrial process control software. This software accompanies this training module and can be used in a variety of ways.
PITOPS™ software consists of two modules - PITOPS-PID and PITOPS-TFI. PID stands for PID Control Tuning and Design.
TFI stands for Transfer Function Identification.
PID module simulates PID controllers, cascade PIDs, feedforward loops and Dead Time Compensator. Various other features are provided for primary and advanced control tuning and design. TFI module identifies transfer functions using time-series plant data. The following nine lab sessions will be conducted using the PITOPS-PID module and tenth session using PITOPS- TFI module.

1. Configure a transfer function and study open-loop response.
2. Configure a PID loop, simulate a setpoint change, and tune the PID.
3. Add random noise to the previous simulation.
4. Configure external disturbances.
5. Tune a Temperature Control PID (TC).
6. Tune a Level Control PID (LC).
7. Tune a cascade PID.
8. Configure Disturbance and Feedforward transfer function.
9. Configure a Model-based Dead-time compensator.
10. Identify a transfer function using simulated plant data.
11. Guidelines and Recommendations