Photovoltaic Solar Energy Modular Trainers

Technical Teaching Equipment

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MINI-EESF. **Photovoltaic Solar Energy Modular Trainer** (Complete)

MINI-EESF/M. **Photovoltaic Solar Energy Modular Trainer** (Intermediate)

MINI-EESF/B. **Photovoltaic Solar Energy Modular Trainer** (Basic)

GENERAL DESCRIPTION

Photovoltaic Solar Energy Modular Trainer "MINI-EESF" is a laboratory scaled unit designed to study all the parameters involved in the solar radiation direct conversion into electricity.
The trainer is based on some application modules and photovoltaic solar panels assembled in mobile structures.
It is specially designed for the theoretical and practical study of the electrical installations with photovoltaic solar energy, the typical configurations used in photovoltaic installations and the operation of the different elements involved in the conversion.
The power obtained from the solar energy can be:

- Regulated to obtain a DC power to charge a battery, studying parameters such as solar module´s current output charge level, battery voltage, etc.
- Delivered to DC loads, studying parameters such as solar module´s current output and current consumption by the loads.
- Converted to AC power to be delivered to AC loads, studying parameters such as current consumption by the loads.
- Injected to the grid, studying parameters such as simulated solar module´s current and voltage outputs, power injected to the grid, mains voltage and frequency, etc.

Three different versions are available with different practical possibilities and levels of difficulty: MINI-EESF, MINI-EESF/M and MINI-EESF/B.

ISO 9000: Quality Management
(for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate
(total safety)

Certificates ISO 14000 and
ECO-Management and Audit Scheme
(environmental management)

Worlddidac Quality Charter Certificate
(Worlddidac Member)

Photovoltaic Solar Energy Modular Trainer (Complete)

MINI-EESF

SPECIFICATIONS

Main features:

Supply and Consumption at 12 V (DC).

Supply and Consumption in alternating current (AC).

Supply to the network (grid).

Photovoltaic module:

Solar Panel (polycrystalline) mounted on an anodized aluminum structure with wheels for mobility, and with calibrated cell to measure solar irradiation.

It consists of 36 high performance photovoltaic cells (35 x 55 mm), with a typical power of 50Wp for a 17Vdc voltage.

Both the protections and the used materials give it water proof properties, abrasion protection, hail impact protection and several other adverse environmental factors protection.

Technical data:

Maximum nominal power: 66W.

Voltage at maximum power point (Vmpp): 17.8 V.

Current at maximum power point (Impp): 3.70 A.

Short-circuit current (Isc): 4.05 A.

Open circuit voltage (Voc): 22.25 V.

Dimensions: 660 x 35.5 x 780 mm. Weight: 3 Kg. approx.

Battery offering optimal performance with low power applications.

Set of interconnection cables.

Rack for modules allocation:

Modules:

N-ES10. Solar charge controller with an automatic recognition for operating voltage 12 V or 24 V. It monitors several parameters such as voltage, current and charge level of the battery, load current, status, etc. Additional functions can be activated such as the settings, night light function and auto-test. The regulator is equipped with various devices to protect its electronics, battery and load.

N-ES20. Loads module that incorporates two 12 V, 20W lamps, with independent switches.

N-ES30. DC/AC inverter that outputs a sinewave shaped output of 230V/50Hz ± 2% and the nominal input voltage is 12Vdc. Two different operating modes: continuous mode and ASB mode (Auto Standby) to reduce the power consumption. It is provided with a diagnosis system to indicate the user the status by different flash sequences.

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N-ES40. AC Voltage measurements module until 250V. and DC until 250 V. (digital multimeter).

N-ES50. Loads module that incorporates two lamps of 220V., 50 W., with independent switches.

N-ES80. Module for measurements of solar irradiation (W/m^2) and measurements of current until 10 A., with digital multimeter.

N-ES90. Module for 12Vdc battery charger.

EE-KIT2. Grid Connection Inverter Kit.

Inverter used for the conversion and injection to the grid of the power generated by a simulated source of renewable energy. The simulated source is a simulator used to obtain a variable power to be injected to the grid.

The operation mode is displayed by means of an indicating LED at the front side of the housing.

It is equipped with extensive safety measures to ensure that it is immediately switched off as soon as the AC plug is removed from the wall socket or the operation of the public grid fails.

The inverter can be connected to a computer (PC) through a RS232/USB communication to display some parameters, such as voltage and current inputs, mains voltage and frequency, maximum AC power, Kwh, etc.

- Grid Connection Inverter:

Input (DC):

Nominal power @ 25°C: 150 W.

Maximum power @ 25°C: 220 W.

MPP voltage: 45-125V DC.

Maximum voltage: 155V DC.

Nominal current: 3A.

Output (AC):

Voltage: 230V (207 - 253 V).

Maximum power, fuse: 2A.

Frequency: 50 Hz (49.8 ~ 50.2 Hz).

This unit is supplied with the Grid Simulator (ESR), which simulates a low power grid to inject the power generated by the inverter.

- Grid Simulator (ESR):

ESR is designed to create an isolated low power grid. The unit uses a battery as voltage source and generates a sine signal of 220V/50Hz. The main features of the ESR are:

Inlet voltage source: battery of 12Vdc.

Output: 220V/50Hz.

Isolation transformer.

Battery charger included.

Protection fuses.

The user can work with this module safely. The devices included in the EE-KIT2 can be used worldwide.

Cables and Accessories, for normal operation.

Manuals: This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Determination of the constituent material of the solar cell.
2.- Determination of the I-V first quadrant curve without illuminating the solar cell.
3.- Determination of the inverse (or saturation) current of the cell without illumination.
4.- Determination of parallel and series resistance of a solar cell without illumination.
5.- Dependency of the open circuit voltage (V_{oc}) with lumens (luminous flux).
6.- Determination of the parameters that describe the quality of a solar cell.
7.- Solar energy measurement.
8.- Measurement of the solar panel voltage with no load.
9.- Determination of the disposition of cells in a solar panel.
10.- Familiarisation with the regulator parameters.
11.- Loads connection to 12 Volts DC.
12.- Loads connection to 220 Volts AC.
13.- Study of the grid utility inverter.
14.- Battery charging.

DIMENSIONS & WEIGHTS

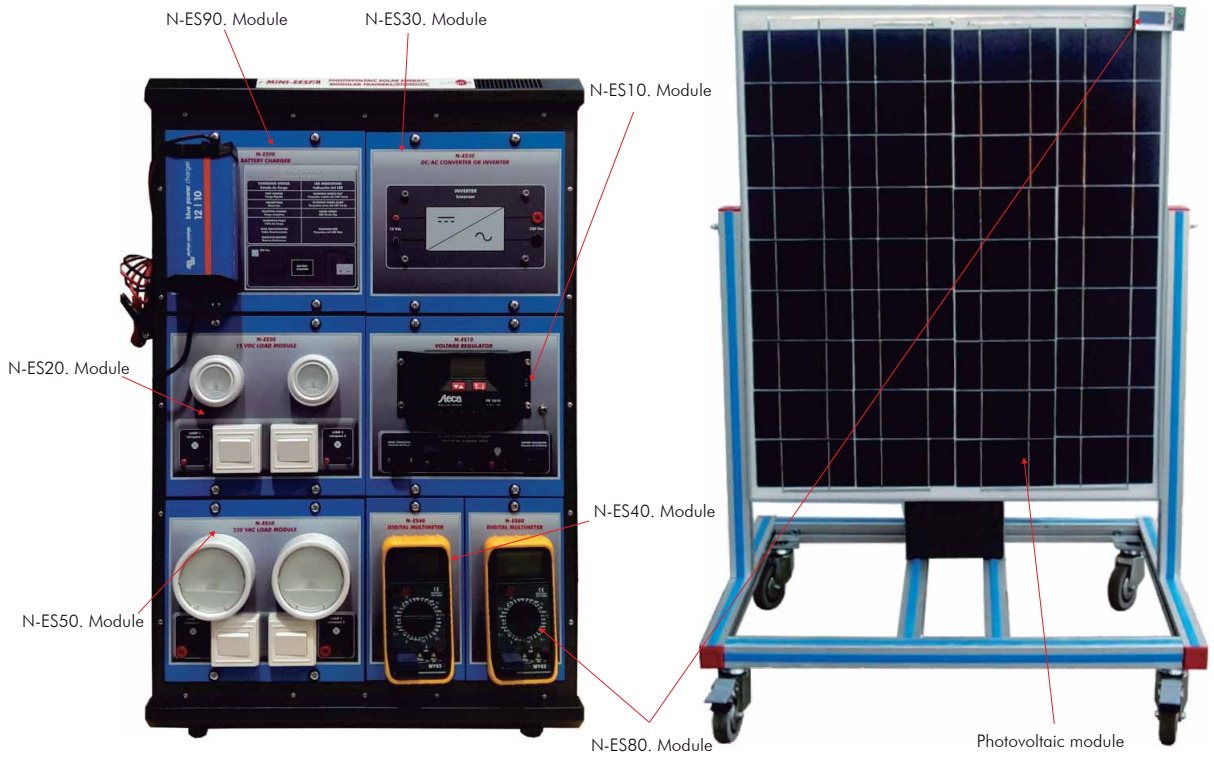
MINI-EESF:

Rack with modules:	Dimensions: 645 x 325 x 925 mm. approx. (25.39 x 12.79 x 36.41 inches approx.)
	Weight: 10 Kg. approx. (22.04 pounds approx.)
Photovoltaic module:	Dimensions: 730 x 510 x 1150 mm. approx. (28.74 x 20.07 x 45.27 inches approx.)
	Weight: 10 Kg. approx. (22.04 pounds approx.)
Grid Connection Inverter Kit:	Dimensions: 550 x 410 x 820 mm. approx. (21.65 x 16.14 x 32.28 inches approx.)
	Weight: 30 Kg. approx. (66.13 pounds approx.)

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

Photovoltaic Solar Energy Modular Trainer (Intermediate)

MINI-EESF/M



SPECIFICATIONS

Main features:

Supply and Consumption at 12 V (DC).

Supply and Consumption in alternating current (AC).

Photovoltaic module:

Solar Panel (polycrystalline) mounted on an anodized aluminum structure with wheels for mobility, and with calibrated cell to measure solar irradiation.

It consists of 36 high performance photovoltaic cells (35 x 55 mm), with a typical power of 50Wp for a 17Vdc voltage.

Both the protections and the used materials give it water proof properties, abrasion protection, hail impact protection and several other adverse environmental factors protection.

Technical data:

Maximum nominal power: 66W. Voltage at maximum power point (Vmpp): 17.8 V.

Current at maximum power point (Impp): 3.70 A.

Short-circuit current (Isc): 4.05 A. Open circuit voltage (Voc): 22.25 V.

Dimensions: 660 x 35.5 x 780 mm. Weight: 3 Kg. approx.

Battery offering optimal performance with low power applications.

Set of interconnection cables.

Rack for modules allocation:

Modules:

N-ES10. Solar charge controller with an automatic recognition for operating voltage 12 V or 24 V. It monitors several parameters such as voltage, current and charge level of the battery, load current, status, etc. Additional functions can be activated such as the settings, night light function and auto-test. The regulator is equipped with various devices to protect its electronics, battery and load.

N-ES20. Loads module that incorporates two 12 V, 20W lamps, with independent switches.

N-ES30. DC/AC inverter that outputs a sinewave shaped output of 230V/50Hz ± 2% and the nominal input voltage is 12Vdc. Two different operating modes: continuous mode and ASB mode (Auto Standby) to reduce the power consumption. It is provided with a diagnosis system to indicate the user the status by different flash sequences.

N-ES40. AC Voltage measurements module until 250V. and DC until 250 V. (digital multimeter).

N-ES50. Loads module that incorporates two lamps of 220V., 50 W., with independent switches.

N-ES80. Module for measurements of solar irradiation (W/m^2) and measurements of current until 10 A., with digital multimeter.

N-ES90. Module for 12Vdc battery charger.

Cables and Accessories, for normal operation.

Manuals: This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Determination of the constituent material of the solar cell.

2.- Determination of the I-V first quadrant curve without illuminating the solar cell.

3.- Determination of the inverse (or saturation) current of the cell without illumination.

4.- Determination of parallel and series resistance of a solar cell without illumination.

5.- Dependency of the open circuit voltage (V_{oc}) with lumens (luminous flux).

6.- Determination of the parameters that describe the quality of a solar cell.

7.- Solar energy measurement.

8.- Measurement of the solar panel voltage with no load.

9.- Determination of the disposition of cells in a solar panel.

10.- Familiarisation with the regulator parameters.

11.- Loads connection to 12 Volts DC.

12.- Loads connection to 220 Volts AC.

13.- Battery charging.

DIMENSIONS & WEIGHTS

MINI-EESF/M:

Rack with modules: Dimensions: 645 x 325 x 925 mm. approx. (25.39 x 12.79 x 36.41 inches approx.)
Weight: 10 Kg. approx. (22.04 pounds approx.)

Photovoltaic module: Dimensions: 730 x 510 x 1150 mm. approx. (28.74 x 20.07 x 45.27 inches approx.)
Weight: 10 Kg. approx. (22.04 pounds approx.)

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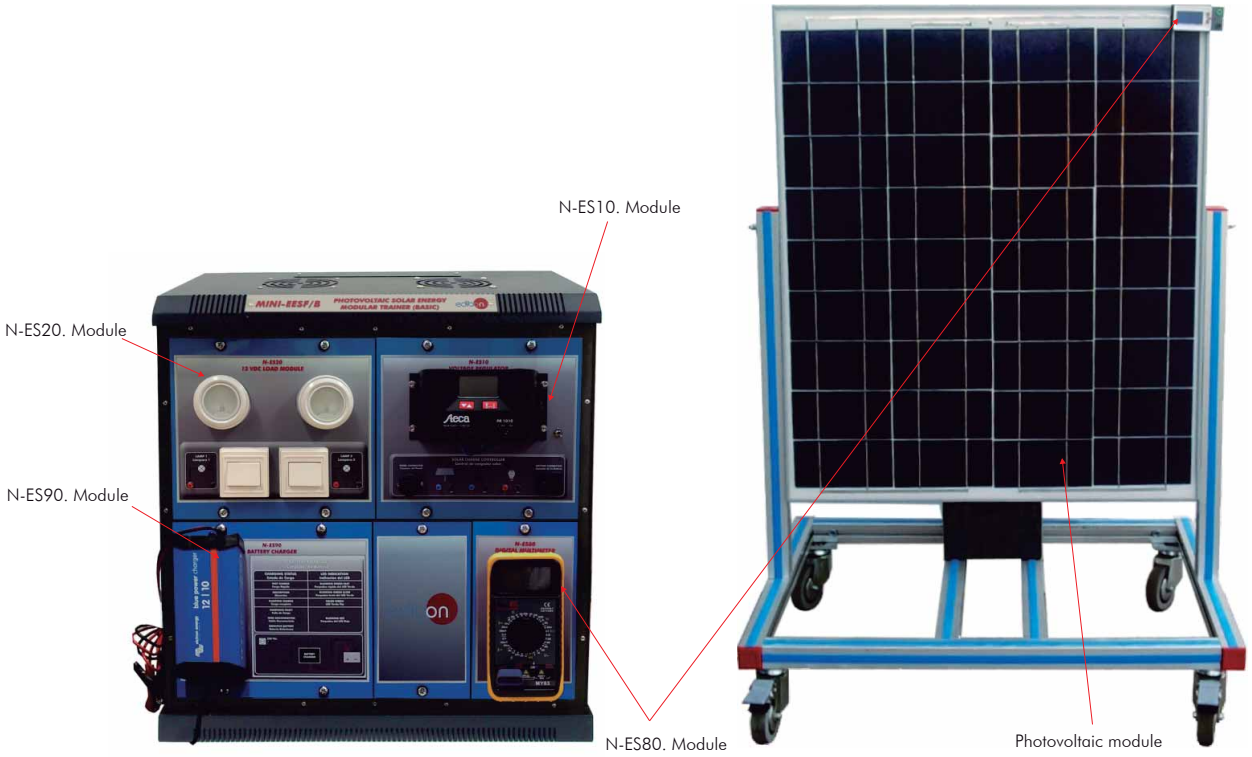
Photovoltaic Solar Energy Modular Trainer (Basic)

MINI-EESF/B



SPECIFICATIONS

Main features:

Supply and Consumption at 12 V (DC).

Photovoltaic module:

Solar Panel (polycrystalline) mounted on an anodized aluminum structure with wheels for mobility, and with calibrated cell to measure solar irradiation.

It consists of 36 high performance photovoltaic cells (35 x 55 mm), with a typical power of 50Wp for a 17Vdc voltage.

Both the protections and the used materials give it water proof properties, abrasion protection, hail impact protection and several other adverse environmental factors protection.

Technical data:

Maximum nominal power: 66W. Voltage at maximum power point (Vmpp): 17.8 V.

Current at maximum power point (Impp): 3.70 A.

Short-circuit current (Isc): 4.05 A. Open circuit voltage (Voc): 22.25 V.

Dimensions: 660 x 35.5 x 780 mm. Weight: 3 Kg. approx.

Battery offering optimal performance with low power applications.

Set of interconnection cables.

Rack for modules allocation:

Modules:

N-ES10. Solar charge controller with an automatic recognition for operating voltage 12 V or 24 V. It monitors several parameters such as voltage, current and charge level of the battery, load current, status, etc. Additional functions can be activated such as the settings, night light function and auto-test. The regulator is equipped with various devices to protect its electronics, battery and load.

N-ES20. Loads module that incorporates two 12 V, 20W lamps, with independent switches.

N-ES80. Module for measurements of solar irradiation (W/m^2) and measurements of current until 10 A., with digital multimeter.

N-ES90. Module for 12Vdc battery charger.

Cables and Accessories, for normal operation.

Manuals: This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Determination of the constituent material of the solar cell.

2.- Determination of the I-V first quadrant curve without illuminating the solar cell.

3.- Determination of the inverse (or saturation) current of the cell without illumination.

4.- Determination of parallel and series resistance of a solar cell without illumination.

5.- Dependency of the open circuit voltage (V_{oc}) with lumens (luminous flux).

6.- Determination of the parameters that describe the quality of a solar cell.

7.- Solar energy measurement.

8.- Measurement of the solar panel voltage with no load.

9.- Determination of the disposition of cells in a solar panel.

10.- Familiarisation with the regulator parameters.

11.- Loads connection to 12 Volts DC.

12.- Battery charging.

DIMENSIONS & WEIGHTS

MINI-EESF/B:

Rack with modules:	Dimensions: 645 x 325 x 670mm. approx. (25.39 x 12.79 x 26.37 inches approx.)
	Weight:6 Kg. approx. (13.22 pounds approx.)
Photovoltaic module:	Dimensions: 730 x 510 x 1150 mm. approx. (28.74 x 20.07 x 45.27 inches approx.)
	Weight: 10 Kg. approx. (22.04 pounds approx.)

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OPTIONAL ELEMENTS

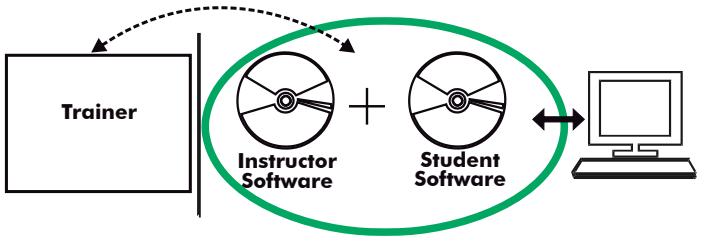
- PSA/PC. Polycrystalline photovoltaic solar panel.

- PSA/MC. Monocrystalline photovoltaic solar panel.

- PSA/AM. Amorphous photovoltaic solar panel.

Optional

MINI-EESF/CAI. Computer Aided Instruction Software System:



With no physical connection between trainer and computer (PC), this complete software package consists of an Instructor Software (INS/SOF) totally integrated with the Student Software (MINI-EESF/SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

INS/SOF. Classroom Management Software (Instructor Software):

The instructor can:

- Organize Students by Classes and Groups.
- Create easily new entries or delete them.
- Create data bases with student information.
- Analyze results and make statistical comparisons.
- Generate and print reports.
- Detect student's progress and difficulties.
- ...and many other facilities.

This software working in network configuration allows controlling all the students in the classroom.

Example of software screens

Instructor Software

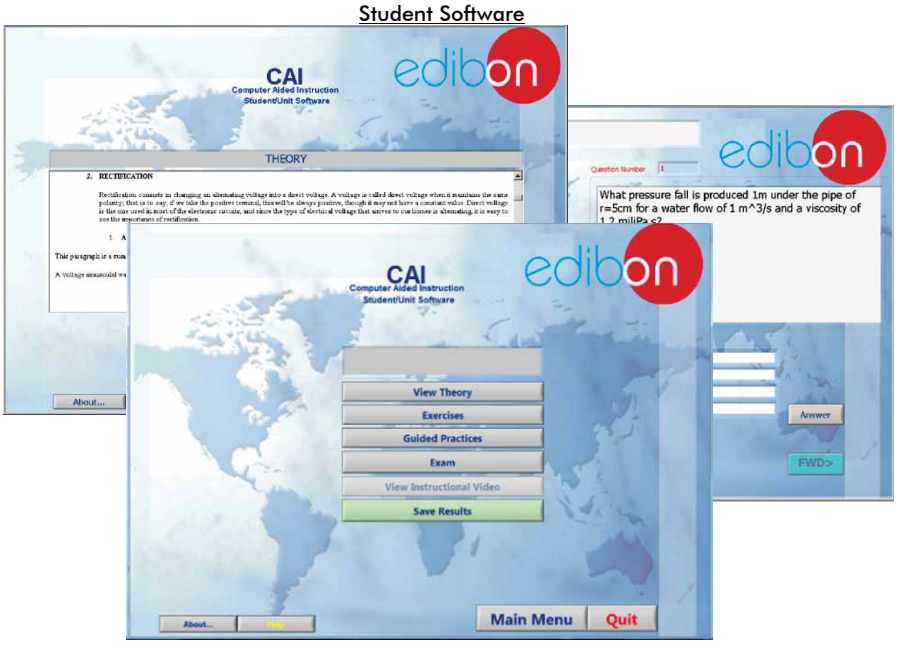
MINI-EESF/SOF. Computer Aided Instruction Software (Student Software):

It explains how to use the trainer, run the experiments and what to do at any moment.

This Software contains:

- **Theory:** gives the student the theoretical background for a total understanding of the studied subject.
- **Exercises:** divided by thematic areas and chapters to check out that the theory has been understood.
- **Guided Practices:** presents several practices to be done with the trainer, showing how to complete exercises and practices.
- **Exams:** set of questions to test the obtained knowledge.

Student Software



For more information see **CAI** catalogue. Click on the following link:

www.edibon.com/products/catalogues/en/CAI.pdf

MINI-EESF/CAL. Computer Aided Learning Software (Results Calculation and Analysis):

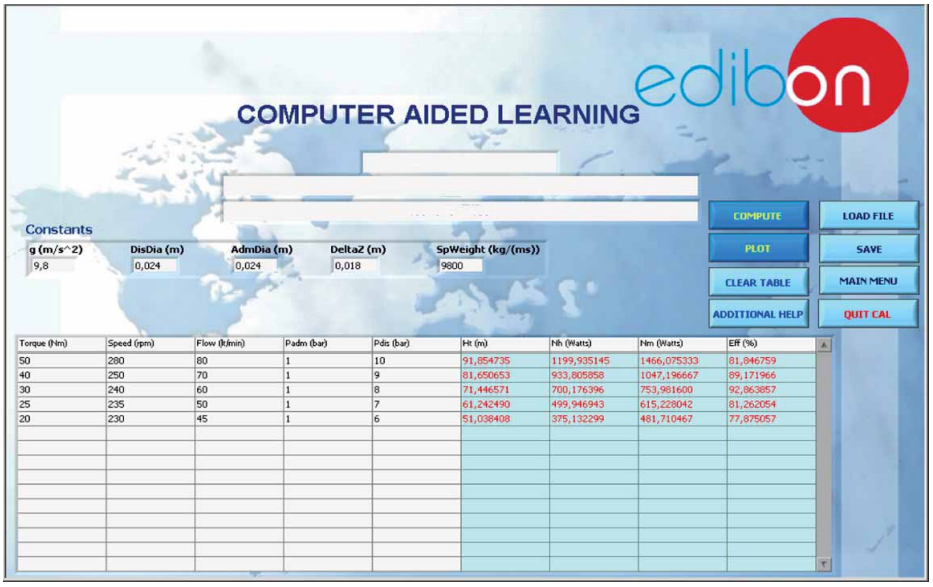
This Computer Aided Learning Software (Results Calculation and Analysis) "CAL" is a Windows based software, simple and very easy to use, specifically developed by EDIBON.

CAL is a class assistant that helps in doing the necessary calculations to extract the right conclusions from data obtained during the experimental practices. With a single click, CAL computes the value of all the variables involved and performs the calculations.

Also, CAL allows to plot and print the results. Within the plotting options, any variable can be represented against any other.

Available different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.



On a table, we introduce data obtained during the development of the exercise.

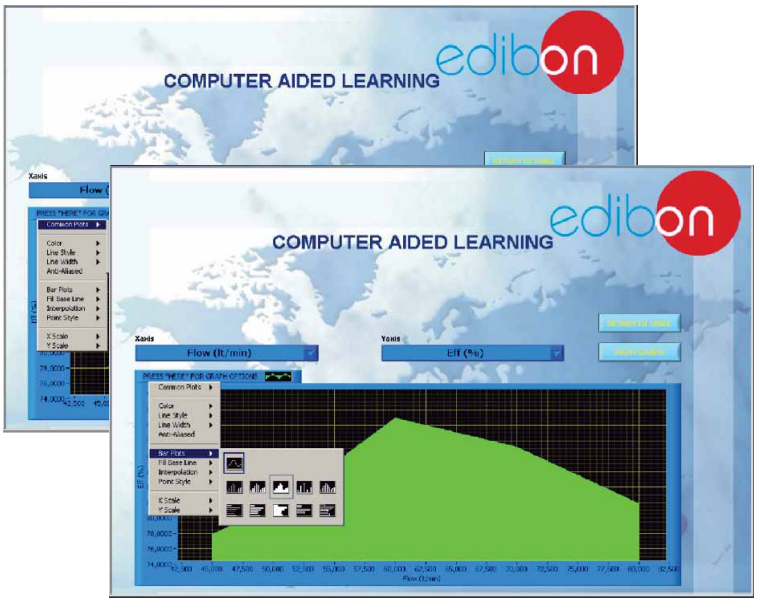
Above this table, it is shown "Constants" theoretically involved with the field of study. The values of these "Constants" may be modified to our convenience, assigning the appropriate values.

Simply, by clicking on "COMPUTE", CAL performs the calculations of the desired variables.

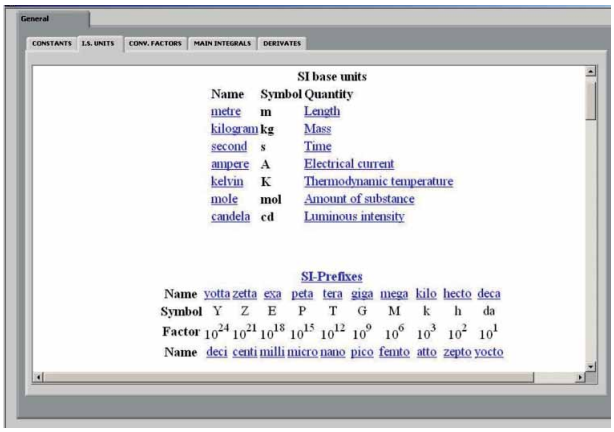
We can save and print the data of the experiment or calculations.

Also we can load any data file saved previously.

With the calculated variables, CAL gives the option of plotting the results. It is possible to represent any variable against any other. It has the option of representing the graph with different layouts. Screens below give an example of the multiple choices.



CAL has a wide range of help information. By clicking the button "ADDITIONAL HELP" opens a window where we have information about typical Constants, International System Units, Conversion Factors, and Table of Main Integrals and Derivatives (General), and there is other specific help for the particular unit.



For more information see **CAL** catalogue. Click on the following link:
www.edibon.com/products/catalogues/en/CAL.pdf

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REPRESENTATIVE: