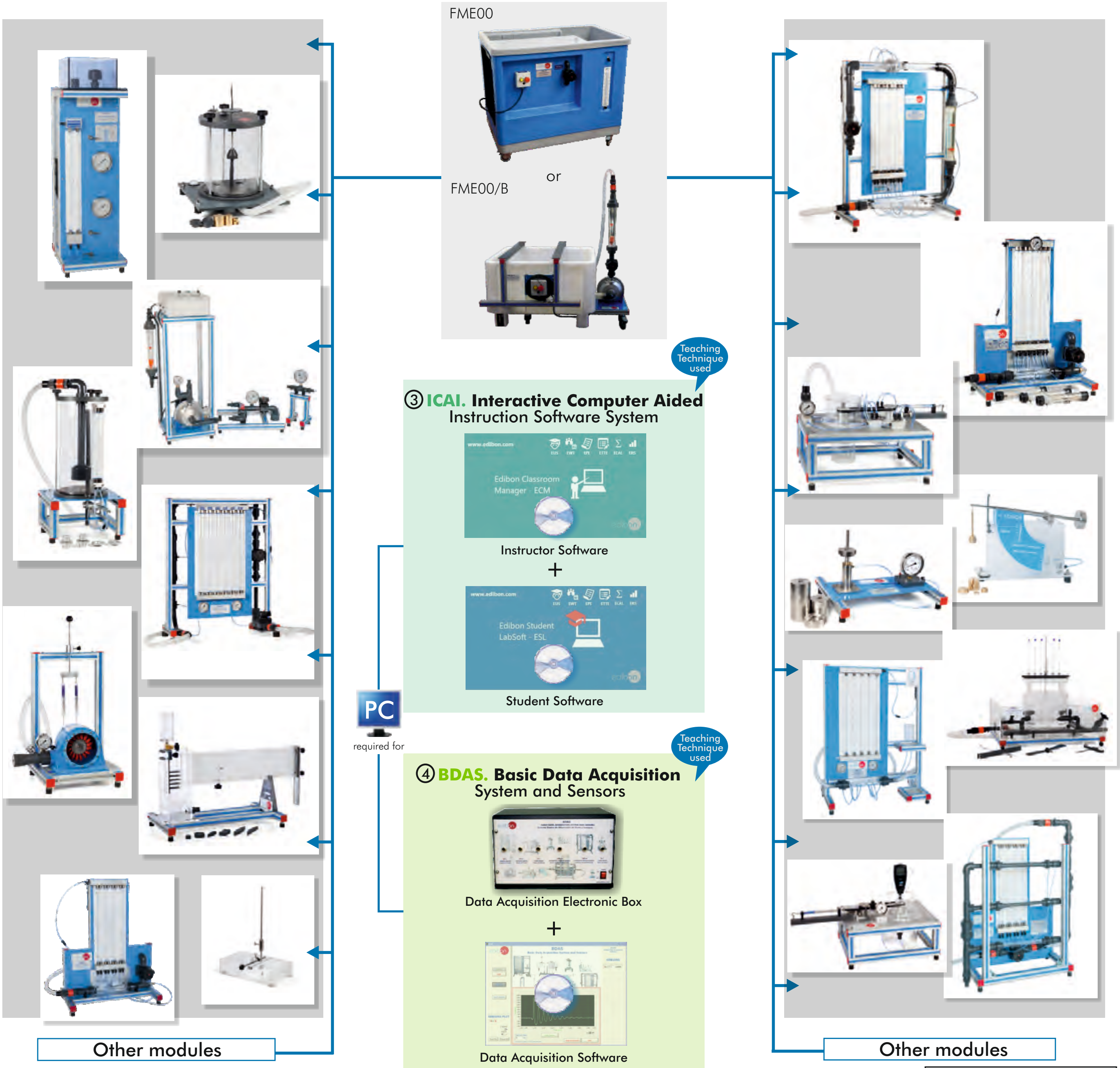
edibon

Engineering and Technical Teaching Equipment

Basic Fluid Mechanics Integrated Laboratory

LIFLUBA

Laboratory structure



The complete laboratory includes parts 1 to 4 and any part can be supplied individually or additionally. (Base Service Unit + Module/s is the minimum supply)

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PRODUCTS
8.- FLUID MECHANICS

Available Modules

➤Fluid Concepts
- -FME02. Flow over Weirs.
- -FME04. Orifice Discharge.
- -FME14. Free and Forced Vortex.
- -FME34. Fluid Statics and Manometry.
- -FME35. Fluid Properties.
- -FME36. Rotameter.

➤General Fluid Applications
- -FME01. Impact of a Jet.
- -FME08. Hydrostatic Pressure.
- -FME10. Dead Weight Calibrator.
- -FME11. Metacentric Height.
- -FME11-A. Metacentric Height of a "V" Shape Floating Body.
- -FME11-B. Metacentric Height of a "U" Shape Floating Body.
- -FME26. Depression Measurement System (vacuum gauge).
- -FME32. Pitot Static Tube Module.

➤Hydraulic Laws
- -FME03. Bernoulli's Theorem Demonstration.
- -FME22. Venturi, Bernoulli and Cavitation Unit.
- -FME06. Osborne-Reynolds' Demonstration.
- -FME31. Horizontal Osborne-Reynolds Demonstration.
- -FME24. Unit for the study of Porous Beds in Venturi Tubes (Darcy's Equation).
- -FME33. Pascal's Module.

➤Hydraulic Demonstration
- -FME09. Flow Visualization in Channels.
- -FME20. Laminar Flow Demonstration.
- -FME30. Vortex Flow Meter.
- -FME15. Water Hammer.
- -FME19. Cavitation Phenomenon Demonstration.
- -FME18. Flow Meter Demonstration.
- -FME25. Flow Channel, 1m. length.
- -FME17. Orifice and Free Jet Flow.

➤Pipes
- -FME05. Energy Losses in Bends.
- -FME07. Energy Losses in Pipes.
- -FME23. Basic Pipe Network Unit.
- -AFT/P. Fluid Friction in Pipes Unit.

➤Hydraulic Machines: Pumps
- -FME12. Series/Parallel Pumps.
- -FME13. Centrifugal Pumps Characteristics.

➤Hydraulic Machines: Turbines
- -FME27. Axial Flow Turbine.
- -FME16. Pelton Turbine.
- -FME28. Francis Turbine.
- -FME29. Kaplan Turbine.
- -FME21. Radial Flow Turbine.

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 Worlddidacber

INTRODUCTION

Hydraulics is the branch of science that deals with the mechanical properties of fluids, and Fluid Mechanics provides the foundation for hydraulics.

With LIFLUBA (Basic Fluids Mechanics Integrated Laboratory), EDIBON tries to give answer to the academic demand for teaching and learning the basics of Fluids Mechanics, in an easy and practical way. With the LIFLUBA modules series, students accomplish experiments that clearly show them the laws of Hydraulics, and they acquire a valuable experience in the use of hydraulics instrumentation and tools, in a natural, pleasant and uncomplicated way.

GENERAL DESCRIPTION

EDIBON presents a flexible and modular-based system for learning Basic Fluid Mechanics.
Any desired configuration can be chosen (see next page), according to the working mode, areas of study and numbers of working posts.
Being a modular and open system, it is very economical and may be enlarged depending on required needs; all previously acquired systems are fully compatible and valid.

What are the parts included in the laboratory?

① **Base Service Units:**

Each module needs to be provided with water in order to run the experiment. There are two options:

-FME00. Hydraulics Bench. This is a mobile hydraulic bench, mounted on resistant wheels, where the modules can be placed on it to ease their manipulation.

-FME00/B. Basic Hydraulic Feed System. This is a simpler and more basic base and service unit.

② **Modules:**

Each module is a set of components that allows the realization of several experiments on Hydraulics.
EDIBON offers 36 different Modules covering the most important topics in the learning of Fluid Mechanics.
Each Module has its own manuals (8 manuals are normally supplied), that gives the theoretical background and explains everything the student needs to carry out the exercises/experiments.
Connectors, pipes and cables for completing the exercises and practices are supplied.

③ **ICAI. Interactive Computer Aided Instruction Software System:**

The best help in classroom for both teacher and students.
It includes:

3.1) 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.

3.2) 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.

Each “FME” type module has its own software.

④ **BDAS.Basic Data Acquisition System and Sensors.**

For being used with modules type “FME”.
BDAS is designed to monitor the measurements of each module type “FME” from a computer (PC).

Complete LIFLUBA/ LABORATORY includes: ①+②+③+④

Minimum supply: ① Base Service Unit + ② Module/s.

Working possibilities

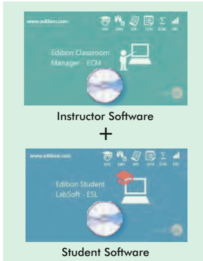
A) ICAI + BDAS working possibility (complete EDIBON system)

Base Service Unit:
FME00. Hydraulics Bench
or
FME00/B. Basic Hydraulic Feed System

+

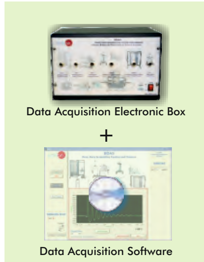
Module/s

+



ICAI.
Interactive Computer Aided
Instruction Software System

+



BDAS.
Basic Data Acquisition
System and Sensors

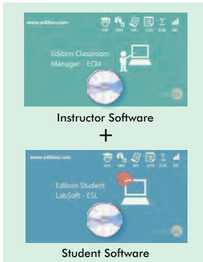
B) ICAI working possibility

Base Service Unit:
FME00. Hydraulics Bench
or
FME00/B. Basic Hydraulic Feed System

+

Module/s

+



ICAI.
Interactive Computer Aided
Instruction Software System

C) BDAS working possibility

Base Service Unit:
FME00. Hydraulics Bench
or
FME00/B. Basic Hydraulic Feed System

+

Module/s

+

BDAS.
Basic Data Acquisition
System and Sensors

D) Simplest working possibility

Base Service Unit:
FME00. Hydraulics Bench
or
FME00/B. Basic Hydraulic Feed System

+

Module/s

FME00. **Hydraulics Bench**

DESCRIPTION

Unit for the study of fluid behaviour, hydraulic theory and the properties of fluid mechanics.

It is formed by a movable hydraulics bench used to hold a wide variety of modules, which allow the student to experiment with the problems presented by fluid mechanics.

Autonomous unit (tank and pump included).

Innovative water saving system consisting of a high capacity sump tank and spillway that sends the excess of water back to the tank.

Easy access drain valve.

The volumetric measuring tank is stepped to accommodate for low or high flow rates. A measuring cylinder (1 l.-capacity) is included in the supply for the measurement of very small flow rates.

Level tube with scale that shows the water level in the upper tank.

Flow adjusted by means of a membrane valve.

Flow stilling baffle for reducing the turbulence rate.

Specially designed channel, in the upper part, to support the modules on test.

The modules are easily mounted on its top without the use of tools. This ensures its simplicity.

Manufactured with corrosion resistant materials, ensuring a long and useful life of the unit.

Centrifugal pump.

Pump breaker starting, safety and contact light.

Each module is supplied as a complete piece of equipment with easy and quick coupling to the bench, maximizing the available student's time to perform the demonstrations or the experimental measurements.

To be used with the different units of Fluid Mechanics Area: "FME" type modules, Fluid Friction in Pipes Equipment "AFT", etc., to increase the profitability.

PRACTICAL POSSIBILITIES

1.-Flow measurement.

SPECIFICATIONS

Mobile hydraulic bench, made of fibreglass reinforced polyester, and mounted on wheels for its mobility.
Centrifugal pump, 0.37 KW, 30 - 80 l./min at 20.1-12.8 m., single phase 220V/50Hz or 110V/60Hz.
Runner made of stainless steel.
Sump tank capacity: 165 l.
Small channel: 8 l.
Flow measurement: volumetric tank, gauged from 0 to 7 l. for low flow values and from 0 to 40 l. for high flow values.
Control valve for regulating the flow.
Open channel to place the test module.
Measuring cylinder is provided for the measurement of small flow rates.
Remote hand-operating dump valve in the base of the volumetric tank.
Rapid and easy interchange of the different modules.

DIMENSIONS AND WEIGHT

Dimensions: 1130 x 730 x 1000 mm. approx.
(44.48 x 28.74 x 39.36 inches approx.)
Weight: 70 Kg. approx.
(154 pounds approx.)

REQUIRED SERVICES

Electrical supply: single-phase 220V/50 Hz or 110V/60 Hz.
Water supply.
Drainage.
FME00-CR. Chronometer. (on request)

FME00/B. **Basic Hydraulic Feed System**

DESCRIPTION AND SPECIFICATIONS

The FME00/B is a service unit for different Fluid Mechanics Units as: "FME" type modules, Fluid Friction in Pipes Unit "AFT", etc., increasing the equipment profitability.

Centrifugal pump: 0.37 KW, 30-80 l./min at 20.1-12.8m., single-phase 220V. / 50Hz. or 110V. / 60Hz.

Stainless steel impeller.

Tank capacity: 140 l. approx.

Flowmeter.

Membrane type flow adjusting valve.

Safety switch ON/OFF.

Supports for accommodating the test module.

This unit incorporates wheels for its mobility.

PRACTICAL POSSIBILITIES

1.- Flow measurement.

DIMENSIONS AND WEIGHT

Dimensions: 1000 x 600 x 700 mm. approx.
(36.36 x 23.62 x 27.55 inches approx.)
Weight: 40 Kg. approx.
(88.18 pounds approx.)

REQUIRED SERVICES

Water supply.
Drainage.
Electrical supply: single-phase 220V/50 Hz or 110V/60 Hz.

➤Fluid Concepts

FME02. **Flow over Weirs**

DESCRIPTION

This module has many elements that are used in combination with the Hydraulics Bench (FME00):

A special mouthpiece is coupled to the outlet mouthpiece for water in the Hydraulics Bench (FME00).

Two soothing screens that, together with the previous element, provide a slow current in the channel.

A level meter consisting of a "nonius" adjusted to a mast, where the heights are pointed out on a caliber coupled to it.

A small hook or point is attached to the bottom of the mast to carry out the measures.

Two drains (a rectangular neckline and a V-shape) are attached to the final part of the channel of the Hydraulics Bench (FME00).

PRACTICAL POSSIBILITIES

1.- Study of the flow characteristics through a weir with a rectangular neckline, made on a thin wall.

2.- Study of the flow characteristics through a weir with a V-shape neckline, made on a thin wall.

SPECIFICATIONS

Dimensions of the weirs: 230 x 4 x 160 mm.

Neckline angle in the V-shape weir: 90º.

Dimension of rectangular notch: 30 x 82 mm.

Scale of the level meter: 0 to 160 mm.

DIMENSIONS AND WEIGHT

Dimensions: 400 x 160 x 600 mm. approx.
(15.74 x 6.29 x 23.62 inches approx.)

Weight: 7 Kg. approx.
(15.43 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00).

Chronometer.

FME04. **Orifice Discharge**

Detail of the
5 type of mouthpieces

DESCRIPTION

The module consists of a transparent cylindrical tank that is fed from the top by the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B). The water flows through an interchangeable mouthpiece (a set of 5 mouthpieces is supplied, representing orifices of different characteristics) located in the base center. The liquid flowing vein goes directly to the volumetric tank of the Hydraulics Bench or from the Basic Hydraulic Feed System.
A Pitot's tube can be placed in any point of the flowing vein to determine its total height of load.
A transverse device, joined to the Pitot's tube, allows to determine the diameter of the liquid flowing vein.
It´s possible to measure the height of the Pitot's tube and the total height through the orifice, in a panel of 2 manometric tubes located beside the tank.

PRACTICAL POSSIBILITIES

1.- Determination of the discharge coefficient for the mouthpiece of thin wall, Venturi type.
2.- Determination of the velocity coefficient for the mouthpiece of thin wall, Venturi type.
3.- Determination of the contraction coefficient for the mouthpiece of thin wall, Venturi type.
4.- Determination of the discharge coefficient for the mouthpiece of thin wall, diaphragm type.
5.- Determination of the velocity coefficient for the mouthpiece of thin wall, diaphragm type.
6.- Determination of the contraction coefficient for the mouthpiece of thin wall, diaphragm type.
7.- Determination of the discharge coefficient for the mouthpiece of thin wall, colloidal type.
8.- Determination of the velocity coefficient for the mouthpiece of thin wall, colloidal type.
9.- Determination of the contraction coefficient for the mouthpiece of thin wall, colloidal type.
10.- Determination of the discharge coefficient for the mouthpiece of thick wall, cylindrical type.
11.- Determination of the velocity coefficient for the mouthpiece of thick wall, cylindrical type.
12.- Determination of the contraction coefficient for the mouthpiece of thick wall, cylindrical type.
13.- Determination of the discharge coefficient for the mouthpiece of thick wall, Venturi type.
14.- Determination of the velocity coefficient for the mouthpiece of thick wall, Ventury type.
15.- Determination of the contraction coefficient for the mouthpiece of thick wall, Ventury type.

SPECIFICATIONS

Transparent cylindrical tank.
Five type of mouthpieces: diaphragm, colloidal, 2 of Venturi and cylindrical.
Height of maximum load: 400 mm.
Easy and quick coupling system built-in.
Anodized aluminum structure.

DIMENSIONS AND WEIGHT

Dimensions: 450 x 450 x 900 mm. approx. (17.71 x 17.71 x 35.43 inches approx.)
Weight: 15 Kg. approx. (33 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME14. **Free and Forced Vortex**

DESCRIPTION

The module has a cylindrical and transparent deposit with two inlet pipes diametrically opposed, slightly inclined to produce a whirl. This deposit has an outlet in the center of its base, where 3 mouthpieces with orifices of different diameters can be coupled. These mouthpieces generate the free vortex and a rotor blade creates the forced vortex acting like a flux strangler shaker.

The profile of the formed vortex is determined by a vortex height meter, placed in the cylinder's upper part, which measures the diameter of the vortex at different depths.

The total pressure can be measured by placing a Pitot's tube in the bridge of measurement.

It also has adjustable legs to level the module.

PRACTICAL POSSIBILITIES

1.- Study of forced vortex without discharge orifice.
2.- Study of forced vortex with discharge orifice.
3.- Study of free vortex.
4.- Analysis of the influence of the jet inlet direction.
5.- Analysis of the influence of the vortex on the discharge velocity.

SPECIFICATIONS

Tank diameter: 300 mm.

Tank height: 300 mm

Mouthpieces orifice diameters: 8, 16 and 24 mm.

Distance between centers: 0, 30, 50, 70, 90 and 110 mm.

Pitot tube with measuring points at: 15, 20, 25 and 30 mm radius and a scale.

Measurement bridge.

Inlet pipes: 9 and 12.5 mm. diameter.

Diameter measurement system by Nonius.

Blind mouthpiece with X-shaped crosses.

Easy and quick coupling system built-in.

Anodized aluminum structure.

DIMENSIONS AND WEIGHT

Dimensions: 600 x 550 x 1400 mm. approx.
(23.62 x 21.65 x 55.11 inches approx.)

Weight: 10 Kg. approx.
(22 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Chronometer.

FME34. **Fluid Statics and Manometry**

DESCRIPTION

This module has been designed to study static fluids and manometry. It provides the user an introduction to the behaviour of liquids under hydrostatic conditions (fluids at rest) and to the application of those principles in the pressure measurement by using different manometric tubes.

It allows the user to demonstrate the properties of Newtonian fluids and to understand a wide range of basic principles before studying fluids in motion.

PRACTICAL POSSIBILITIES

1.- To study the basic principles of hydrostatics and to demonstrate the behaviour of liquids at rest.
2.- To use manometer tubes to measure differential pressure.
3.- To use a manometer tube to measure head.
4.- To use a 'U' tube manometer to measure pressure differences in a gas (air over liquid).
5.- To use a U-shaped manometer for determining the differential pressure.
6.- To use liquids with different densities to change the 'U' tube manometer sensitivity.
7.- To use an inverted pressurized 'U' tube manometer to measure pressure differences in a liquid.
8.- To use an inclined manometer with different inclinations.
9.- Level measurement using Vernier hook and point gauge.
10.- To measure the liquid level using a scale.
11.- Demonstrating that the level of a free surface is not affected by the size or shape of the tube.
12.- Use of a piezometric tube to measure pressure.
13.- Observing the effect of a liquid in motion (losses due to friction).

SPECIFICATIONS

The module is mounted on an aluminum structure and painted steel panels and consists of a vertical tank (made of methacrylate, diameter: 100 mm and height: 575 mm) containing water that is connected to different vertical manometer tubes (460 mm length):

One "U" shape vertical tube.
Two parallel vertical tubes.
One vertical tube with variable section.
One vertical tube with a pivot that allows it to incline from 0 to 90°.

These tubes can be used individually or in combination for the different demonstrations.

Vernier hook and point gauge.

Piezometric tube.

Manual air pump.

Purge valve.

Plug to close the tank, so that it is not open to atmospheric pressure.

DIMENSIONS AND WEIGHT

Dimensions: 700 x 350 x 800 mm. approx.
(27.55 x 13.77 x 31.49 inches approx.)

Weight: 15 Kg. approx.
(33 pounds approx.)

REQUIRED SERVICES

It can work in autonomous way.

FME35. **Fluid Properties**

DESCRIPTION

This module has been designed to allows the study of the fundamental properties of fluids and their behaviour in practical applications.

We can study capillarity, density and relative density (specific gravity), buoyancy (Archimedes principle), viscosity, atmospheric pressure, etc.

PRACTICAL POSSIBILITIES

1.- To study the effect of capillary elevation between flat plates.
2.- To study and measure the effect of capillary elevation inside capillary tubes.
3.- To study and verify the Archimedes principle using a bucket and cylinder with a lever balance.
4.- To measure the fluid density and relative density of a liquid using a hydrometer and using a density bottle.
5.- To measure the atmospheric pressure using a barometer.
6.- To measure the fluid viscosity using a falling sphere viscometer.
7.- To measure the fluid temperature using an alcohol thermometer.
8.- Measuring of liquid levels.

SPECIFICATIONS

Anodized aluminum structure and panels of painted steel.

3 Hydrometers of resolution 0.002°SG:

- Hydrometer 0.8°SG - 1°SG
- Hydrometer 1°SG – 1.2°SG
- Hydrometer 1.2°SG – 1.4°SG

Two hydrometer jars of 450 x 50 mm.

Aneroid barometer, range: 973 – 1047 mbar.

Thermometer with a range between -10 and 50°C.

Pycnometer of 50 ml.

Parallel plates capillary module.

Capillary tubes module with tubes of different size: 5 mm, 4 mm, 3 mm, 2.2 mm, 1.7 mm and 1.2 mm.

Two falling sphere viscometer tubes of 300 x 40 mm, with marks at 0, 25, 175, 200 and 220.

Set of stainless steel balls of different sizes: 3.175 mm, 2.381 mm and 1.588 mm.

Variable scale lever balance to be used with the Archimedes module, up to 310 gr.

Archimedes module: displacement vessel, bucket and cylinder.

Graduated cylinder made of glass (250 ml.)

2 Beakers made of glass (600 ml.)

Digital chronometer.

DIMENSIONS AND WEIGHT

Dimensions: 850 x 500 x 800 mm. approx.
(33.46 x 19.68 x 31.49 inches approx.)

Weight: 20 Kg. approx.
(44 pounds approx.)

REQUIRED SERVICES

It can work in autonomous way.

FME36. **Rotameter**

DESCRIPTION

The FME36 module is a variable area flowmeter with float. This type of flowmeter can be used for flow rate measurements in almost all media.

The operation mode of this flowmeter is based on the fact that if a medium is flowing upwards at a sufficient rate of flow through a vertically mounted tube, the float is raised to the point at which a state of equilibrium sets between the lifting force of the medium and the weight of the float. Since the mean rate of flow is proportional to the quantity flowing through per unit of time, this state of equilibrium corresponds to the measurement of the instantaneous flow rate.

An additional advantage of this type of flowmeter is that it does not require minimum straight sections of pipe, therefore it can also be installed directly before or after elbows and valves since the pressure loss is low.

PRACTICAL POSSIBILITIES

1.- Flow measurement.

SPECIFICATIONS

Anodized aluminum structure and panel of painted steel.

Variable area rotameter with float.

- Measurement range: 600-6000 l./h.
- Material: transparent PVC.
- Accuracy class: 4.

Quick-plug for an easy connection.

DIMENSIONS AND WEIGHT

Dimensions: 400 x 300 x 900 mm. approx.
(15.74 x 11.81 x 35.43 inches approx.)

Weight: 10 Kg. approx.
(22 pounds approx.)

REQUIRED SERVICES

It can work either on its own or with the Hydraulics Bench (FME00).

FME01. **Impact of a Jet**

DESCRIPTION

The module consists of a cylindrical tank with lateral transparent surfaces where a nozzle, connected to the Hydraulics Bench (FME00), is aligned with a device in which the problem surface is fitted. The vertical force made by the water against the surface is measured using calibrated weights that balance this force. Taking as a reference a gauge, which has been previously adjusted to a zero reference, we measure the force thanks to a mark that appears on the surface where the masses were placed.

Adjustable supports that let the device balance.

Holes made on the tank base in order to drain the water. In this way, splashes are avoided.

PRACTICAL POSSIBILITIES

1.- Impact against a flat surface.

2.- Impact against a curve surface of 120°.

3.- Impact against a hemispherical surface.

4.- Use of the fast connectors.

SPECIFICATIONS

Jet diameter: 8 mm.

Impact surfaces diameter: 40 mm.

Impact surfaces:

180° hemispherical surface.

120° curve surface.

90° flat surface.

A set of masses of 5, 10, 50 and 100 g. is supplied.

Easy and quick coupling system built-in.

DIMENSIONS AND WEIGHT

Dimensions: 250 x 250 x 500 mm. approx.
(36.36 x 23.62 x 27.55 inches approx.)

Weight: 5 Kg. approx.
(11 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Chronometer.

FME08. **Hydrostatic Pressure**

DESCRIPTION

The module consists of a quadrant assembled to the arm of a scale that swings around an axis.

When the quadrant is immersed in the water tank, the force that acts on the flat rectangular front surface exerts a momentum with respect to the supporting axis.

The swinging arm is fitted with a tray and an adjustable counter balance.

The tank has adjustable supporting legs for levelling.

It has a drainage valve.

The level reached by the water inside the tank is indicated by a graduated scale.

PRACTICAL POSSIBILITIES

1.- Determination of the center of pressures with an angle of 90°, partially submerged.

2.- Determination of the resultant force with an angle of 90°, partially submerged.

3.- Determination of the center of pressures, angle <> 90° partially submerged.

4.- Determination of the equivalent force with an angle <>90° partially submerged.

5.- Determination of the center of pressures with an angle of 90° totally submerged.

6.- Determination of the resultant force with an angle of 90° totally submerged.

7.- Determination of the center of pressures, angle <>90° totally submerged.

8.- Determination of the resultant force, angle <>90° totally submerged.

9.- Balance of momentum.

SPECIFICATIONS

Tank capacity: 5.5 l.

Distance between the suspended masses and the support point: 285 mm.

Area of the section: 0.007 m^2.

Total depth of the submerged quadrant: 160 mm.

Height of the support point on the quadrant: 100 mm.

A set of masses of different weights is supplied (4 of 100 gr, 1 of 50 gr, 5 of 10 gr, and 1 of 5 gr).

DIMENSIONS AND WEIGHT

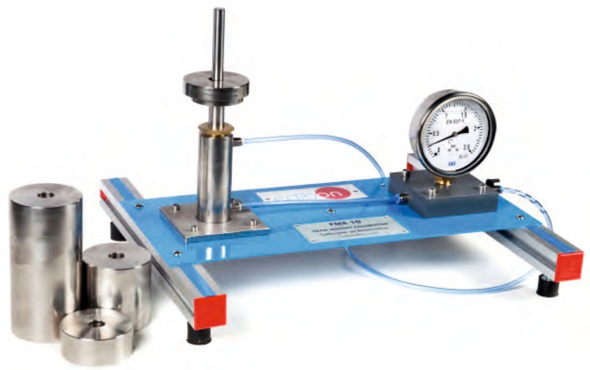
Dimensions: 550 x 250 x 350 mm. approx.
(21.63 x 9.48 x 13.77 inches approx.)

Weight: 5 Kg. approx.
(11 pounds approx.)

REQUIRED SERVICES

It can work in autonomous way.

FME10. **Dead Weight Calibrator**



DESCRIPTION

The module consists of a hollow cylinder in whose interior a precision piston moves. Using a system of calibrated weights, we produce predetermined pressures inside the cylinder.

The Bourdon manometer that must be contrasted is connected to the cylinder by means of a flexible pipe.

Module levelling through adjustable feet.

PRACTICAL POSSIBILITIES

1.- Bourdon type manometer calibration.

2.- Hysteresis curve determination.

SPECIFICATIONS

Pressure manometer:

Bourdon type.

0 - 2.5 bar.

Masses (approximated weights):

0.5 kg.

1.0 kg.

2.5 kg.

5 kg.

Piston diameter: 18 mm.

Piston weight: 0.5 kg.

Anodized aluminum structure.

DIMENSIONS AND WEIGHT

Dimensions: 500 x 400 x 500 mm. approx.
(21.63 x 9.48 x 13.77 inches approx.)

Weight: 10 Kg. approx.
(11 pounds approx.)

REQUIRED SERVICES

It can work in autonomous way.

FME11. **Metacentric Height**

DESCRIPTION

The module consists of a floating methacrylate prismatic base, with a vertical mast placed on it. An adjustable mobile mass has been added to alter the position of the center of gravity.

A weight that can be horizontally and vertically displaced allows for modification of the floating base heel.

A plumb bob, attached to the upper part of the mast, is used to measure the angle of heel of the floating base with the aid of a graduated scale.

PRACTICAL POSSIBILITIES

1.- Study of the stability of a floating body. Angular displacements.

2.- Study of the stability of a floating body. Different positions of the center of gravity.

3.- Determination of the metacentric height.

SPECIFICATIONS

Maximum angle: +/- 13°.

Corresponding lineal dimension: +/- 90 mm.

Dimension of the float:

Length: 353 mm.

Width: 204 mm.

Total height: 475 mm.

DIMENSIONS AND WEIGHT

Dimensions: 750 x 400 x 750 mm. approx.
(21.63 x 9.48 x 13.77 inches approx.)

Weight: 5 Kg. approx.
(11 pounds approx.)

REQUIRED SERVICES

It can work in autonomous way.

Scale.

FME11-A. Metacentric Height of a "V" Shape Floating Body

DESCRIPTION

The module consists of a floating methacrylate body with a vertical mast placed on it. An adjustable mobile mass has been added to alter the position of the center of gravity.

The base of the floating body is V shaped, simulating one of the different frame cross-sections of a boat.

A weight that can be horizontally and vertically displaced allows for modification of the floating base heel.

A plumb bob, attached to the upper part of the mast, is used to measure the angle of heel of the floating base with the aid of a graduated scale.

PRACTICAL POSSIBILITIES

1.-Study of the stability of a floating body with V shaped base. Angular displacements.

2.-Study of the stability of a floating body with V shaped base. Different positions of the center of gravity.

3.-Determination of the metacentric height of a floating body with V shaped base.

SPECIFICATIONS

Floating body made of methacrylate with V shape base.

Maximum angle: +/- 13°.

Corresponding linear dimension: +/- 90 mm.

DIMENSIONS AND WEIGHT

Dimensions: 350 x 200 x 500 mm. approx.
(13.77 x 7.87 x 19.68 inches approx.)

Weight: 5 Kg. approx.
(11 pounds approx.)

REQUIRED SERVICES

- It can work autonomously.
- Scale.

FME11-B. Metacentric Height of a "U" shape floating body

DESCRIPTION

The module consists of a floating methacrylate body with a vertical mast placed on it. An adjustable mobile mass has been added to alter the position of the center of gravity.

The base of the floating body is U shaped, simulating one of the different frame cross-sections of a boat.

A weight that can be horizontally and vertically displaced allows for modification of the floating base heel.

A plumb bob, attached to the upper part of the mast, is used to measure the angle of heel of the floating base with the aid of a graduated scale.

PRACTICAL POSSIBILITIES

1.- Study of the stability of a floating body with U shaped base. Angular displacements.

2.- Study of the stability of a floating body with U shaped base. Different positions of the center of gravity.

3.- Determination of the metacentric height of a floating body with U shaped base.

SPECIFICATIONS

Floating body made of methacrylate with U shaped base.

Maximum angle: +/- 13°.

Corresponding linear dimension: +/- 90 mm.

DIMENSIONS AND WEIGHT

Dimensions: 350 x 200 x 500 mm. approx.
(13.77 x 7.87 x 19.68 inches approx.)

Weight: 5 Kg. approx.
(11 pounds approx.)

REQUIRED SERVICES

- It can work autonomously.
- Scale.

FME26. **Depression Measurement System** (vacuum gauge)

DESCRIPTION

Anodized aluminum structure that supports a vacuum gauge whose reading gives us the measurement.

Two quick connections at both sides of the vacuum gauge allow connecting reinforced flexible pipes.

PRACTICAL POSSIBILITIES

1.- To measure the depression caused for the fluid aspiration by an hydraulic pump.

2.- We can observe the different negative readings due to the different methods of fluid aspiration for its subsequent impulsion.

SPECIFICATIONS

Anodized aluminum structure.

Pressure-vacuum gauge adjusted from -1 to 0 bar.

Quick connections.

DIMENSIONS AND WEIGHT

Dimensions : 220 x 110 x 420 mm. approx.
(8.66 x 4.33 x 16.53 inches approx.)

Weight: 2 Kg. approx.
(4.4 pounds approx.)

REQUIRED SERVICES

Reinforced flexible pipes.

FME32. **Pitot Static Tube Module**

DESCRIPTION

With this unit the change in flow speed within a tube can be determined.

The Pitot static tube can be moved across the whole cross-section of the tube, and thus to measure the pressure profile.

This tube is connected to manometers via hoses.

The position of the measuring head relative to the bottom edge of the tube can be measured on a scale.

The water supply can come from the Hydraulics Bench (FME00) or from the Basic Hydraulic Feed System (FME00/B).

PRACTICAL POSSIBILITIES

1.- Study of the function of a pitot static tube.
2.- To use a pitot static tube.
3.- Determination of tube flow speed profiles.
4.- Demonstration that the flow speed is proportional to the pressure difference between the total pressure and the static pressure.
5.- Error determination in flow measurements using the Pitot tube as measurement instrument.
6.- Factor C_d determination in the Pitot tube.

SPECIFICATIONS

Pitot static tube:
  Head diameter: 2.5 mm.
Transparent pipe:
  32 mm. internal diameter and 430 mm. length approx.
Hose connections.
Water manometer, 500 mm. length.
Easy and quick coupling system built-in.
Anodized aluminum structure and panel of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 800 x 450 x 700 mm. approx.
(31.49 x 17.71 x 27.55 inches approx.)

Weight: 15 Kg. approx.
(33 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

FME03. **Bernoulli's Theorem Demonstration**

DESCRIPTION

Bernoulli's Theorem Demonstration module is mainly composed of a circular section conduit with shape of a truncated cone, transparent and with seven pressure taps to measure, simultaneously, the static pressure of each section.
All the pressure taps are connected to a manometer with a water collector (water might be pressurized).
The ends of the conduits are removable, enabling to be placed in either convergent or divergent form with respect to the stream direction.
There is also a probe (Pitot's tube) moving along the conduit for measuring the height in every section (dynamic pressure).
The flow rate and the pressure in the module can be modified by adjusting the control valve located at the end of the module.
A flexible hose attached to the outlet pipe is directed to the volumetric measuring tank.
For the operation, the module is placed on the Hydraulics Bench (FME00).
It has adjustable legs for levelling.
The inlet pipe ends in a female coupling which may be directly connected to the bench supply.

PRACTICAL POSSIBILITIES

1.- Determination of the exact section in Venturi's tube.
2.- Demonstration of Bernoulli's Theorem. Divergent-convergent position.
3.- Determination of Bernoulli's Theorem equation. Convergent-divergent position.
4.- Observation of differences between convergent and divergent position.

SPECIFICATIONS

Manometer range: 0 to 300 mm of water.
Number of manometer tubes: 8.
Upstream diameter of the throat: 25 mm.
Narrowing:
  Downstream: 21°.
  Upstream: 10°.
Easy and quick coupling system built-in.
Anodized aluminum structure and panel of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 800 x 450 x 700 mm. approx.
(31.49 x 17.71 x 27.55 inches approx.)
Weight: 15 Kg. approx.
(33 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME22. **Venturi, Bernoulli and Cavitation Unit**

DESCRIPTION

This module is designed for demonstrating some practical possibilities with the Venturi's tube. This Venturi is made of transparent methacrylate for a better visualization.
It consist of a circular transverse section Venturi tube with 6 taps (Divergent/Convergent). Being transparent, it gives a better visualization of the cavitation phenomenon.
It includes a manometer and a vacuum gauge, as well as 5 manometric tubes.

PRACTICAL POSSIBILITIES

1.- How to fill the manometric tubes.
2.- Flow calculation.
3.- Determination of the exact section in Venturi's tube. Bernoulli's theorem study.
4.- Cavitation study.
5.- Pressure reduction in a tank.
6.- Aspiration pump.
7.- Aspiration pump for mixing two liquids.
8.- Using for air and water mixing.

SPECIFICATIONS

Manometer (Bourdon type), range: 0-2.5 bar.
Manometer (Bourdon type), range: 0-(-1) bar.
2 Tanks, height: 135 mm and internal diameter: 64 mm.
Venturi tube with 6 tappings (Divergent/Convergent).
Differential manometers: 0-500 mm.
5 Manometric tubes.
Easy and quick coupling system built-in.
Anodized aluminum structure and panels of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 750 x 400 x 850 mm. approx.
(29.52 x 15.74 x 33.46 inches approx.)
Weight: 10 Kg. approx.
(22 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.
Vegetable Colouring (Fluorescein C20H12O5).

FME06. **Osborne-Reynolds' Demonstration**

DESCRIPTION

The module consists of a cylindrical tank endowed with a nozzle, that is fitted to a methacrylate pipe, which allows the fluid visualization.

A spillway guarantees the homogeneity of the flow and a needle fitted to the deposit provides the dye. Water is supplied by the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B).

The visualization of the laminar or turbulent regime can be carried out through the flow control valve.

PRACTICAL POSSIBILITIES

1.- Observation of the laminar, transition and turbulent regime.

2.- Study of the velocity profile, reproducing the Osborne-Reynolds's experiment.

3.- Reynold's number calculation.

SPECIFICATIONS

Tube inner diameter: 10 mm.

Tube outer diameter: 13 mm.

Visualization pipe length: 700 mm.

Capacity of the dye tank: 0.3 l.

Tank capacity: 10 l.

Flow control valve: diaphragm type.

The coloured fluid is regulated with a needle valve.

Easy and quick coupling system built-in.

Anodized aluminum structure and panels of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 450 x 450 x 1250 mm. approx.
(17.71 x 17.71 x 49.21 inches approx.)

Weight: 20 Kg. approx.
(44 pounds approx.)

REQUIRED SERVICES

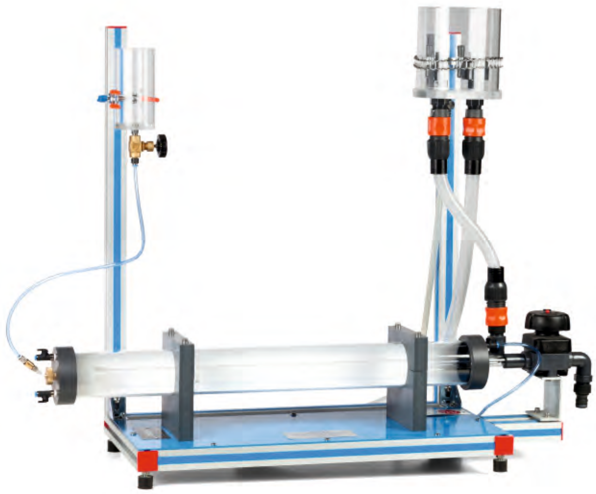
Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Thermometer.

Vegetable Colouring (Fluorescein C20H12O5).

Chronometer.

FME31. **Horizontal Osborne-Reynolds Demonstration**



DESCRIPTION

The Osborne-Reynolds experiment is used to study the characteristics of a liquid flow through a pipe. It is also used to determine the Reynolds number at each state of the liquid.

The FME31 module makes it possible to study the characteristics of the flow of a liquid inside a pipe and the behaviour of such flow. Besides, it is possible to determine the range of the laminar and turbulent flows using the Reynolds number. Thus, difference between laminar, turbulent and transition flows can be demonstrated and the Reynolds number can be calculated for each regime.

This module consists on a transparent and horizontal pipe section, which makes it possible to visualize the fluid, a water supply tank, which guarantees the flow homogeneity, and a needle connected to a tank through a hose, from where the dye is supplied. Water flow in the test section can be regulated by means of a valve. Water can be supplied either using the Hydraulics Bench (FME00) or from the Basic Hydraulic Feed System (FME00/B).

PRACTICAL POSSIBILITIES

1.- Observation of laminar, transition and turbulent flows.

2.- Association of laminar, transition and turbulent flows with their corresponding Reynolds number.

3.- Observation of the parabolic velocity profile.

SPECIFICATIONS

This module is mounted on an anodized aluminum structure with painted steel panel.

Methacrylate test pipe with an airfoil-shaped inlet section:

Inner diameter: 16 mm.

External diameter: 20 mm.

Length: 750 mm.

Water supply tank with level fitting and connection for its feeding. It has a section that makes it possible to generate a constant pressure at the tank inlet. Capacity: 2.4 l.

Dye or vegetable colouring tank with a valve and an injection needle, tank capacity: 0.4 l.

Colouring matter injection is regulated with a needle valve.

Control valve to adjust the water flow in the experiments.

Easy and quick coupling system built-in.

DIMENSIONS AND WEIGHT

Dimensions: 1100 x 400 x 700 mm. approx.
(17.71 x 17.71 x 49.21 inches approx.)

Weight: 20 Kg. approx.
(44 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Vegetable Colouring (Fluorescein $C_{20}H_{12}O_5$).

Chronometer.

Thermometer.

FME24. **Unit for the study of Porous Beds in Venturi Tubes (Darcy's Equation)**

Detail of the Venturi´s tubes with porous bed

DESCRIPTION

The module is formed by a circular section conduit with a truncated cone shape, transparent, and with pressure taps that allow measuring simultaneously the values of static pressure corresponding to any point of different sections.

It also has three another conduits, full of sand of different diameters of grain.

The conduit ends can be extracted, so they can be placed in a convergent or in a divergent way in regard to the flow direction.

There is a probe (Pitot's tube) that moves along the section in order to measure the height of each section (dynamic pressure).

The flow velocity in the module can be modified by adjusting the control valve and by using the Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

PRACTICAL POSSIBILITIES

1.- Demonstration of Bernoulli's theorem and its limitations in divergent - convergent position.
2.- Demonstration of Bernoulli's theorem and its limitations in convergent-divergent position.
3.- Direct measurement of the static height and of the total distribution of heights in Venturi's tubes.
4.- Determination of the exact section in a Venturi's tube.
5.- Head losses in the porous bed (elements FME24/A, FME24/B and FME24/C).

SPECIFICATIONS

Manometer range: 0-300 mm. of water.
Number of manometric tubes: 8.
Strangulation diameter upstream: 25 mm.
Narrowing:
 upstream: 10°.
 downstream: 21°.
Venturi's tube with Pitot tube.
Venturi's tube with porous bed of a grain diameter of 1.0 to 1.5 mm (FME24/A).
Venturi's tube with porous bed of a grain diameter of 2.5 to 3.5 mm (FME24/B).
Venturi's tube with porous bed of a grain diameter of 5.5 to 7.0 mm (FME24/C).
Easy and quick coupling system built-in.
Anodized aluminum structure and panels of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 800 x 450 x 700 mm. approx.
(31.49 x 17.71 x 27.55 inches approx.)
Weight: 15 Kg. approx.
(33 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME33. **Pascal's Module**

Detail of the 3 different vessels

DESCRIPTION

The FME33 module allows to demonstrate Pascal's principle, that is to say, that pressure in an incompressible fluid has no relation with the size of the column section, it only depends on its head (level of the liquid) and on the nature of the liquid. For that purpose, the unit consists of three vessels with the same diameter on their base but different shape, so that they can be compared.

It also allows to determine the hydrostatic pressure quantitatively and to study the linear relation between pressure and filling height.

This module is made up of a body with a diaphragm or membrane to which any of the three vessels can be attached. The membrane transfers the force to a lever arm that is balanced with masses and a spirit level.

A movable pointer adjustable in height located in a vertical rod allows to fix the height of the water in the vessels to the same level, so that the force or pressure is common for the three vessels regardless their shape.

PRACTICAL POSSIBILITIES

1.- Demonstration of Pascal's principle by comparing three vessels of different shape.
2.- Determining the hydrostatic pressure.
3.- Determining the linear relation between pressure and filling head of the vessel.

SPECIFICATIONS

Anodized aluminum profile frame and painted steel panel that guarantees good stability and resistance to the environment.
Three vessels of 230 mm high:
 Straight shaped vessel with internal diameter of 26 mm.
 Conical vessel with internal diameter from 26 mm. to 80 mm.
 Inverted conical vessel with internal diameter from 26 mm. to 10 mm.
Support for the vessel and membrane.
Lever arm and spirit level to measure the weight at the base of the vessel.
Fastening nut for levelling.
Masses set.
Vertical rod with portable indicator to fix the fluid level in the vessels.

DIMENSIONS AND WEIGHT

Dimensions: 550 x 350 x 500 mm. approx.
(21.63 x 13.77 x 19.68 inches approx.)
Weight: 7 Kg. approx.
(15 pounds approx.)

REQUIRED SERVICES

It can work in autonomous way.

FME09. **Flow Visualization in Channels**

DESCRIPTION

The module consists of a transparent methacrylate channel with an overflow pipe on top and an adjustable plate in the discharge end. This plate allows for regulating the flow level.

The water is supplied to the channel by the pulse mouth of the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B), by means of a flexible pipe, passes through a damping tank that eliminates the turbulences.

It has a colouring injection system consisting of a tank, a flow control valve and some needles that allow a better visualization of the flow around the different hydrodynamic models, which have to be placed in the middle of the channel.

Module levelling through adjustable feet .

Several hydrodynamic models are given to study the flow around them.

PRACTICAL POSSIBILITIES

1.- Leakage of liquids by thin-wall weirs.
2.- Liquid leakage by thick-wall weirs.
3.- Models with wing profile submerged in a fluid current.
4.- Circular models submerged in a fluid current.
5.- Demonstration of the phenomenon associated to the flow in open channels.
6.- Visualization of the flow lines around different submerged hydrodynamic models.

SPECIFICATIONS

Capacity of the dye tank: 0.3 l.
Width/length of the channel approx.: 15/630 mm.
Depth of channel approx.: 150 mm.
Damping tank that eliminates the turbulences.
Hydrodynamic models:
- Two lengthened.
- Two circular of 25 and 50 mm. diameter.
- Rectangle with rounded edges.
- Wedge.

Easy and quick coupling system built-in.
Anodized aluminum structure.

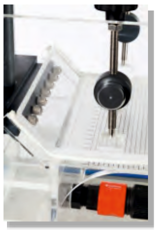
DIMENSIONS AND WEIGHT

Dimensions: 900 x 450 x 500 mm. approx.
(35.43 x 17.71 x 19.68 inches approx.)
Weight: 7 Kg. approx.
(15.43 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Vegetable Colouring (Fluorescein $C_{20}H_{12}O_5$).
Chronometer.

FME20. **Laminar Flow Demonstration**



Detail of the hydrodynamic models

DESCRIPTION

This module allows a complete study of the bi-dimensional problems associated with laminar flow. Thanks to an efficient system of dye injection we can observe the different models of flow. It consists on an enlargement of the device of Hele-Shaw.

Water is supplied to the accessory from the driving mouth of the Hydraulics Bench (FME00) or from the Basic Hydraulic Feed System (FME00/B), by a flexible pipe. Then, water passes through a damping deposit that eliminates the turbulence.

It has a dye injection system, which consists of a deposit, a flow control valve and some needles that allow for a better visualization of the flow around the different hydrodynamic models, placed in the central part of the channel.

The module can be levelled with the adjustable legs.

PRACTICAL POSSIBILITIES

1.- Ideal flow around a submerged cylinder.
2.- Ideal flow around a submerged profile.
3.- Ideal flow around a body in peak.
4.- Ideal flow in a convergent channel.
5.- Ideal flow in a divergent channel.
6.- Ideal flow in an elbow of 90°.
7.- Ideal flow in a sudden contraction.
8.- Ideal flow in a sudden broadening.
9.- Substitution of a line of current for a solid edge.

SPECIFICATIONS

Capacity of dye tank: 0.3 l.
Width/length of the table: 400/210 mm.
Depth of the table: adjustable depending on the models.
Hydrodynamic models:
- Two circular ones of 25 and 50 mm. diameter.
- Two rectangular ones of 25 x 25 and 50 x 50 mm.
- Wedge.

Easy and quick coupling system built-in.
Anodized aluminum structure.

DIMENSIONS AND WEIGHT

Dimensions: 870 x 450 x 400 mm. approx.
(34.25 x 17.71 x 15.74 inches approx.)
Weight: 10 Kg. approx.
(22 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Vegetable Colouring (Fluorescein $C_{20}H_{12}O_5$).
Chronometer.

FME30. **Vortex Flow Meter**

DESCRIPTION

The design of the FME30 module makes it possible to study different methods of volumetric and mass flow measurement, as well as to compare continuous and intermittent methods.

This module includes two continuous and two intermittent methods to carry out the experiments. The continuous methods include a vortex flowmeter and a variable-area flowmeter (or rotameter). A series of oscillating vortices, where the oscillating frequency is proportional to the flow rate, are generated in the vortex flowmeter. Dye or colouring is used to visualize such vortices.

Intermittent methods include the measurement of volumetric and mass flows. A precision scale is used to measure the mass flow and compare the measurements.

The water supply may be provided either from the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B).

PRACTICAL POSSIBILITIES

1.- Study and experiments with a vortex flow meter.
2.- Study and experiments with a variable area flow meter.
3.- Measurement of volumetric volume flow rate.
4.- Measurement of gravimetric volume flow rate.
5.- Comparison of methods on several volumetric and mass flow measurements.
6.- Flow meters calibration.
7.- Comparison among different flowmeters.

SPECIFICATIONS

Structure of anodized aluminum and panels of painted steel.
PVC pipe to connect to a water supply of the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B).
Needle valve to control the flow at the pipe inlet.
Vortex flow meter with flow oscillation made visible by dye injection.
Variable-area flow meter (rotameter), range: 150-1600 l./min.
Two regulating ball valves to control the flow in the vortex and variable-area flow meters.
Water tank at a constant height and connection for its drainage, capacity: 2.4 l.
Dye or colouring tank with control valve, capacity: 0.4 l.
A control ball valve to regulate the flow at the pipe's outlet.
Quick connection system.
A digital precision balance, range: 0-2000 gr., graduated at 1 gr.
Graduated glass vessel with a capacity of 2 l.
Easy and quick coupling system built-in.

DIMENSIONS AND WEIGHT

Dimensions: 900 x 570 x 900 mm. approx.
(35.43 x 22.44 x 35.43 inches approx.)
Weight: 30 Kg. approx.
(66.13 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Vegetable colouring (Fluorescein $C_{20}H_{12}O_5$).
Chronometer.

FME15. **Water Hammer**

DESCRIPTION

The module is designed to demonstrate the effects of instantaneous or gradual velocity variation in a fluid.

As a consequence of a quick change in the velocity of a fluid, the Water Hammer phenomenon can be studied.

PRACTICAL POSSIBILITIES

1.- Subduing of the water hammer effects.
2.- Study of the subduing depending on the diameter of the chimney.
3.- Calculations of the energy losses in pipes.

SPECIFICATIONS

Constant level deposit, in methacrylate.

Unload deposit, in methacrylate.

Pipe circuits in PVC.

Valves to select the circuit.

2 adjustable equilibrium chimneys and subjection clips.

Connections system to the Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B) with fast plugs.

Easy and quick coupling system built-in.

Anodized aluminum structure.

DIMENSIONS AND WEIGHT

Dimensions: 1215 x 270 x 1430 mm. approx.
(47.83 x 10.62 x 53.29 inches approx.)

Weight: 15 Kg. approx.
(33 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Chronometer.

FME19. **Cavitation Phenomenon Demonstration**

DESCRIPTION

The module consists of a rectangular transversal section Venturi-pipe, with transparent wall for a better observation of the Cavitation Phenomenon.

It includes a manometer and a vacuum meter that are respectively connected to the inlet section and to the reduction throat section.

The existing pressure in the Venturi sections is transmitted by thin capillary tubes placed at the back of the frame.

PRACTICAL POSSIBILITIES

1.- Study of cavitation.

2.- Visualization of the cavitation phenomenon with forced conduction.

SPECIFICATIONS

Manometer range: 0 to 2.5 bar.

Vacuum gauge range: from-1 to 0 bar.

Throat section: 36 mm^2.

Normal section: 150 mm^2.

Easy and quick coupling system built-in.

Anodized aluminum structure and panel of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 750 x 400 x 650 mm. approx.
(29.52 x 15.74 x 25.59 inches approx.)

Weight: 5 Kg. approx.
(11 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FM00) or Basic Hydraulic Feed System (FME00/B).

Chronometer.

FME18. **Flow Meter Demonstration**

DESCRIPTION

The module consists of a Venturi meter, a flowmeter and an orifice plate, installed in a series configuration to permit a direct comparison.
Several pressure taps are connected to a panel of eight tubes.
The flow control valve allows the variation of the flow rate through the circuit, and its adjustment, along with the bench control valve, allows for varying the system static pressure.
The pressure taps of the circuit are connected to an eight-bank manometer, which incorporates an air inlet valve at the top manifold which facilitates the connection to the hand pump.
This enables to adjust the levels in the manometer bank to a convenient level to suit the system static pressure.

PRACTICAL POSSIBILITIES

1.- Filling of the manometric tubes.
2.- Determination of the error in flow measurements using the Venturi.
3.- Determination of the C_d factor in the Venturi.
4.- Determination of the strangulation in the Venturi.
5.- Determination of the error in flow measurements using the orifice plate.
6.- Determination of the C_d factor in the orifice plate.
7.- Determination of the effective area in an orifice plate.
8.- Comparison of the energy loss in the three different elements.
9.- Comparison among the Venturi, the orifice plate and the flowmeter.

SPECIFICATIONS

Manometer range: 0 to 500 mm. of water column.
Number of manometric tubes: 8.
Orifice plate diameter: 25 mm.
Flowmeter: 2 to 30 l./min.
Venturi dimensions:
- Throat diameter: 20 mm.
- Upstream pipe diameter: 32 mm.
- Downstream taper: 21°.
- Upstream taper: 14°.

Orifice Plate dimensions:
- Upstream pipe diameter: 35 mm.
- Downstream orifice diameter: 19 mm.

Easy and quick coupling system built-in.
Anodized aluminum structure and panel of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 750 x 450 x 950 mm. approx.
(29.52 x 17.71 x 37.40 inches approx.)
Weight: 10 Kg. approx.
(22 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME25. **Flow Channel, 1m. length**

DESCRIPTION

This module has been designed for studying the behaviour of water flowing through a one-meter channel.

It basically consists of a channel of rectangular cross section with transparent walls, through which water flows.

It has a mechanism that allows to vary the shape of the channel and it can directly be placed on the Hydraulics Bench.

Water is taken from the tank of the Hydraulics Bench (FME00) or the Hydraulic Feed System (FME00/B) by means of a pump and, through the pipe, it is driven to the tank, where there is a settling of the flow. After this, the water circulates through the channel and returns to the storage tank. Therefore, the closed circuit is completed.

There is a mechanism that allows to adjust the slope of the channel.

PRACTICAL POSSIBILITIES

1.- Study of the fundamental aspects of fluid flow.

Practical possibilities depending on the accessories used:

2.- Measurement of water level and velocity along the channel.

3.- Measurement of flow rate using a Pitot tube.

4.- Determination of the static and total pressure.

5.- Use of hydraulic structures to control level.

6.- Study of the effects of gradual and sudden changes in cross section (energy losses).

7.- Use of a contraction to measure flow.

8.- Use of hydraulic structures to measure flow in an open channel.

9.- Study of flow patterns associated with flow around hydraulic structures.

10.- Comparison between the theoretical and experimental flow.

SPECIFICATIONS

Channel of rectangular section with transparent walls in methacrylate, length: 1 m.

Rigid and flexible pipes.

Regulating valves.

Storage tank.

Tank with soothing of flow.

Easy and quick coupling system built-in.

Anodized aluminum structure.

Wide range of available accessories.

DIMENSIONS AND WEIGHT

Dimensions: 1500 x 500 x 500 mm. approx.
(59.04 x 19.68 x 19.68 inches approx.)

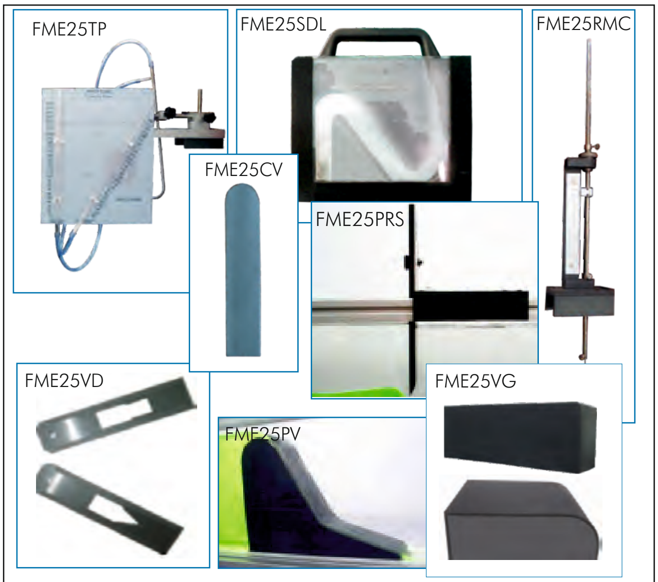
Weight: 40 Kg. approx.
(88 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Chronometer.

Accessories for the Flow Channel, 1m. length (FME25)



FME25TP. **Pitot tube.**

Pitot tube with a panel (with two manometric tubes) that is introduced in the channel to measure pressures and obtain the speed and flow rates at different points of the channel.

The FME25TP accessory consists of a Pitot tube mounted on a movable XYZ stand, which can move all the length and breadth of the flow channel, and a panel with two manometric tubes to measure static and total pressure. The difference between both pressures allows us to calculate the speed of the fluid and, knowing the section, the flow can be calculated at any point.

Practical possibilities:

1.-Measurement of the flow rate with a Pitot tube.

2.-Determination of the static and total pressure.

3.-Filling of manometric tubes.

FME25CV. **Vertical flat gate.**

The FME25CV accessory is a vertical flat gate made of PVC that is located at the outlet of the channel to avoid the flow of fluid.

FME25SDL. **Syphon spillway.**

One way to regulate the flow in a channel is by using a syphon. When the level exceeds a specific height, water flows through the syphon and the level is regulated upstream of the syphon.

The FME25SDL accessory can be fixed to any part of the channel.

Practical possibilities:

1.-Understanding the operation of a syphon with free discharge.

2.-Calculation of the maximum flow admitted by the syphon.

3.-Level control through a syphon with free discharge.

FME25SDS. **Self-regulating syphon.**

One way to regulate the flow in a channel is by using a syphon. When the level exceeds a specific height, water flows through the syphon and the level is regulated upstream of the syphon.

The FME25SDS accessory can be fixed to any part of the channel.

Practical possibilities:

1.-Understanding the operation of a syphon with submerged discharge.

2.-Calculation of the maximum flow admitted by the syphon.

3.-Level control through a syphon with submerged discharge.

continue...

Accessories for the Flow Channel, 1m. length (FME25)

FME25RM. **Scale to measure the water level (limnimeter).**
The limnimeter is used to measure the water level in the flow channel.
The instrument consists of several feeler tips that can move along a graduated scale from 0 to 500 mm. to obtain the level.
The scale is divided into tenth parts of a millimeter (adjustable Vernier scale).
Main metallic elements are made of stainless steel and this device can move along the whole channel.
Practical possibilities:
1.-Use of a limnimeter.
2.-Measuring the water level in the flow channel.

FME25PR. **Adjustable undershot weir.**
One way to regulate the flow in a channel is by using control gates. When the gate is totally closed, no water flows, and when the gate is open, water starts to flow through the channel.
The FME25PR accessory consists of a PVC gate mounted on a frame that can be displaced along the channel.
This system allows the gate to be fixed to the desired height and to measure that height. It has flexible lateral reinforcements that guarantee watertightness.
Practical possibilities:
1.-Flow control with gates.
2.-Observation of discharge processes when using a weir.
3.-Observation of alternating changes during the discharge.

FME25VD. **Sharp crested discharge weirs** (two different models).
Sharp crested weirs are hydraulic weirs, generally used to measure flow rates. Their name is due to the fact that the discharge is done through a plate whose profile, regardless of its shape, ends in a sharp edge.
The FME25VD accessory includes 2 weirs (a V shaped and a U shaped one) made of PVC lodged in slots, reinforced with flexible rubber, designed for that purpose at the outlet of the channel, guaranteeing watertightness.
Practical possibilities:
1.-Comparison between the main types of weirs.
2.-Measurement of the flow rate with a triangular sharp-crested weir (V shaped).
3.-Measurement of the flow rate with a rectangular sharp-crested weir (U shaped).
4.-Comparison between the theoretical and experimental flows.

FME25VG. **Broad-crested weirs** (two different models).
Broad crested weirs have a lower discharge capacity for the same volume of water than sharp crested weirs. They are most frequently used as level control structures, although they can also be calibrated and used as flow measurement structures.
The FME25VG accessory includes two broad crested weirs, made of PVC, which can be fixed to any part of the bottom of the channel. The edge of one of the weirs is rounded and the edge of the other one is straight. Both weirs have flexible lateral reinforcements that guarantee watertightness.
Practical possibilities:
1.-Measurement of the flow rate with a broad crested weir.
2.-Comparison between the theoretical and experimental flows.

FME25PV. **Ogee-crested weir.**
The Ogee weir is a fixed weir, that is to say, it does not allow regulation of the water surface profile.
They are used to divert flow rates since, if it is compared to other types of weirs, the special shape of their crest enables the maximum discharge for the same water level.
It is made of PVC, can be fixed to any part of the bottom of the channel and has flexible lateral reinforcements that guarantee watertightness.
Practical possibilities:
1.-Measurement of the flow rate with an Ogee-crested weir.
2.-Comparison between the theoretical and experimental flows.

FME17. **Orifice and Free Jet Flow**

DESCRIPTION

The module consists of a cylindrical methacrylate tank that enables to maintain a constant level and that is fed by the Hydraulics Bench (FME00) or by the Basic Hydraulic Feed System (FME00/B).

Two nozzles with orifices of different diameters are provided. They are placed in the base of the tank, and can easily be interchanged.

The trajectory of the jet can be drawn by following the position of some vertical needles placed in the annexed panel. These are adjusted by means of some command screws.

This panel includes a silk-screen scale that enables to measure the profile of the jet.

Adjustable feet permit levelling.

PRACTICAL POSSIBILITIES

1.- Determination of the orifice velocity coefficient.
2.- Obtaining of the orifice discharge coefficient in permanent regime.
3.- Obtaining of the orifice discharge coefficient in variable regime.
4.- Obtaining of the tank discharge time.

SPECIFICATIONS

Orifices with diameters of 3.5 and 6 mm.

Jet trajectory Probes: 8.

Maximum height: 500 mm.

Easy and quick coupling system built-in.

Anodized aluminum structure.

DIMENSIONS AND WEIGHT

Dimensions: 600 x 550 x 1400 mm. approx.
(23.62 x 21.65 x 55.11 inches approx.)

Weight: 10 Kg. approx.
(22 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Chronometer.

FME05. **Energy Losses in Bends**

DESCRIPTION

This module can work with the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B).
This module consists of a hydraulic circuit with a set of elements that disrupt the normal flow of the fluid that circulates by the pipe, due to sudden section and direction variations, as well as friction.
These elements are:

- Two 90° elbows, a short one and a middle one.
- A 90° curve or long elbow.
- A broadening.
- A sudden narrowing section.
- A sudden direction change, miter type.

The module has two manometers, Bourdon type: 0 - 2.5 bar and twelve manometric pipes of pressurized water. The system pressurization is carried out with a manual air pump.
The hydraulic circuit has pressure tappings along the whole system, which enable to measure the local load losses in the system.
This module has two membrane valves, a valve which enables the regulation of the outlet flow, and a valve placed in series with the rest of accessories of the hydraulic circuit.

PRACTICAL POSSIBILITIES

1.- Filling of the manometric tubes.
2.- Measurement of the flow.
3.- Measurement of load losses for a short elbow of 90°.
4.- Measurement of load losses for a medium elbow of 90°.
5.- Measurement of load losses for a curve of 90°.
6.- Measurement of load losses for a broadening of 25/40.
7.- Measurement of load losses for a narrowing 40/25.
8.- Measurement of load losses for a miter type abrupt direction change.
9.- Measurement of load losses for a membrane valve.

SPECIFICATIONS

Range of the two Bourdon type manometers: 0 to 2.5 bar.
Differential manometers range: 0 to 500 mm.
Number of manometric tubes: 12.
PVC Rigid pipes:
- Internal diameter: 25 mm.
- External diameter: 32 mm.

Flexible pipes:
- Pressure taking-differential manometer. External diameter: 10 mm.
- Pressurizing equipment. External diameter: 6 mm.
- Drain. External diameter: 25 mm.

Fittings:
- Miter (90° angle).
- 90° curve.
- 90° medium elbow.
- 90° short elbow.
- 90° long elbow.
- Broadening of 25/40.
- Narrowing of 40/25.

Valves:
- Membrane valves. Diameter: 25 mm.
- Antireturn: 6 mm.

Easy and quick coupling system built-in.
Anodized aluminum structure and panel of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 750 x 550 x 950 mm. approx. (29.52 x 21.65 x 37.40 inches approx.)
Weight: 10 Kg. approx. (22 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME07. **Energy Losses in Pipes**

DESCRIPTION

The module consists of the following elements, used in combination with the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B):

- Pipe with quick connector to be coupled to the water outlet's mouthpiece at the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B).
- 6 mm external/4 mm inner diameter metallic test pipe.
- One water column differential manometer.
- Constant height tank.
- Two Bourdon type manometers.

PRACTICAL POSSIBILITIES

1.- Energy loss in pipes for a turbulent regime.
2.- Determination of the energy loss in a turbulent regime.
3.- Determination of the number of Reynolds for a turbulent regime.
4.- Energy loss in pipes for a laminar regimen.
5.- Determination of the energy loss factor f for a pipe in laminar regime.
6.- Determination of Reynolds number for the laminar regime.
7.- Determination of the kinematic viscosity of water.

SPECIFICATIONS

Test pipe of 4 mm. of inner diameter, 6 mm. of external diameter and 500 mm. of length.
1 differential manometer of water column.
Manometer scale: 0 to 500 mm (water).
2 Bourdon type manometers, range: 0 to 2 bar.
Constant height tank.
Easy and quick coupling system built-in.
Anodized aluminum structure and panels of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 330 x 330 x 900 mm. approx.
(12.99 x 21.65 x 35.43 inches approx.)
Weight: 30 Kg. approx.
(66 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Thermometer.
Chronometer.

FME23. **Basic Pipe Network Unit**

DESCRIPTION

This pipe network module is designed for the study of pressures and flows created by interconnected pipes, i.e. in a network.

The objective of this module is to simulate the problems that could originate in pipe networks, with pipes of different lengths and diameters, as often happens in cities.

With this study, the distribution and arrangement of the networks will be understood, in order to obtain the necessary flows and pressures in them.

The module is formed by a pipe network, valves, their connection systems, water manometers and anodized aluminum structure where the pipes network is located and the subjection panel of the manometers.

PRACTICAL POSSIBILITIES

1.- Load loss in a PVC pipe.
2.- Load loss in a methacrylate pipe.
3.- Study of the load loss in pipes made of the same material.
4.- Study of the load loss depending on the material.
5.- Friction coefficient in a PVC pipe.
6.- Friction coefficient in a methacrylate pipe.
7.- Study of the friction coefficient depending on the material.
8.- Study of the friction coefficient depending on the diameter.
9.- Configuration of network in parallel for pipes of the same material but different diameter.
10.- Configuration of network in parallel for pipes of the same diameter but different material.

SPECIFICATIONS

Anodized aluminum structure where the pipe network is located and the subjection panel of the manometers.

Test pipes:

Three PVC pipes, with different diameters.

One methacrylate pipe.

8 Pressure intakes, connected to a manometric tubes panel of pressurized water.

Pressurization system.

Manometric tubes panel:

Number of manometric tubes: 8.

Range: 0 to 470 mm of water.

Inlet pipe. Outlet pipe.

Regulation valves for controlling the flow through the network.

Adjustable legs for leveling the unit.

Easy and quick coupling system built-in.

DIMENSIONS AND WEIGHT

Dimensions: 600 x 350 x 800 mm. approx.
(23.62 x 13.77 x 31.49 inches approx.)

Weight: 30 Kg. approx.
(66 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Chronometer.

AFT/P. **Fluid Friction in Pipes Unit**

DESCRIPTION

The Fluid Friction in Pipes Unit (AFT/P) is designed to determine the friction coefficient in pipes, to study the pressure losses in different types of valves and different fittings and to compare different methods to measure the flow.

This unit contains five straight pipe sections made of different materials and with different diameters and roughness. Additionally, a wide range of accessories are included for the study of losses in straight pipes, several types of valves, pipe fitting, etc.

The different pipe sections, valves and pipe fittings include several pressure measurement points with quick action connections.

The unit includes two water manometric tubes, two Bourdon manometers and a flowmeter.

PRACTICAL POSSIBILITIES

1.- Determination of pressure loss due to friction in pipes made of different materials and with different diameters and roughness.
2.- Study of the influence of the diameter in the pressure loss due to friction in rough and smooth pipes.
3.- Study of the influence of the roughness on the pressure loss.
4.- Determination of the friction coefficient in pipes with different diameters and roughness.
5.- Study of the influence of the diameter on the friction coefficient in rough and smooth pipes.
6.- Comparison of the friction coefficient in smooth and rough pipes.
7.- Determination and comparison of pressure loss in different types of valves (angle-seat valve, gate valve, diaphragm valve, ball valve).
8.- Determination and comparison of pressure loss in different fittings (in-line strainer, elbows, narrowing, gradual widening, etc.).
9.- Measurement of the flow with the Venturi tube and the Pitot tube.
10.- Determination and comparison of the discharge coefficient determined in the Venturi tube and the Pitot tube.

SPECIFICATIONS

5 Pipes of different internal diameter, roughness and materials.

4 Different types of valves (angle-seat, gate, diaphragm and ball).

10 Different types of couplings (in-line strainer, elbows, sudden widening, sudden contraction, etc.).

3 Special couplings: Pitot tube, Venturi tube and diaphragm with measuring plate.

34 Pressure tappings with quick action connections.

Two water manometers, range: 0-1000 mm.

Two Bourdon manometers, range: 0 - 2.5 bar

One flowmeter, range: 600-6000 l./h.

DIMENSIONS AND WEIGHT

Dimensions: 2300 x 850 x 1100 mm. approx.
(90.55 x 33.46 x 43.30 inches approx.)

Weight: 100 Kg. approx.
(220 pounds approx.)

REQUIRED SERVICES

It can work in autonomous way, or with Hydraulics Bench (FM00) or Basic Hydraulic Feed System (FME00/B).

For information in detail see **AFT/P** catalogue. Click on the following link:
http://www.edibon.com/en/files/equipment/AFT-P/catalog

FME12. **Series/Parallel Pumps**

DESCRIPTION

The module consists of a pump of similar characteristics to the one in the Hydraulics Bench (FME00) or the Basic Hydraulic Feed System (FME00/B).

This module has three Bourdon-type manometers: two of manometric pressure and one of absolute pressure. The absolute pressure manometer has been placed at the pump input; the other two at the discharge and at the discharge accessory supplied with the module.

The accessory has a flow-regulating valve. Moreover, for the parallel connection, a Y-shape accessory is supplied with two ball-valves. This accessory is connected to both pumps and to the discharge device.

The module includes an easy connection system for the installation of pumps in series and in parallel.

PRACTICAL POSSIBILITIES

1.- Water flow calculation.
2.- H (Q) curve obtaining of a centrifugal pump.
3.- Series coupling of two pumps with the same characteristics.
4.- Parallel coupling of two pumps with the same characteristics.

SPECIFICATIONS

Centrifugal pump: 0.37 KW, 30 - 80 l./min. at 20.1 - 12.8 m., single-phase, 220V/50 Hz or 110V/60 Hz.

Absolute pressure manometer placed at the pump input, range - 1 to 3 bar.

2 Manometers (manometric pressure), one of them placed in the discharge and the another one in the discharge accessory, range: 0 - 4 bar.

Membrane valve for flow regulating.

Two way valve: 2 positions: open or close.

Accessories:

Two flexible pipes with quick connections.

Reinforced pipe with quick connections.

Discharge accessory.

Easy and quick coupling system built-in.

Anodized aluminum structure and panels of painted steel.

DIMENSIONS AND WEIGHT

Dimensions of the FME12 module: 500 x 400 x 400 mm. approx. (19.68 x 15.74 x 15.74 inches approx.)

Dimension of the discharge accessory: 500 x 400 x 250 mm. approx. (19.68 x 15.74 x 9.84 inches approx.)

Weight: 20 Kg. approx. (44 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Electrical supply: single-phase 220V/50 Hz or 110V/ 60Hz.

Chronometer.

FME13. **Centrifugal Pumps Characteristics**

DESCRIPTION

The module has a centrifugal pump with similar characteristics to the one in the Hydraulics Bench (FME00) and the Basic Hydraulic Feed System (FME00/B). It is armed with two Bourdon-type pressure manometers placed at the pump's inlet and outlet. There is another one in the discharge accessory supplied with the module.

The pump is driven by a three-phase asynchronous motor whose speed can be varied by a speed variator.

The module has visualization display that allows to know the r.p.m. and the power consumed.

It is included a discharge accessory, with manometer, flow control valve and diffuser.

The variator's control panel allows to vary the pump speed and the start.

PRACTICAL POSSIBILITIES

1.- Obtaining of the curves H (Q), N (Q), Eff% (Q) of a centrifugal pump.
2.- Making of the map of a centrifugal pump.
3.- Representation of the adimensional curves H*, N* and rpm*.
4.- Series coupling of two pumps of similar characteristics.
5.- Series coupling of two pumps of different characteristics.
6.- Parallel coupling of two pumps of similar characteristics.
7.- Parallel coupling of two pumps of different characteristics.

SPECIFICATIONS

Centrifugal pump: 0.37 KW, 30 - 80 l./min. at 20.1 - 12.8 m. with speed variator.

Bourdon type manometers.

Control panel for the variator, allowing to modify the speed, with visualization display that allows to know the r.p.m. and the power consumed, and with on/off switch.

Discharge accessory, with manometer, flow control valve and diffuser.

Vacuum meter.

Easy and quick coupling system built-in.

Anodized aluminum structure and panels of painted steel.

DIMENSIONS AND WEIGHT

Dimensions: 450 x 500 x 1250 mm. approx.
(17.71 x 19.68 x 49.21 inches approx.)

Weight: 40 Kg. approx.
(88 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

Electrical supply: single-phase, 220V/50 Hz or 110V/60 Hz.

Chronometer.

FME27. **Axial Flow Turbine**

DESCRIPTION

This module consists of an Axial Turbine, in miniature, with 8 inclined nozzles at 20° and 30° degrees with respect to the perpendicular direction at the rotating axis.
The pallets of the turbine runner are clearly visible through the transparent tank.
A band brake connected to one load cell varying the load given to the turbine by means of a connection device.

PRACTICAL POSSIBILITIES

1.- Flow calculation.
2.- Determination of the discharge coefficient of the nozzle.
3.- Determination of the curve N (Q,n), P_m(Q, n) and η (Q, n); (20° nozzle).
4.- Determination of the curve N (Q,n), P_m(Q, n) and η (Q, n); (30° nozzle).
5.- Adimensional analysis.

SPECIFICATIONS

Nozzle:
- Inlet diameter of the throat: 2.5 mm.
- Outlet diameter of the throat: 2.5 mm.
- Discharge angle: 20° and 30°.

Turbine rotor:
- External diameter: 53 mm.
- Internal diameter: 45 mm.
- Number of blades: 40.
- Inlet angle of the blades: 40°.
- Outlet angle of the blades: 40°.
- Used material: Brass.

Brake:
- Pulley diameter: 60 mm.
- Real diameter: 50 mm.

Bourdon type manometer.
8 ball valves.
Easy and quick coupling system built-in.
Anodized aluminum structure.
Tachometer.

DIMENSIONS AND WEIGHT

Dimensions: 550 x 300 x 600 mm. approx.
(21.65 x 11.81 x 23.62 inches approx.)
Weight: 20 Kg. approx.
(44 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME16. **Pelton Turbine**

DESCRIPTION

This module comprises a miniature Pelton's Turbine with a retractable needle valve that allows to adjust the flow.

The Pelton's Turbine runner is clearly visible through the transparent cover of the turbine.

A manometer placed at the inlet of the turbine enables to measure the inlet pressure at that point (water discharge pressure).

A band brake, connected to two dynamometers allows varying the load supplied to the turbine by means of a connection device.

The turbine axis velocity is determined by an optic tachometer.

PRACTICAL POSSIBILITIES

1.- Determination of the operative characteristics of the Pelton Turbine.
2.- Determination of the operation mechanical curves.
3.- Determination of the operation hydraulic curves.
4.- Adimensionalization.

SPECIFICATIONS

Speed range: 0 - 2000 r.p.m.
Power: 10 W.
Manometer range: 0 - 2.5 bar.
Number of buckets: 16.
Drum radius: 30 mm.
Dynamometers range: 0 - 20 N.
Easy and quick coupling system built-in.
Anodized aluminum structure.
Tachometer.

DIMENSIONS AND WEIGHT

Dimensions: 750 x 400 x 750 mm. approx.
(29.52 x 15.74 x 29.52 inches approx.)
Weight: 15 Kg. approx.
(33 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME28. **Francis Turbine**

Detail of
the turbine

DESCRIPTION

This unit consists on a miniature Francis turbine. The water inlet flow is controlled by a valve situated in the Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

It includes a distributor with adjustable guide vanes that allow for control of the water angle of incidence in the turbine. To adjust the turbine distributor, the unit has a lever on the front of the same. It also has a braking system, connected to two dynamometers, that allows to vary the load supplied to the turbine. It is provided with a draft tube that consists of a conduction that joins the turbine with the outlet channel; its objective is to recover the maximum amount of water kinetic energy when it gets out of the turbine.

The inlet pressure of the turbine is measured with a manometer situated at the turbine inlet. The feed or spiral chamber is provided with a damping cover and two tubes to avoid water overflow. Its name indicates that it is spiral-shaped and for this reason it is known as snail chamber. Thanks to its design, the water flows at a constant velocity without forming swirls. This way, there are no load losses. The turbine's axis velocity is determined by a tachometer.

PRACTICAL POSSIBILITIES

1.- To determine the operating characteristics of a Francis turbine at different velocities.
2.- Determination of the typical turbine curves (operating mechanical curves and operating hydraulic curves).
3.- Turbine power output versus speed and flow rate at various heads.
4.- Effect of guide vane setting on turbine performance.
5.- Adimensionalization.

SPECIFICATIONS

Functional model of Francis turbine.
Velocity range: 0-1000 r.p.m. Power: 5 W.
Diameter of the turbine: 52 mm.
Number of blades on the turbine: 15.
Number of adjustable guide vanes of the distributor: 10.
Manometer range: 0-250 mbar.
Braking system connected to 2 dynamometers:
    Dynamometers range: 0-10 N.
Feed chamber.
Easy and quick coupling system built-in.
Anodized aluminum structure.
Tachometer.

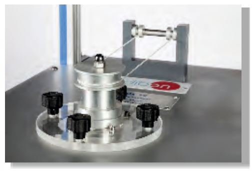
DIMENSIONS AND WEIGHT

Dimensions: 500 x 350 x 600 mm. approx.
(19.68 x 13.77 x 23.62 inches approx.)
Weight: 20 Kg. approx.
(44 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME29. **Kaplan Turbine**



Detail of
the turbine

DESCRIPTION

This unit consists on a miniature Kaplan turbine. The water inlet flow is controlled by a valve situated in the Hydraulic Bench (FME00) or Basic Hydraulic Feed System (FME00/B).

It includes a distributor with adjustable guide vanes that allow for control of the water flow in the turbine. It has a braking system, connected to two dynamometers, that allows to vary the load supplied to the turbine. The feed or spiral chamber is provided with a damping cover and two tubes to avoid water overflow; its name indicates that it is spiral-shaped and for this reason it is known as snail chamber. Thanks to its design, the water flows at a constant velocity without forming swirls; this way, there are no load losses.

It is also provided with a draft tube that consists of a connection that joins the turbine with the outlet channel; its objective is to recover the maximum amount of water kinetic energy when it gets out of the turbine. The inlet pressure of the turbine is measured with a U-manometer situated at the turbine inlet. The turbine's axis velocity is determined by a tachometer.

PRACTICAL POSSIBILITIES

1.- Determination of the operative characteristics of Kaplan Turbine at different velocities.
2.- Flow calculation.
3.- Determination of the operation mechanical curves.
4.- Determination of the operation hydraulic curves.
5.- Adimensional analysis.

SPECIFICATIONS

Functional model of Kaplan Turbine.
Velocity range: 0-1000 r.p.m. Power: 10 W.
Number of blades of the turbine: 4.
Turbine diameter: 52 mm.
Number of adjustable guide vanes of the distributor: 8.
Manometer range: 0-200 mm. of water.
Braking system connected to 2 dynamometers:
    Dynamometers range: 0-10 N.
Feed chamber.
Draft tube.
Easy and quick coupling system built-in.
Anodized aluminum structure.
Tachometer.

DIMENSIONS AND WEIGHT

Dimensions: 500 x 350 x 600 mm. approx.
(19.68 x 13.77 x 23.62 inches approx.)
Weight: 20 Kg. approx.
(44 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

FME21. **Radial Flow Turbine**

DESCRIPTION

This module consist of a miniature Radial Turbine with two nozzles at 180° degrees with respect to the perpendicular direction at the rotating axis. A Bourdon type manometer is placed at the inlet nozzle.

A band brake connected to a dynamometer allows to control the load given to the turbine.

A tachometer determines the velocity measurement.

PRACTICAL POSSIBILITIES

1.- Flow calculation.
2.- Obtaining of the M (n, H_o), N(n, H_o), η (n, H_o) curves.
3.- Obtaining of the M (n, Q), Nm (n, Q), η (n, Q) curves.
4.- Adimensionalization.

SPECIFICATIONS

Nozzles:
- Inlet diameter: 21 mm.
- Outlet diameter: 2.0 mm.
- Discharge angle: 180°.

Turbine rotor:
- External diameter: 69 mm.
- Internal diameter: 40 mm.
- Number of nozzles: 2.
- Inlet angle to the nozzle: 180°.
- Outlet angle to the nozzle: 180.°
- Used material: aluminum.

Brake:
- Pulley diameter:60 mm.
- Effective diameter: 50 mm.

Easy and quick coupling system built-in.
Anodized aluminum structure.
Tachometer.

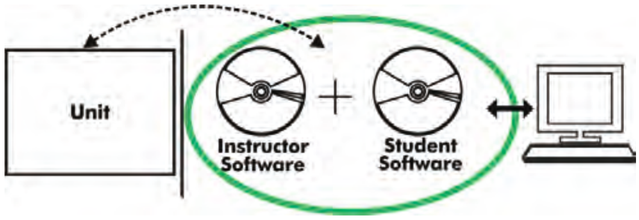
DIMENSIONS AND WEIGHT

Dimensions: 800 x 500 x 600 mm. approx.
(31.49 x 19.68 x 23.62 inches approx.)
Weight: 50 Kg. approx.
(110 pounds approx.)

REQUIRED SERVICES

Hydraulics Bench (FME00) or Basic Hydraulic Feed System (FME00/B).
Chronometer.

③ ICAI. Interactive Computer Aided Instruction Software System



With no physical connection between unit and computer (PC), **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.

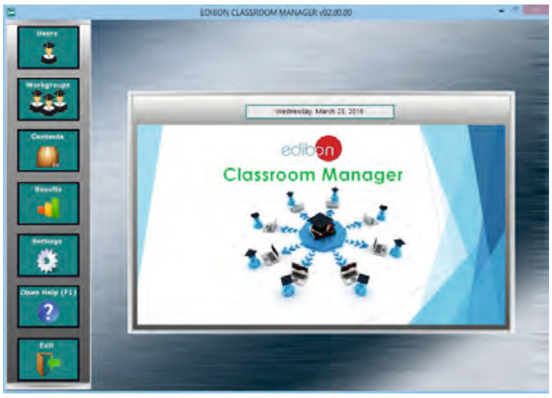
Instructor Software

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

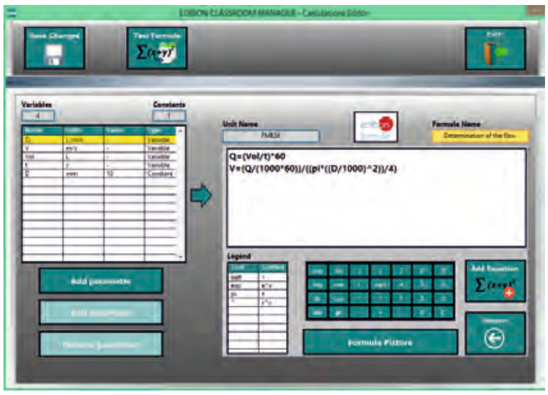
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual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

Innovative features:

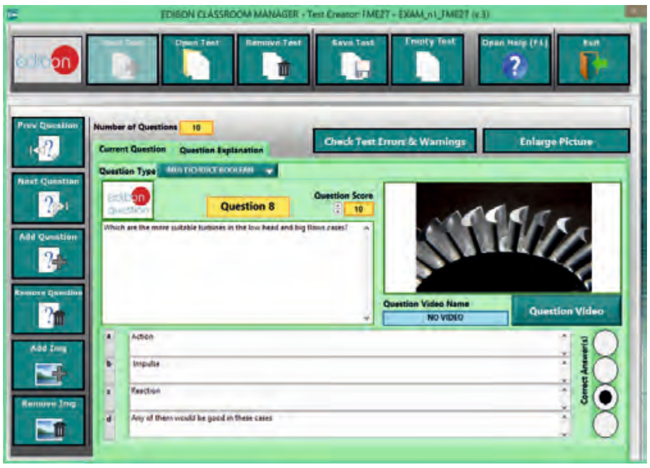
- **User Data Base Management.**
- **Administration and assignment of Workgroups, Tasks and Training sessions.**
- **Creation and Integration of Practical Exercises and Multimedia Resources.**
- **Custom Design of Evaluation Methods.**
- **Creation and assignment of Formulas & Equations.**
- **Equation System Solver Engine.**
- **Updatable Contents.**
- **Report generation, User Progression Monitoring and Statistics.**



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



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



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

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

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

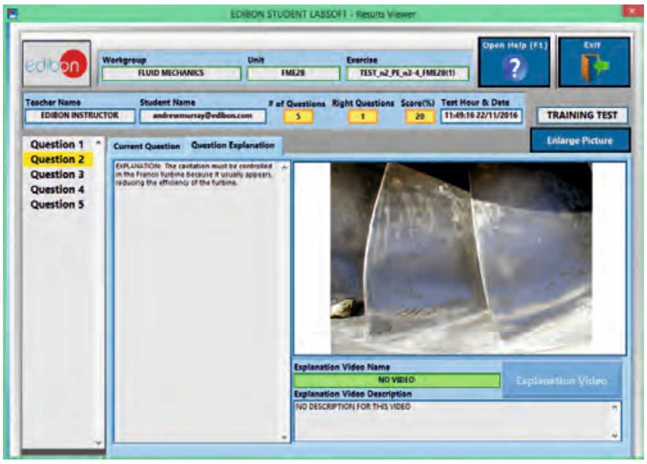
ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are 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:

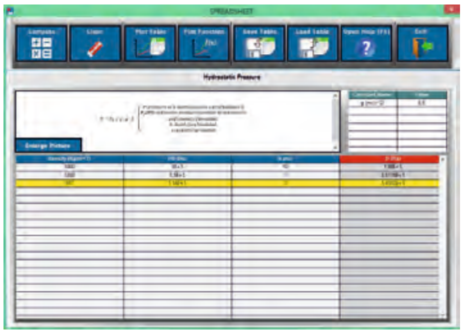
- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge and progression.**
- **Test self-correction.**
- **Calculations computing and plotting.**
- **Equation System Solver Engine.**
- **User Monitoring Learning & Printable Reports.**
- **Multimedia-Supported auxiliary resources.**

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

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

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

Available Student/Module Softwares:

➤ Fluid Concepts

- -ESL-FME02-SOF. EDIBON Student LabSoft for Flow over Weirs.
- -ESL-FME04-SOF. EDIBON Student LabSoft for Orifice Discharge.
- -ESL-FME14-SOF. EDIBON Student LabSoft for Free and Forced Vortex.
- -ESL-FME34-SOF. EDIBON Student LabSoft for Fluid Statics and Manometry.
- -ESL-FME35-SOF. EDIBON Student LabSoft for Fluid Properties.
- -ESL-FME36-SOF. EDIBON Student LabSoft for Rotameter.

➤ General Fluid Applications

- -ESL-FME01-SOF. EDIBON Student LabSoft for Impact of a Jet.
- -ESL-FME08-SOF. EDIBON Student LabSoft for Hydrostatic Pressure.
- -ESL-FME10-SOF. EDIBON Student LabSoft for Dead Weight Calibrator.
- -ESL-FME11-SOF. EDIBON Student LabSoft for Metacentric Height.
- -ESL-FME11-A-SOF. EDIBON Student LabSoft for Metacentric Height of a "V" Shape Floating Body.
- -ESL-FME11-B-SOF. EDIBON Student LabSoft for Metacentric Height of a "U" Shape Floating Body.
- -ESL-FME26-SOF. EDIBON Student LabSoft for Depression Measurement System (vacuum gauge).
- -ESL-FME32-SOF. EDIBON Student LabSoft for Pitot Static Tube Module.

➤ Hydraulic Laws

- -ESL-FME03-SOF. EDIBON Student LabSoft for Bernoulli's Theorem Demonstration.
- -ESL-FME22-SOF. EDIBON Student LabSoft for Venturi, Bernoulli and Cavitation Unit.
- -ESL-FME06-SOF. EDIBON Student LabSoft for Osborne-Reynolds' Demonstration.
- -ESL-FME31-SOF. EDIBON Student LabSoft for Horizontal Osborne-Reynolds Demonstration.
- -ESL-FME24-SOF. EDIBON Student LabSoft for Unit for the study of Porous Beds in Venturi Tubes (Darcy's Equation).
- -ESL-FME33-SOF. EDIBON Student LabSoft for Pascal's Module.

➤ Hydraulic Demonstration

- -ESL-FME09-SOF. EDIBON Student LabSoft for Flow Visualization in Channels.
- -ESL-FME20-SOF. EDIBON Student LabSoft for Laminar Flow Demonstration.
- -ESL-FME30-SOF. EDIBON Student LabSoft for Vortex Flow Meter.
- -ESL-FME15-SOF. EDIBON Student LabSoft for Water Hammer.
- -ESL-FME19-SOF. EDIBON Student LabSoft for Cavitation Phenomenon Demonstration.
- -ESL-FME18-SOF. EDIBON Student LabSoft for Flow Meter Demonstration.
- -ESL-FME25-SOF. EDIBON Student LabSoft for Flow Channel, 1m. length.
- -ESL-FME17-SOF. EDIBON Student LabSoft for Orifice and Free Jet Flow.

➤ Pipes

- -ESL-FME05-SOF. EDIBON Student LabSoft for Energy Losses in Bends.
- -ESL-FME07-SOF. EDIBON Student LabSoft for Energy Losses in Pipes.
- -ESL-FME23-SOF. EDIBON Student LabSoft for Basic Pipe Network Unit.
- -ESL-AFT/P-SOF. EDIBON Student LabSoft for Fluid Friction in Pipes Unit.

➤ Hydraulic Machines: Pumps

- -ESL-FME12-SOF. EDIBON Student LabSoft for Series/Parallel Pumps.
- -ESL-FME13-SOF. EDIBON Student LabSoft for Centrifugal Pumps Characteristics.

➤ Hydraulic Machines: Turbines

- -ESL-FME27-SOF. EDIBON Student LabSoft for Axial Flow Turbine.
- -ESL-FME16-SOF. EDIBON Student LabSoft for Pelton Turbine.
- -ESL-FME28-SOF. EDIBON Student LabSoft for Francis Turbine.
- -ESL-FME29-SOF. EDIBON Student LabSoft for Kaplan Turbine.
- -ESL-FME21-SOF. EDIBON Student LabSoft for Radial Flow Turbine.

④ BDAS. Basic Data Acquisition System and Sensors

For being used with modules type “FME”.

BDAS is designed to monitor the measurements of each module type “FME” from a computer (PC).

This system can monitor any module, checking the revolutions given by the water pump or the torque, differential pressures for Bernoulli theorems, pressure measurements, flow measurements, etc.

It consist of:

BDAS/BFA:

Base Module:

Anodized aluminum frame and panel made of painted steel.

Main elements made of stainless steel.

This unit has wheels to facilitate its mobility.

Sensors (only the sensors that correspond according to the purchased module/s will be included):

2 Pressure sensors, range: 0-100 PSI (0-7 bars).

2 Differential pressure sensors: they measure displacement through two manometers with a range of up to 1 meter, scale: 0.1 mm.

Flow sensor for high working flows, range: 5-150 l./min.

Flow sensor for low working flows, range: 1.5-30 l./min.

Piezoresistive force sensor. It measures from 0 Kg to 1.5 Kg and converts the value into Newton.

Force sensor to calculate the braking torque of turbines. It measures from 0 Kg to 2 Kg and converts the value into Newton.

Optical speed sensor to measure the speed of turbines.

Measurements of the speed and torque of the pumps.

Base Module

Data Acquisition System:

Data Acquisition Electronic Box, with connectors for the different sensors.

PCI Express data acquisition board (National Instruments) that is lodged in a slot of the computer. PCI Express bus.

Data acquisition software.

This system enables:

To represent the system responses curves in real time.

To record all the measurement values and results in a file.

To plot the characteristic curves.

To calibrate the sensors that take part in the process.

Data Acquisition Electronic Box

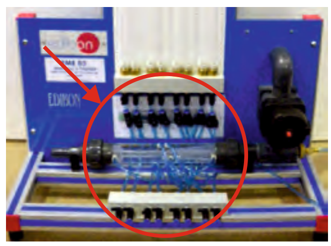
BDAS/BFI. Specific Accessories for each module type “FME”:

These accessories are used to adapt each module in order to operate them and connect them to the Base Module (BDAS/BFA) easily.

Examples:

FME03/BDAS-BFI: manifold with pressure takings to connect the FME03 module to the Base Module (BDAS/BFA).

FME08/BDAS-BFI: device that supports the force exerted by water, which is measured with the force sensor.



FME03/BDAS-BFI

FME08/BDAS-BFI

Dimensions and weights (approx.):

BDAS/BFA:

-Base Module: Dimensions: 300 x 550 x 1200 mm. approx. Weight: 10 Kg. approx.

-Data Acquisition Electronic Box: Dimensions: 490 x 330 x 310 mm. approx. Weight: 10 Kg. approx.

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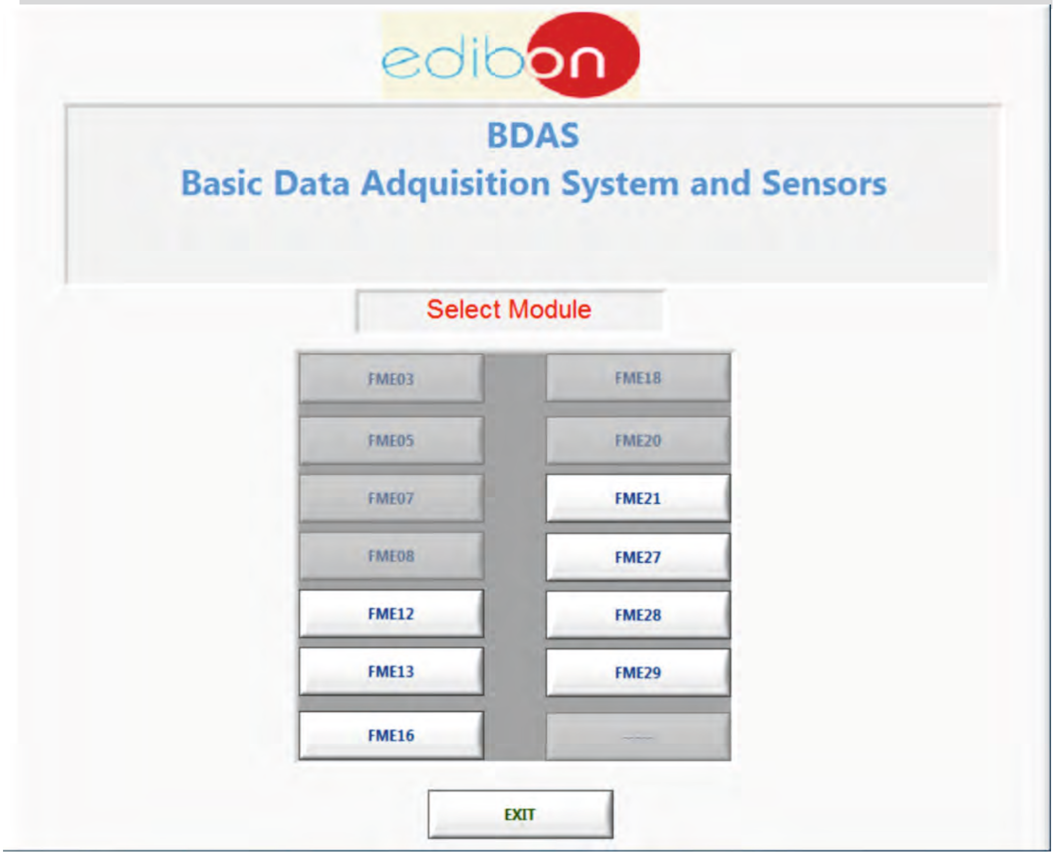
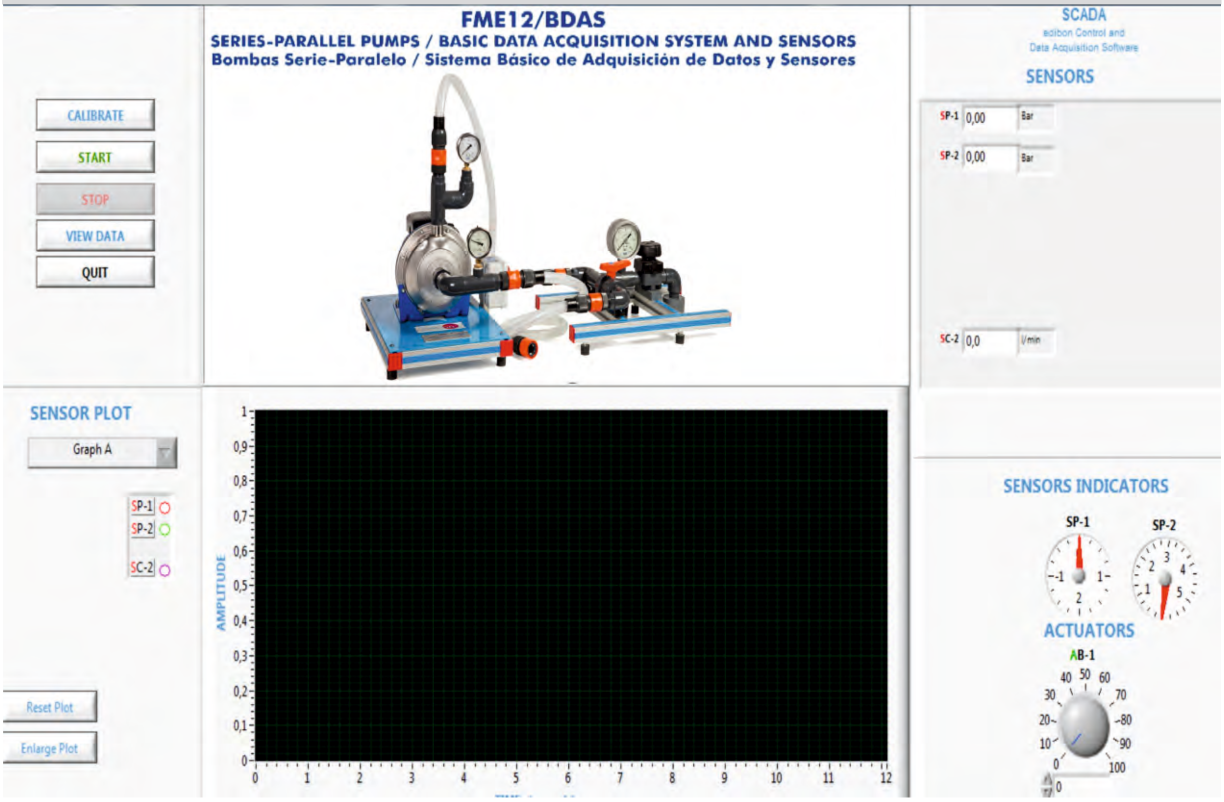
Some Software screens

Main Screen. Selection of the module to work with.



Data acquisition from the FME12 module. It allows to be operated either in parallel or in series and to visualize in the software the inlet and outlet pressures and the flow impelled by the pumps.



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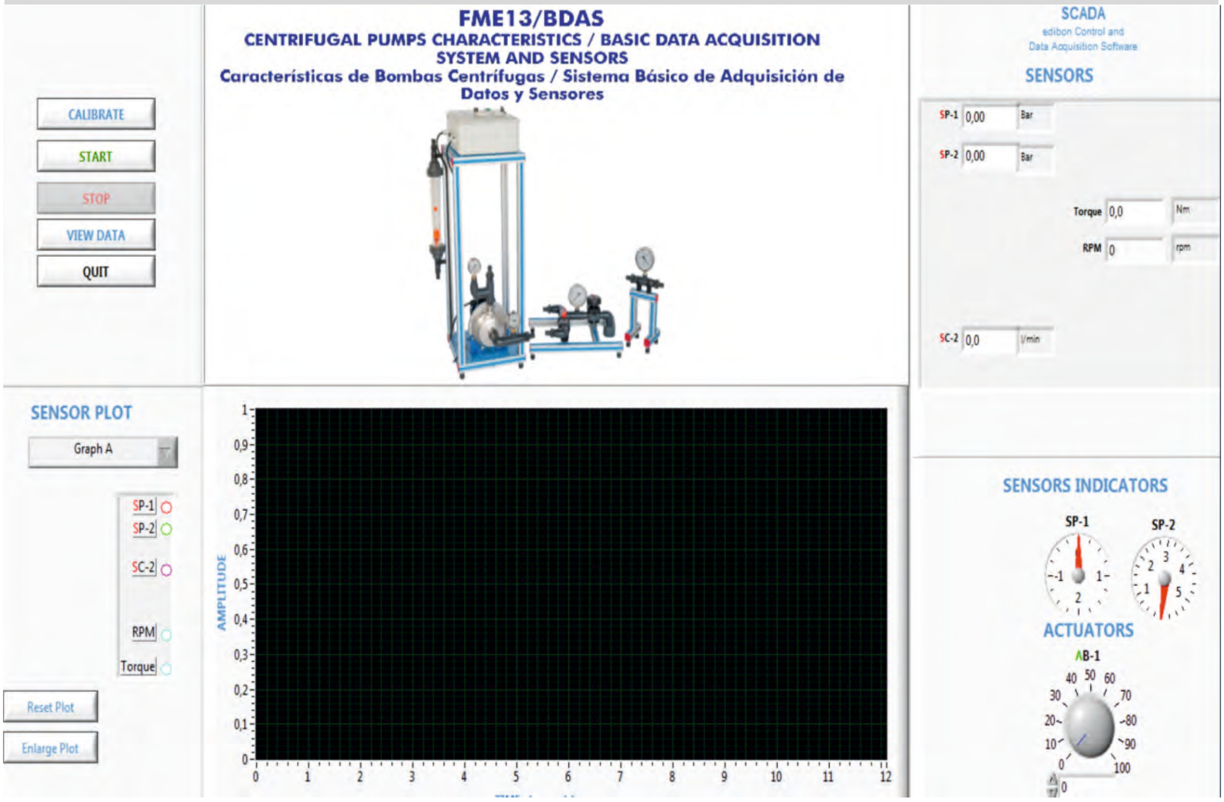
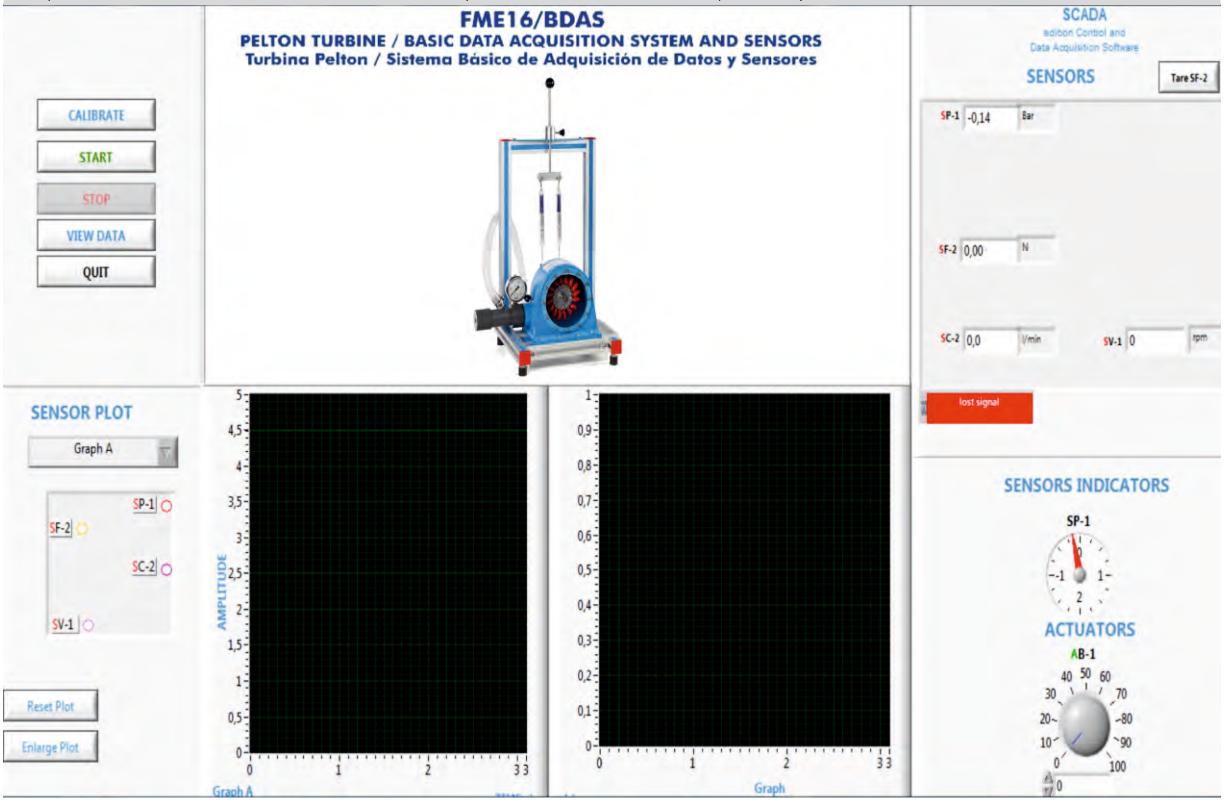
Data acquisition from the FME13 module. Inlet and outlet pressures are measured to study the centrifugal pump, the flow rate impelled by the pump and the revolutions and torque generated by the pump motor to move the water (liters per minute).



Data acquisition from the FME16 module. This module consists of a Pelton turbine. To study this type of turbine the braking torque, the revolutions of the turbine and the pressure and flow rate impelled by the turbine are measured.



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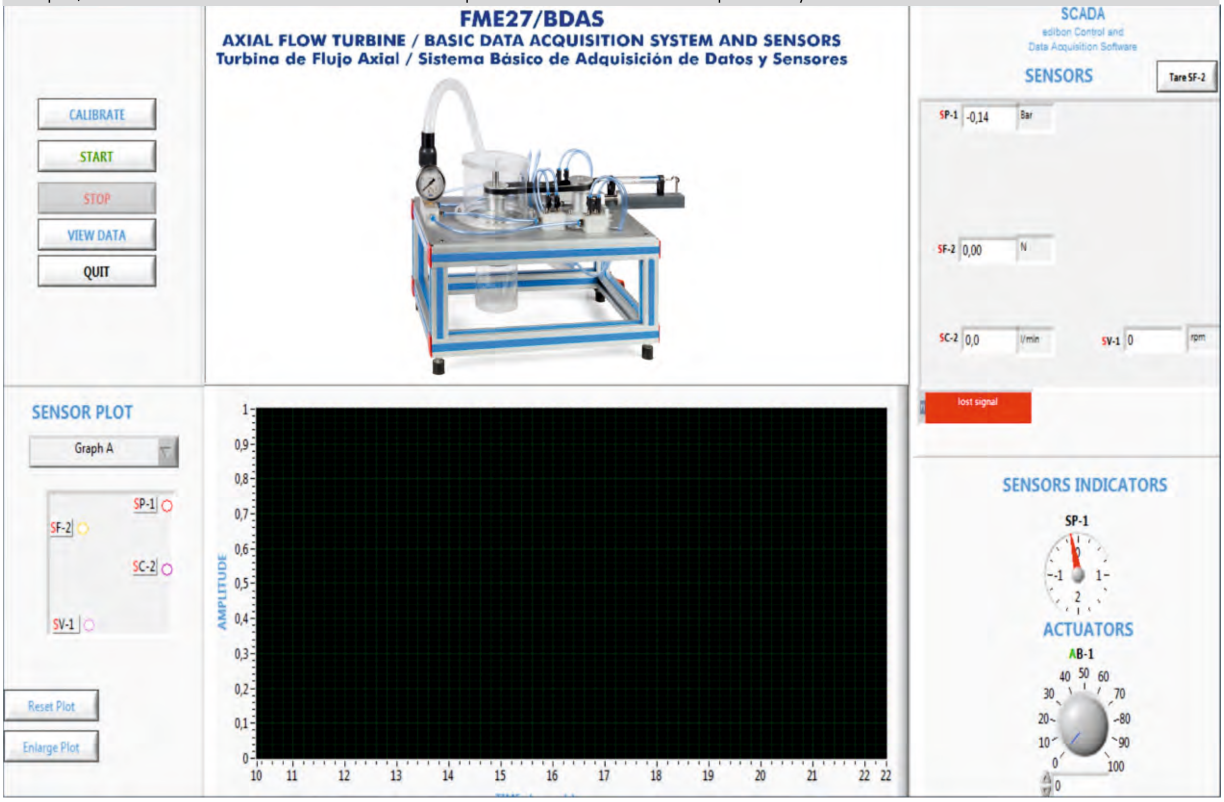
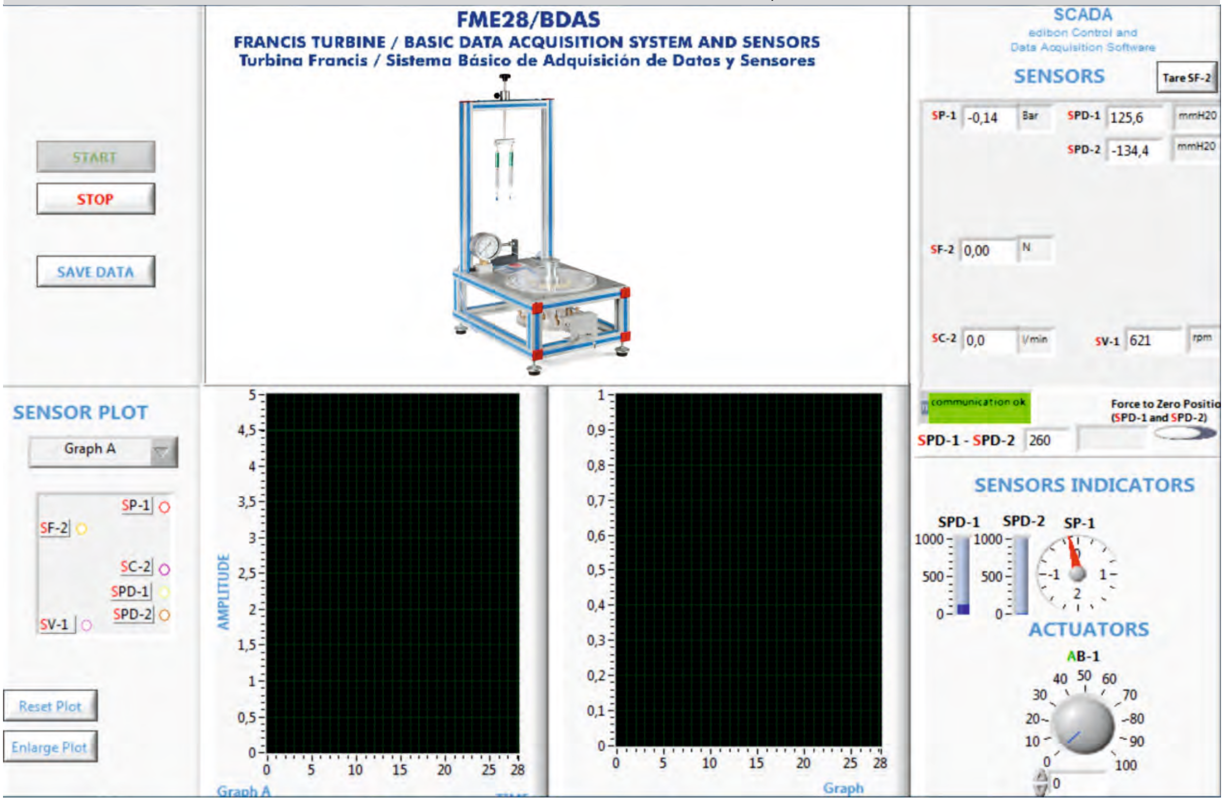
Data acquisition from the FME27 module. This module consists of an axial turbine. To study this type of turbine the braking torque, the revolutions of the turbine and the pressure and flow rate impelled by the turbine are measured.



Data acquisition from the FME28 module. This module consists of a Francis turbine. To study this type of turbine the braking torque, the revolutions of the turbine and the pressure (both low and high pressures can be measured) and flow rate impelled by the turbine are measured. To measure the revolutions of the turbine, since it is performed from an optical meter, the software indicates when a correct communication to measure the velocity is established.



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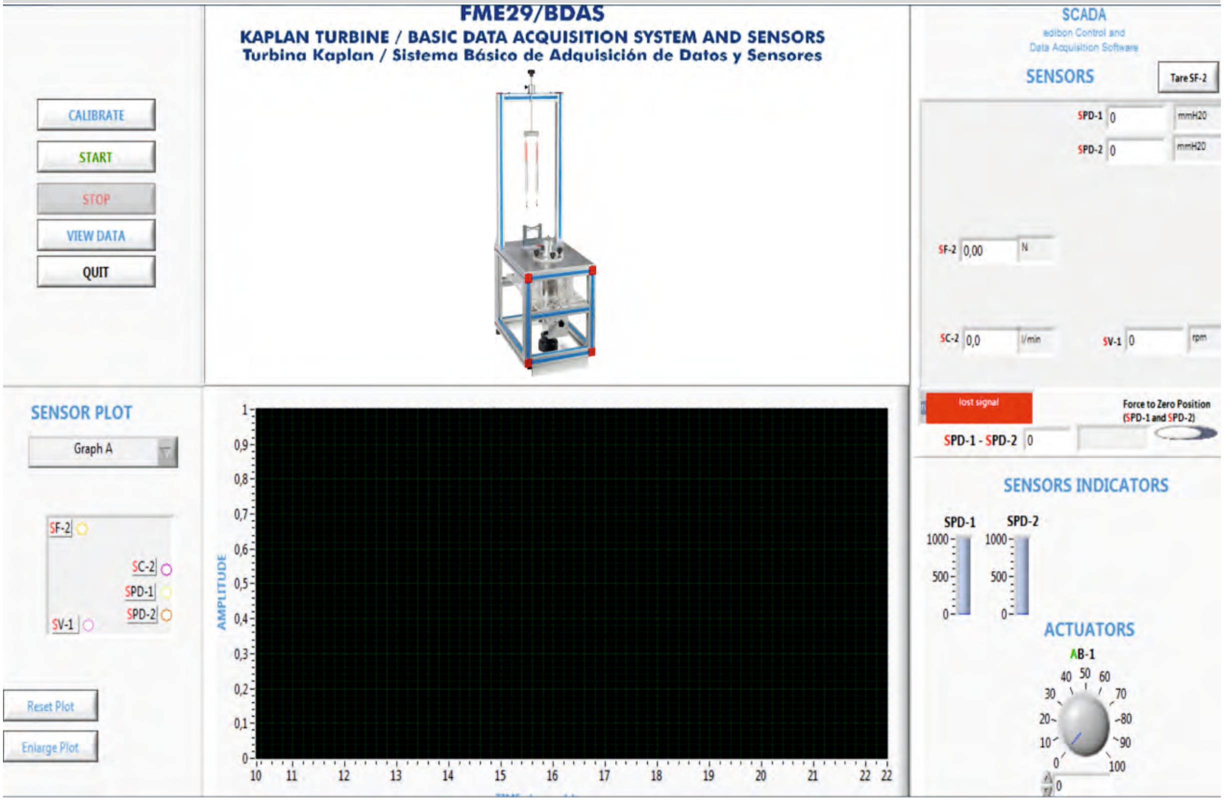
Data acquisition from the FME29 module. This module consists of a Kaplan turbine. To study this type of turbine the braking torque, the revolutions of the turbine and the pressure and flow rate impelled by the turbine are measured. The outlet pressure is measured with the differential pressure sensors.



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

INTERNATIONAL

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REPRESENTATIVE: