Computer Controlled **Controller Tuning Unit**, with SCADA

CEAC

Engineering and Technical Teaching Equipment

EDIBON **SCADA** System

① Unit: CEAC. Computer Controlled Controller Tuning Unit

USB communication

④ Software for:
- Computer Control
- Data Acquisition
- Data Management

Computer
(not included in the supply)

⑤ Cables and Accessories

⑥ Manuals

* Minimum supply always includes: 1 + 2 + 3 + 4
(Computer not included in the supply)

Key features:

➤ **Advanced Real-Time SCADA.**

➤ **Open Control + Multicontrol + Real-Time Control.**

➤ **Specialized EDIBON Control Software based on LabVIEW.**

➤ **National Instruments Data Acquisition board (250 KS/s, kilo samples per second).**

➤ **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**

➤ **Capable of doing applied research, real industrial simulation, training courses, etc.**

➤ **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**

➤ **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**

➤ **Designed and manufactured under several quality standards.**

➤ **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

For more information about Key Features, click here

**OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL**

POWERED BY
NATIONAL INSTRUMENTS
LabVIEW

www.edibon.com
➥PRODUCTS
➥6.- MECHATRONICS, AUTOMATION & COMPUMECHATRONICS AND
10.-PROCESS CONTROL

ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate (total safety)

Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)

"Worlddidac Quality Charter" and Platinum Member of Worlddidac

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INTRODUCTION

Nowadays, most of the industries and factories use industrial controllers in order to reach an accurate and automatic control of its processes.

The correct installation and parameterization of the industrial controllers is a difficult task if the operator does not know the theory of the industrial controller tuning.

One of the last techniques to adjust industrial controllers without risk to damage the equipment, is to simulate the process to control in a real-time hardware or Hardware-in-the-loop (HIL) system, and adjust the industrial controller connecting it to the simulated process.

Once the industrial controller is adjusted, the parameters can be set in the real process with a small adjustments.

The Computer Controlled Controller Tuning Unit, "CEAC", provides the tools to simulate different industrial processes in a HIL system and control them with a commercial industrial controller. The CEAC unit works in conjunction with a computer, in order to visualize all signals involved in the process and adjust the parameters of the industrial controller.

The CEAC unit is provided with a set of practical exercises, through which the students will familiarize with the control of most common type of industrial processes, and how to control them with a commercial industrial controller with the following controls: PID (proportional integrative derivative) pPI (predictive proportional integrative), gain scheduling PID for non-linear systems, etc.

GENERAL DESCRIPTION

The CEAC unit is an advanced system that operates in conjunction with a computer, which allows to change the control parameters performed by the industrial controller.

Through the CEAC unit the students will understand the operation mode of an industrial controller. They will learn how to set up the controller to control different systems, such as 1st and 2nd order system, time-delayed system, systems with non-linear actuators, etc. and how to control them using different types of controls such as PID, pPI, gain scheduling, etc.

The CEAC unit main components are: the industrial controller and the System Simulator. Both components have an USB connector to communicate easily with the computer.

In the following lines there is a brief description of each block:

- **Industrial Controller:** the controller uses one analog input and one analog output, that is enough to perform the control of the single input-single output (SISO) systems.

  The analog input is used to connect the process variable signal (PV). The analog output is used for the output controller signal (O/P).

  Once the control is configured, the control parameters can be change through the software.

- **Process Simulator:** performs a **real-time hardware-in-the-loop (HIL)** simulation of different industrial process, in order to control each one with the industrial controller. The process simulator can be configured, with the type of the process to simulate (integrator system, first order system, second order system, etc.) and the parameters of the system. The simulated system takes the O/P signal from the industrial controller and provides the feedback of the system (PV) to the controller.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + Control Interface Box + Computer Control, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

INDUSTRIAL CONTROLLER
Controlador Industrial

USB INDUSTRIAL CONTROLLER CONNECTOR
Conector USB del Controlador Industrial

USB SYSTEM SIMULATOR CONNECTOR
Conector USB del Simulador de Sistemas

With this unit there are several options and possibilities:
  - Main items: 1, 2, 3 and 4.
  - Optional items: 5.
Let us describe first the main items (1 to 4):

① **CEAC. Unit:**
  CEAC interface box.
  System simulator:
      Based in Hardware-in-the-loop (HIL) technology.
      HIL with a 0.01 second per loop time.
      Real time simulation with all industrial system configured.
      Analog Input:
          Number: 10.
          Aggregate sample rate: 500kS/s.
          Resolution: 12 bits.
          2 differential analog inputs with ±10V range.
      Analog Output:
          Number: 6.
          Aggregate sample rate: 345 kS/s.
          Resolution: 12 bits.
          2 single-ended channel with ±10V range.
      Digital I/O:
          Number: 24.
          5 V compatible LVTTL.
          3.3 V LVTTL output.
      USB connection to PC.
  Industrial Controller:
      ABB Control Master CM30.
      Display:
          Full-color LCD 9 cm (3.5in.) with built-in backlight.
      Language:
          English, German, French, Italian and Spanish.
      Operator keypad:
          6 tactile membrane keys.
      Password protection:
          Basic / Advanced user-assigned password protection.
      Trend display:
          Recording of 2 variables.
          Configurable sample rate (1 second to 5 minutes).
      Control output types:
          Voltage proportioning (through resistor).
      Control parameters:
          Proportional band: 0 to 999.9 %.
          Integral: 0 to 10000 s.
          Derivative: 0 to 999.9 s.
          Manual Reset: 0.0 to 100 %.
          Time delay range: 0 to 1000s.
          3 sets of PID parameters when used with Gain Scheduling facility.
      Set points:
          Up to 4 local set points, all selectable via digital inputs or front panel.
          Remote selectable via digital input.
      Auto tune:
          On-demand calculation of control settings.
      Process alarms:
          Number: 8.
          Types: High / Low process and High / Low latch.
          Acknowledgement: via front panel keys or digital signals.
          Source: Fully configurable (for example, PV, analog input, math block inbuilt, OP control loop deviation).
          Hysteresis: Level and time.
          Alarm enable: Enable / Disable of individual alarms via a digital signal.
      Analog inputs:
          Number: 2.
          Sample rate: 125 ms.
          Type: Voltage (pre-configured), Current, Resistance (ohms), 3-Wire RTD, Thermocouple, Digital volt-free, Digital 24V, Frequency (Input 1) and pulse.
      Analog outputs:
          Number: 1.
          Type: Configurable as analog or digital pulse.
          Analog range: 0 to 10 V through a resistor.
      Relays:
          Number: 2.
          Type: N/O.
          Contact ratings: 5A, 240V.
      Communication: RS-485 MODBUS protocol.
      RS-485 to USB converter to make the connection with PC easy.

Unit: CEAC

Industrial Controller

The complete unit includes as well:

Advanced Real-Time SCADA.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on LabVIEW.

National Instruments Data Acquisition board (250 KS/s, kilo samples per second).

Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.

Capable of doing applied research, real industrial simulation, training courses, etc.

Remote operation and control by the user and remote control for EDIBON technical support, are always included.

Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).

Designed and manufactured under several quality standards.

Optional ICAI software helps the user perform calculations and comprehend the results.

This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② **CEAC/CCSOF. Computer Control + Data Acquisition + Data Management Software:**

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

The software allow to set different systems to control, such as integral systems, first order systems (with or without delay time) and second order systems.

Every system has different dynamic animations that shows the response of the systems.

The CEAC/CCSOF allows to show the mathematical model of the current simulated system.

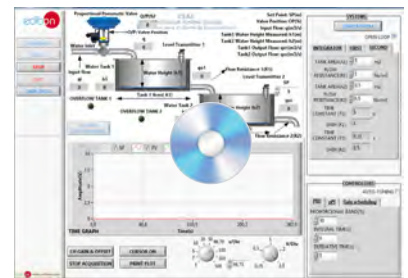Control menu to adjust the different controls as PID, pPI and gain scheduling.

Management, processing, comparison and storage of data.

Sampling velocity up to 500 KS/s (kilo samples per second).

CEAC/CCSOF

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

③ **Cables and Accessories**, for normal operation.

④ **Manuals:**

This unit is **supplied with 7 manuals**: Required Services, Assembly and Installation, Control Software, Starting-up, Safety, Maintenance & Practices Manuals.

∗ References 1 to 4 are the main items: CEAC + CEAC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

1.- Familiarization with the navigation of an industrial controller.

2.- To determine the system parameters in a level control system with a tank without drain (integer system).

3.- To determine the system parameters in a level control system with a tank with drain (first order system).

4.- To determine the system parameters in a level control system with two tanks (second order system).

5.- Study the difference between open and closed loop control.

6.- Integer system response in open loop.

7.- Closed loop PID control of an integer system with an industrial controller.

8.- First order system response in open loop.

9.- Closed loop PID control of a first order system with an industrial controller.

10.- Second order system response in open loop.

11.- Closed loop PID control of a second system with an industrial controller.

12.- Control of a system with time-delayed response with a predictive proportional integrative (pPI) controller.

13.- Auto-tuning: Obtaining the PID parameters automatically.

14.- Control of a system with a non-linear actuator using the gain scheduling controller.

15.- Alarms and diagnostics generation.

Other possibilities to be done with this Unit:

16.- Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

17.- Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the gains; proportional, integral, derivate parameters; etc, in real time.

18.- The Computer Control System with SCADA allows a real industrial simulation.

19.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.

20.- This unit can be used for doing applied research.

21.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

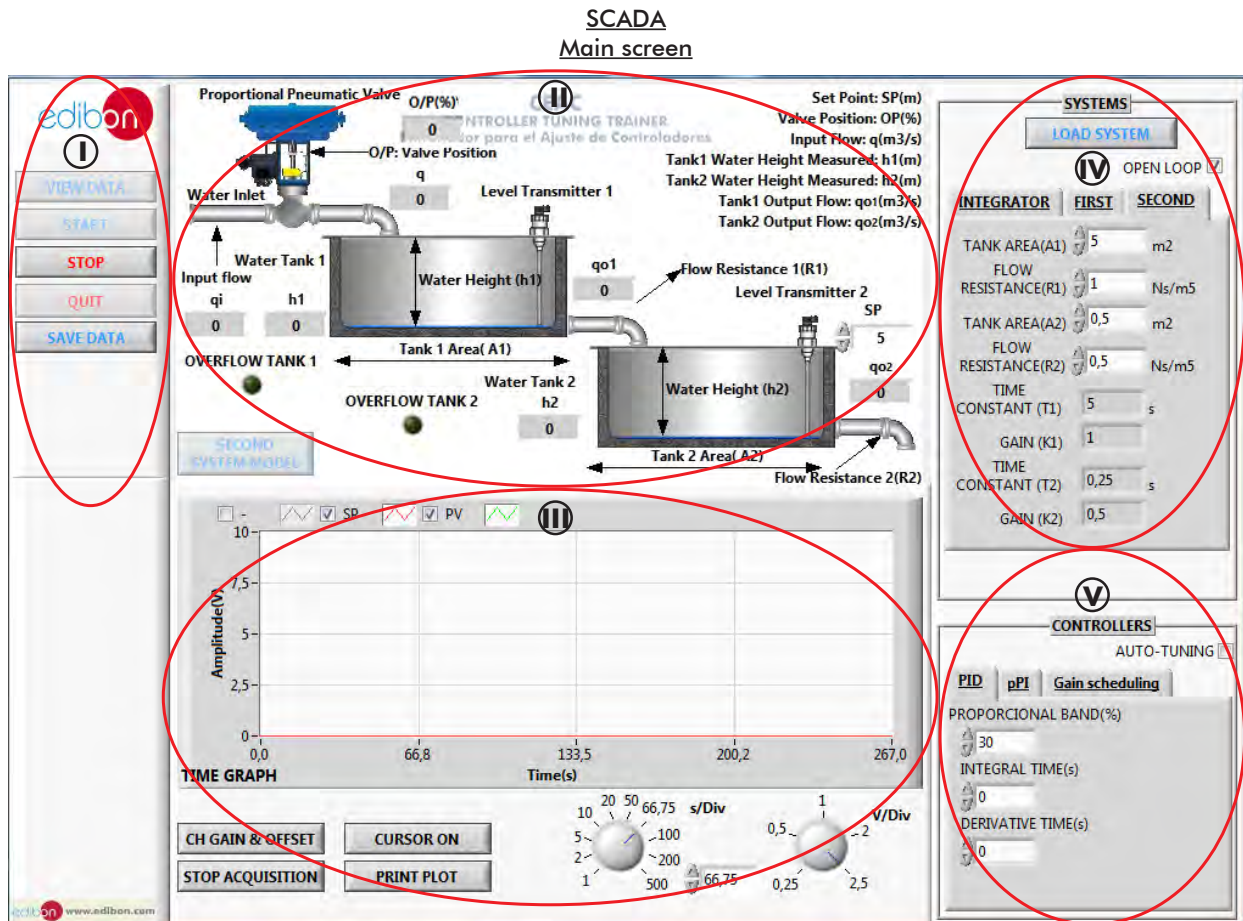- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Computer.

DIMENSIONS AND WEIGHTS

CEAC:
- Dimensions: 310 x 220 x 180 mm approx.
                        (12.20 x 8.26 x 7.08 inches approx.)
- Weight: 3 kg approx.
   (6.61 pounds approx.)

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SCADA
Main screen

Ⓘ Main software operation possibilities.

Ⓘ System animations. This box shows different animations for each system (integrator, first order system and second order system). The system animation contains a SYSTEM MODEL button that shows the mathematical model of the current simulated system.

Ⓘ Time Graph. It contains the option to add cursors, print plot, stop de acquisition of data, change the offset, gain and scale of the signals to make easily the study of the signals.

Ⓘ Systems box. This box is used to change the parameters of the system, for example, the tank area, the flow resistance, etc.

Ⓘ Controllers box. This box is used to adjust the parameters of the different controllers used by the unit; Proportional-Integrative-Derivative Control (PID), Predictive Proportional-Integrative Control (pPI) and PID control for non-linear system with Gain scheduling.

SOME **REAL** RESULTS OBTAINED FROM THIS UNIT

The screen below shows a first order system composed by one water tank. The system is controlled by a PI control. As it can be seen in the image the time graph shows that different set points are set along the experiment to test the system response.
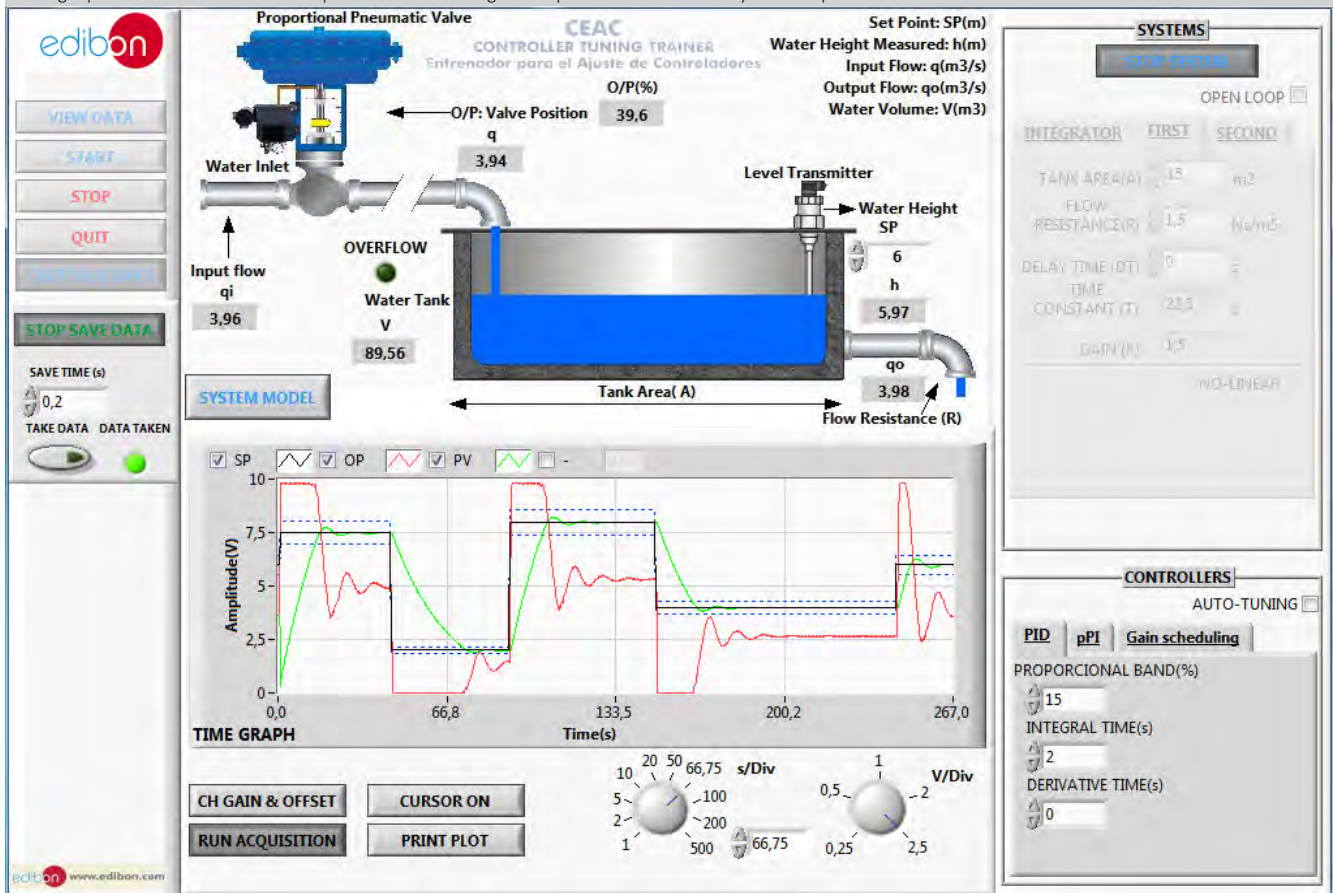

The screen below shows a second order system composed by two non-interacting water tanks. The system is controlled by a PID control. As it can be seen in the image the time graph shows the two water heights inside of each tank to see the differences between them.

Some **real** results obtained from this Unit
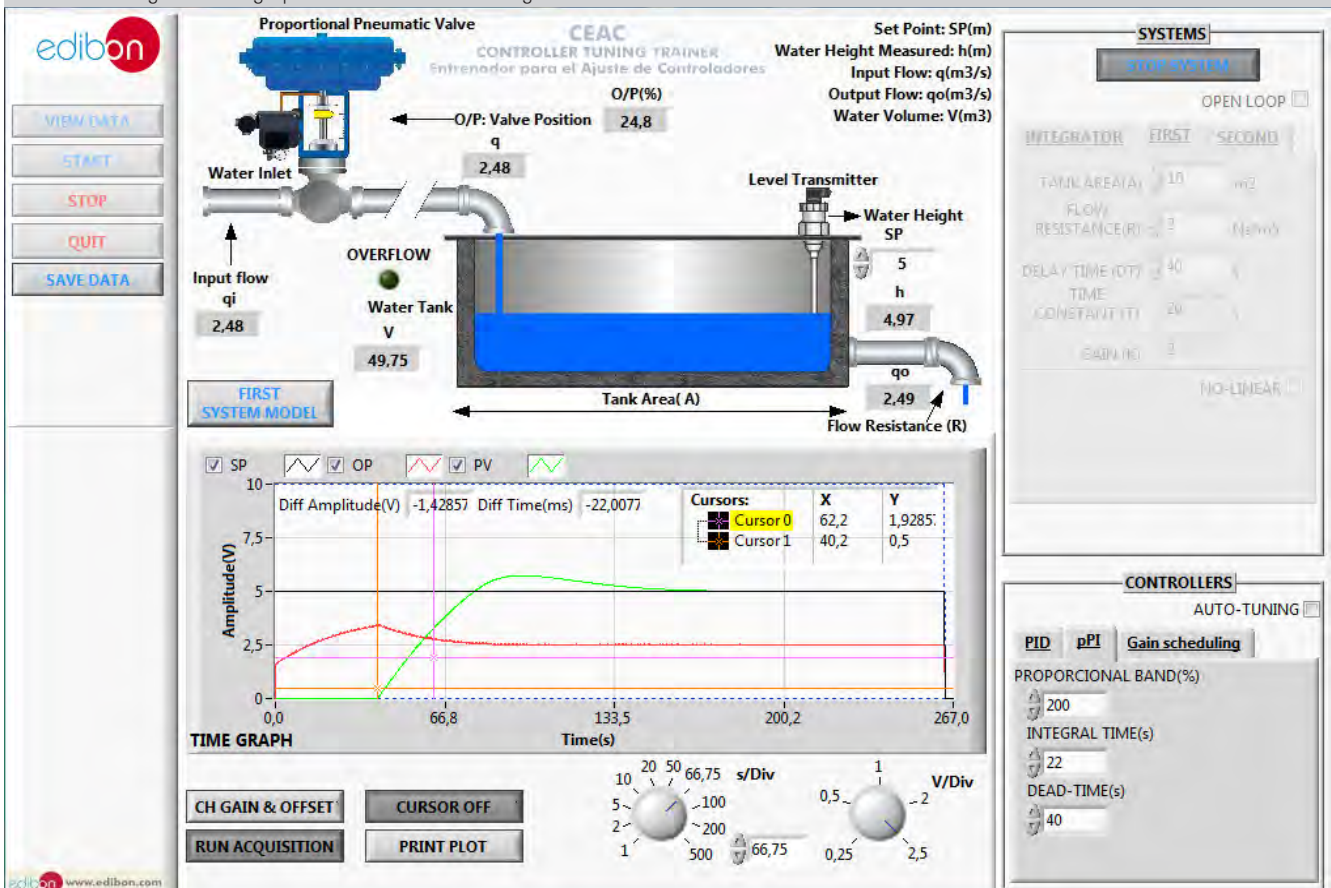
The screen below shows the mathematical model of the simulated system, this model changes if a new system parameters are selected.
The mathematical model of the system are shown if the SYSTEM MODEL button is pushed.
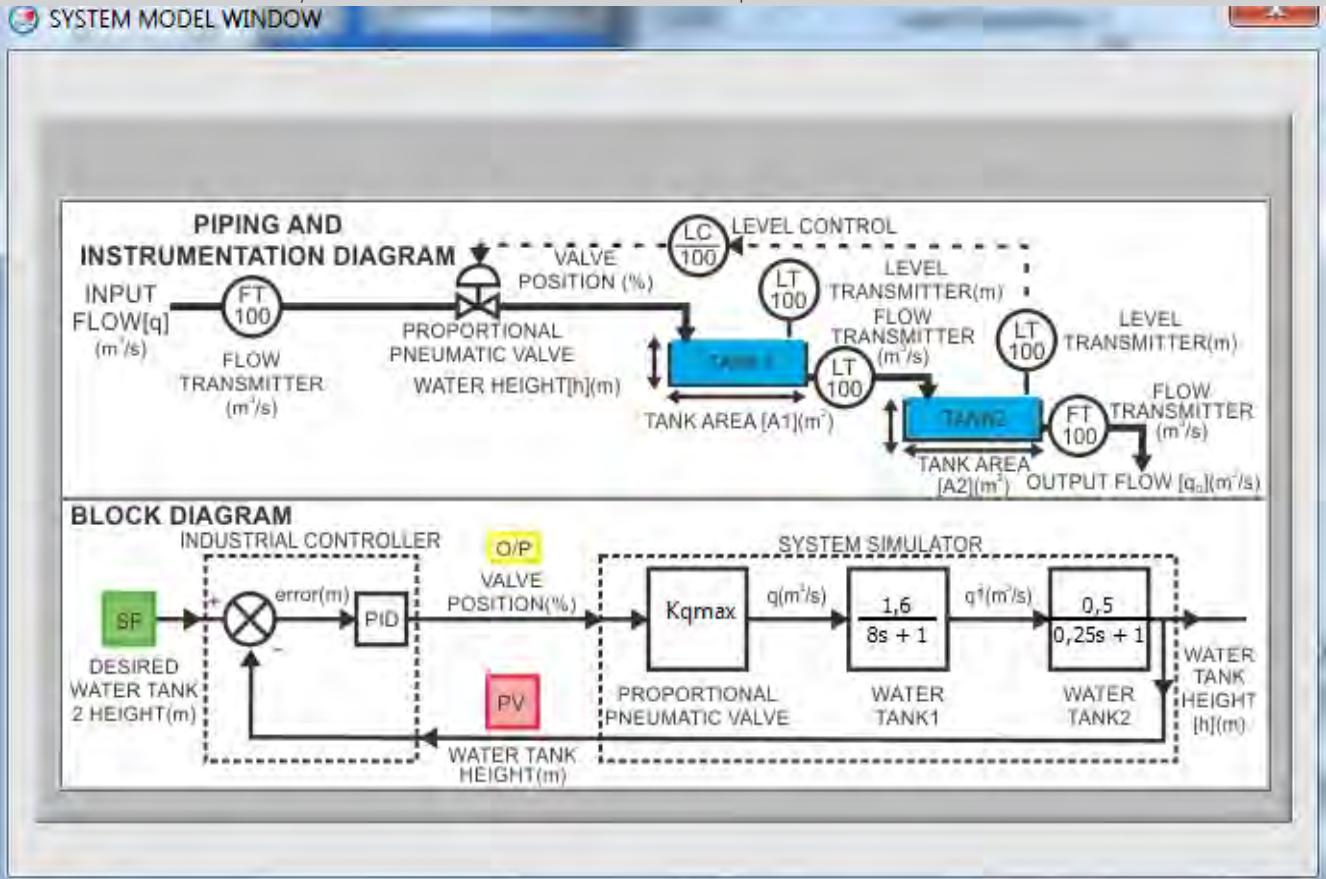
The screen below shows a first order system with a delay time of 40 seconds. The predictive proportional integrative control (pPI) is used to control these type of systems.

www.edibon.com
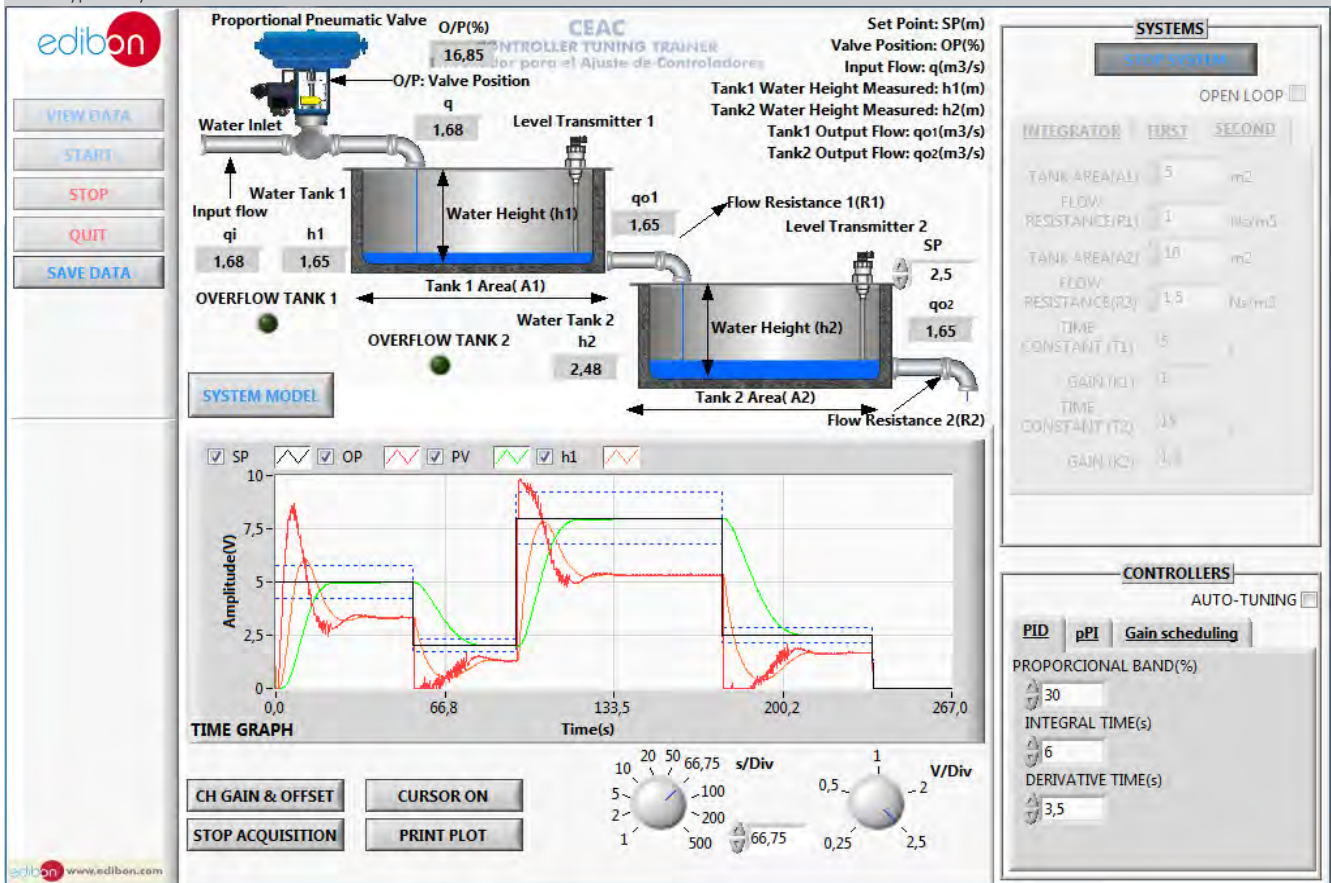
Additionally to the main items (1 to 4) described, we can offer, as optional, other items from 5.

All these items try to give more possibilities for:

a) Technical and Vocational Education configuration. (ICAI)

a) Technical and Vocational Education configuration

⑤ **CEAC/ICAI. Interactive Computer Aided Instruction Software.**
This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

This software is optional and can be used additionally to items (1 to 6).

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

• User Data Base Management.

• Administration and assignment of Workgroup, Task and Training sessions.

• Creation and Integration of Practical Exercises and Multimedia Resources.

• Custom Design of Evaluation Methods.

• Creation and assignment of Formulas & Equations.

• Equation System Solver Engine.

• Updatable Contents.

• Report generation, User Progression Monitoring and Statistics.

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

• Student Log-In & Self-Registration.

• Existing Tasks checking & Monitoring.

• Default contents & scheduled tasks available to be used from the first session.

• Practical Exercises accomplishment by following the Manual provided by EDIBON.

• Evaluation Methods to prove your knowledge and progression.

• Test self-correction.

• Calculations computing and plotting.

• Equation System Solver Engine.

• User Monitoring Learning & Printable Reports.

• Multimedia-Supported auxiliary resources.

For more information see **ICAI** catalogue. Click on the following link:
www.edibon.com/en/files/expansion/ICAI/catalog

Instructor Software

ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen
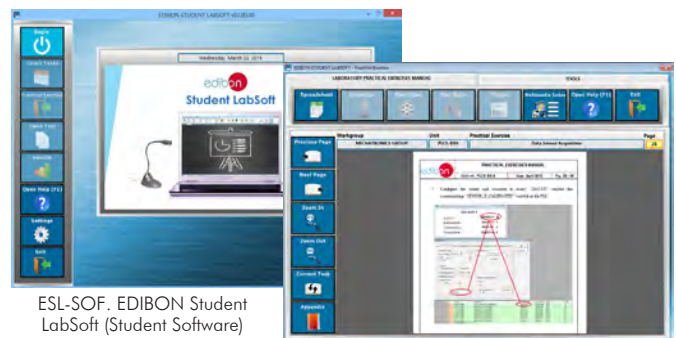

ECAL. EDIBON Calculations Program Package - Formula Editor Screen

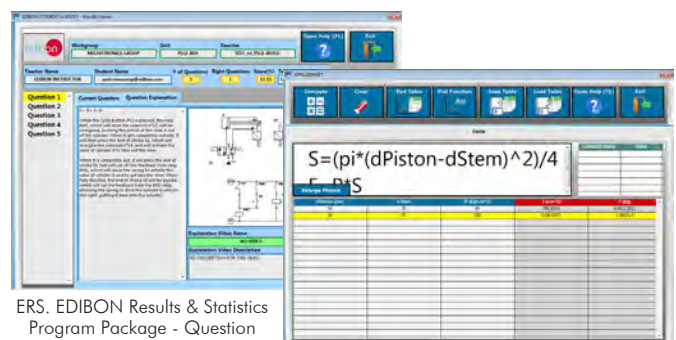ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram

ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

Student Software

ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen

EPE. EDIBON Practical Exercise Program Package Main Screen

ERS. EDIBON Results & Statistics Program Package - Question Explanation

ECAL. EDIBON Calculations Program Package Main Screen

Main items (always included in the supply)

Minimum supply always includes:

① Unit: CEAC. Computer Controlled Controller Tuning Unit.

② CEAC/CCSOF. Computer Control + Data Acquisition + Data Management Software.

③ Cables and Accessories, for normal operation.

④ Manuals.

*IMPORTANT: Under CEAC we always supply all the elements for immediate running as 1, 2, 3 and 4.

Optional items (supplied under specific order)

a) Technical and Vocational Education configuration

⑤ CEAC/ICAI. Interactive Computer Aided Instruction Software.

①CEAC. Unit:

CEAC interface box.

   System simulator:

      Based in Hardware-in-the-loop (HIL) technology.

      HIL with a 0.01 second per loop time.

      Real time simulation with all industrial system configured.

      Analog Input:

         Number: 10.

         Aggregate sample rate: 500kS/s.

         Resolution: 12 bits.

         2 differential analog inputs with ±10V range.

      Analog Output:

         Number: 6.

         Aggregate sample rate: 345 kS/s.

         Resolution: 12 bits.

         2 single-ended channel with ±10V range.

      Digital I/O:

         Number: 24.

         5 V compatible LVTTL.

         3.3 V LVTTL output.

      USB connection to PC.

   Industrial Controller:

      ABB Control Master CM30.

      Display:

         Full-color LCD 9 cm (3.5in.) with built-in backlight.

      Language:

         English, German, French, Italian and Spanish.

      Operator keypad:

         6 tactile membrane keys.

      Password protection:

         Basic / Advanced user-assigned password protection.

      Trend display:

         Recording of 2 variables.

         Configurable sample rate (1 second to 5 minutes).

      Control output types:

         Voltage proportioning (through resistor).

      Control parameters:

         Proportional band: 0 to 999.9 %.

         Integral: 0 to 10000 s.

         Derivative: 0 to 999.9 s.

         Manual Reset: 0.0 to 100 %.

         Time delay range: 0 to 1000s.

         3 sets of PID parameters when used with Gain Scheduling facility.

      Set points:

         Up to 4 local set points, all selectable via digital inputs or front panel.

         Remote selectable via digital input.

      Auto tune:

         On-demand calculation of control settings.

      Process alarms:

         Number: 8.

         Types: High / Low process and High / Low latch.

         Acknowledgement: via front panel keys or digital signals.

         Source: Fully configurable (for example, PV, analog input, math block inbuilt, OP control loop deviation).

         Hysteresis: Level and time.

         Alarm enable: Enable / Disable of individual alarms via a digital signal.

      Analog inputs:

         Number: 2.

         Sample rate: 125 ms.

         Type: Voltage (pre-configured), Current, Resistance (ohms), 3-Wire RTD, Thermocouple, Digital volt-free, Digital 24V, Frequency (Input 1) and pulse.

      Analog outputs:

         Number: 1.

         Type: Configurable as analog or digital pulse.

         Analog range: 0 to 10 V through a resistor.

      Relays:

         Number: 2.

         Type: N/O.

         Contact ratings: 5A, 240V.

      Communication: RS-485 MODBUS protocol.

      RS-485 to USB converter to make the connection with PC easy.

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Control menu to adjust the different controls as PID, pPI and gain scheduling.

Management, processing, comparison and storage of data.

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20.- This unit can be used for doing applied research.

21.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

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• Administration and assignment of Workgroup, Task and Training sessions.

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• Custom Design of Evaluation Methods.

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• Equation System Solver Engine.

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• Default contents & scheduled tasks available to be used from the first session.

• Practical Exercises accomplishment by following the Manual provided by EDIBON.

• Evaluation Methods to prove your knowledge and progression.

• Test self-correction.

• Calculations computing and plotting.

• Equation System Solver Engine.

• User Monitoring Learning & Printable Reports.

• Multimedia-Supported auxiliary resources.

✱ Specifications subject to change without previous notice, due to the convenience of improvement of the product.

REPRESENTATIVE: