Sediment Transport Demonstration Channel

Engineering and Technical Teaching Equipment

CAS

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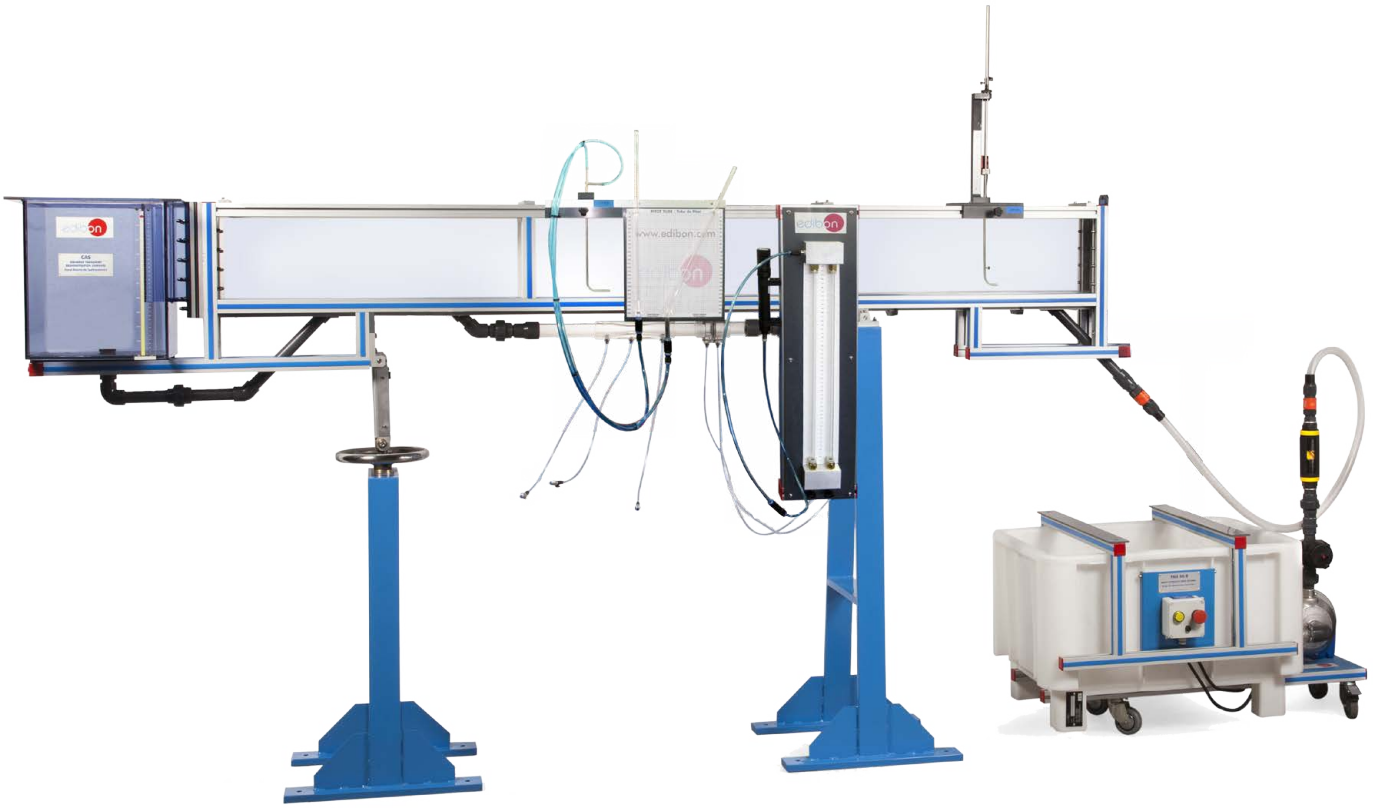
↳PRODUCTS
↳8.- FLUID MECHANICS AND 13.-ENVIRONMENT



INTRODUCTION

Fluvial geomorphology is the branch of geomorphology that has as its fundamental objective the explanation of the relationships between physical processes of flow in moving bed channels, the mechanics of flow-forced sediment transport, and the alluvial channel forms created by sediment transport.

The transport of bottom or stream-driven deposits is often the fundamental factor influencing flow behavior.

The Sediment Transport Demonstration Channel, "CAS", allows demonstration of the full range of bedforms that arise in a mobile bed as the slope and / or flow are increased.

This unit can play a useful role in any course concerting the mechanics of open channel flow and sediment transport.

GENERAL DESCRIPTION

The Sediment Transport Demonstration Channel, "CAS", designed by EDIBON, consist of an inclinable channel mounted on a base plate, supported by two supports, with a discharge tank and recirculating pump. This tank is in the Basic Hydraulic Feed System (FME00/B) that contains the recirculating pump.

The channel sides are transparent allowing the observation of bed profile changes, and a section of one side is provided with graphical grid markings to permit quantitative assessments to be made of bedform dynamics.

A water level gauge is included to measure the head over the channel discharge weir and therefore to deduce flow rates from a calibration chart. For demonstrating scour effects of structures on rivers beds, solids models, as an adjustable undershot weir and bridge pier are supplied.

To start a demonstration, sand is placed along the channel bed, between the inlet tank and the overfall discharge weir. Water is circulated around the system at one of the flow rates. The slope of the channel is adjustable.

SPECIFICATIONS

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

Transparent, inclinable flow channel through which water can be recirculated by a pump over a mobile bed to demonstrate the whole range of bed forms from incipient particle movement to bed wash out.

Channel of rectangular section with transparent walls.

Channel section: 80 mm, lenght: 2.5 m.

The channel is assembled on two supports, with a system to control the inclination of the channel.

The unit is self-contained and it can be installed with easiness, and it has a complete range of profiles.

Inlet tank with stilling of flow and with drain valve, capacity: 38 l.

Pipes.

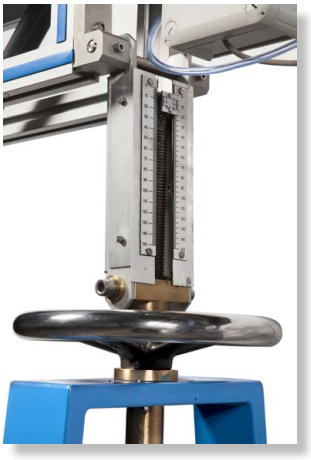
Diaphragm flow meter.

Sediment filter in tank and inlet section.

Manometric tubes panel formed by two methacrylate tubes of 500 mm of length, with a graduated panel.

Hand pump.

The grain diameter of the sediment oscillates among 0.1 – 0.3 mm.



CAS detail

Included elements:

- FME00/B. Basic Hydraulic Feed System.
- CFRM. Level Gauge for Measurement of the Water Height (Hook and Point Gauge).
- CFDA. Sand Distributor.
- CFPR. Adjustable Undershot Weir.
- CFPS. Single Bridge Pier.
- CFCV. Vertical Flat Weir.

Cables and accessories, for normal operation.

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

Additional recommended elements (Not included):

- CFTP. Pitot Tube with Tubes Manometer Board.
- CFVDG. Broad and Thin Crested Weirs.
- CFCVR. Vertical Flat Gate and Radial Gate.
- CFSDL. Syphon Spillway.
- CFPVP. Dams Spillway and Flow Splitters.
- CFCA. Culvert Fitting.
- CFVC. Crump Weir.
- CFVEN. Venturi Flume.
- CFSDS. Air Regulated Syphon.
- CFFS. False Floor Sections.
- CFPLR. Artificial Roughened Bed.
- CFFD. Flow Divider.
- CFAS. Sediment Feeder.
- CFDI. Digital Inclinometer.

Included elements

FME00/B. Basic Hydraulic Feed System

The FME00/B is a service unit:

- Anodized aluminum frame and panels made of painted steel.
- The unit includes wheels to facilitate its mobility.
- Centrifugal pump: 0.37 KW, 30 – 80 l/min at 20.1 – 12.8 m, - single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Stainless steel impeller.
- Tank capacity:140 l approx.
- Flowmeter.
- Membrane type flow adjusting valve.
- Safety switch ON/OFF.
- Supports for accommodating the test module.

CFRM. Level Gauge for Measurement of the Water Height (Hook and Point Gauge)

In many cases it is decisive in hydraulics to know the discharge depth. The ruler to measure the height is used to measure the water level in the fluids channel.

The "CFRM" accessory is an instrument formed by a probe tip in contact with water and the level is directly read in a graduated scale.

Its length is enough to enable the measurement of any water level in the channel and its main elements are made of stainless steel.

The accessory is mounted on a mobile support, which can be displayed up and down the length and width of the fluids channel.

CFDA. Sand Distributor

The "CFDA" accessory consists of a plate that serves as a sand distributor along the channel.

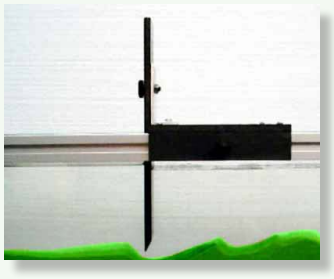
It has flexible lateral reinforcements to ensure watertightness.

CFPR. Adjustable Undershot Weir

One way to regulate the flow in a channel is by using control floodgates. When the floodgate is totally closed, the flow of water is blocked, and when it is open, water flows underneath and starts a flow circulating through the channel.

The "CFPR" accessory consists of a PVC floodgate mounted on a frame that can be displaced along the whole fluids channel. The floodgate can be fixed at the desired height, allowing for measuring that height.

It has flexible lateral reinforcements to assure water-tightness.



CFPS. Single Bridge Pier

Pillars in a channel are obstacles that reduce the cross section of the flow. In this way, a backwater can be created before the obstacles.

The "CFPS" accessory includes a single bridge abutment that can be fixed anywhere in the channel.

Included elements

CFCV. Vertical Flat Weir

One of the ways to regulate the flow through a canal is the use of control gates. When the gate is fully closed, water circulation is obstructed and when it is opened, water flows underneath and a circulating flow is established in the channel.

The "CFCV" accessory consists of a vertical flat gate that allows to close completely and obstruct the water circulation.

Additional recommended elements (Not included)

CFTP. Pitot Tube with Tubes Manometer Board

The Pitot tube is a device to measure the total pressure and the static pressure in a random point of the flow.

The pressure difference between the static pressure and the total pressure corresponds to the dynamic pressure from which the flow velocity and the flow rate in any point can be calculated.

The "CFTP" accessory is a Pitot tube mounted on a mobile support that can be displaced up and down the length and width of the channel, connected to a tubes manometer board where the total and static pressures are measured.

CFVDG. Broad and Thin Crested Weirs

Sharp crested weirs and broad crested weirs are hydraulic weirs, the sharp crested ones generally used as measuring weirs and the broad crested ones as sill and level control structure.

The "CFVDG" accessory includes two sharp crested weirs made of PVC that are housed in grooves prepared for this purpose at the outlet of the channel, reinforced with flexible rubber, ensuring watertightness. It also includes a broad-crested weir made of PVC with sufficient thickness to maintain the verticality of the weir and its non-deformation and with flexible lateral reinforcements that ensure watertightness. It can be fixed to any part of the bottom of the channel. The broad-crested weir can be installed on one side with a rounded crest edge or on the other side with a straight edge.

CFCVR. Vertical Flat Gate and Radial Gate

One way to regulate the flow in a channel is by using control floodgates. When the floodgate is totally closed, the flow of water is blocked, and when it is open, water flows underneath and starts a flow circulating through the channel.

Radial floodgates are part of movable control structures and are normally used together with fixed control structures to adjust the flow according to the necessity.

The "CFCVR" accessory consists of two floodgates, a flat vertical floodgate and a radial floodgate. The radial floodgate is mounted on a frame that can be displaced along the whole fluids channel. The floodgate can be fixed at the desired degree of inclination.

They have flexible lateral reinforcements to assure water-tightness.

CFSDL. Syphon Spillway

One way to regulate the water level in a channel is by using syphons.

Syphon weirs are part of fixed weirs. They are installed as spillways in reservoirs and have a high specific discharge capacity.

When the level exceeds a specific height water flows through the syphon, being the upstream level regulated.

The syphon spillway designed by EDIBON can be fixed to any part of the bottom of the channel and it is made of PVC with walls made of PMMA to visualize flow lines. It has flexible lateral reinforcements to assure water-tightness.

Additional recommended elements (Not included)

CFPVP. Dams Spillway and Flow Splitters

Ogee profile weirs are fixed spillways and are part of control structures. They are commonly used to divert flows and create backwaters in a river.

The "CFPVP" accessory includes three Ogee profile weirs with different discharge inclinations.

They are made of PVC and can be fixed to any part of the bottom of the channel, and have flexible lateral reinforcements to ensure watertightness.

In addition, it includes an element with two long transparent pillars made of methacrylate. It can be fixed to any part of the channel.

CFCA. Culvert Fitting

Culverts belong to crossing structures and enable the passage of water. They can be a sewer, syphon, aqueduct, bridge, etc.

The "CFCA" accessory is made of PVC and represents the connection of the channel to the culvert, allowing the regulation of its height.

They can be fixed to any part of the bottom of the channel and has flexible lateral reinforcements to assure water-tightness.

CFVC. Crump Weir

Crump weirs belong to control structures. It is a weir with triangular longitudinal profile, triangular transverse profile and smooth slopes. It is normally used as sill to reduce the flow rate and prevent erosion.

The "CFVC" accessory includes a critical weir made of PVC; it can be fixed to any part of the bottom of the channel and has flexible lateral reinforcements to assure water-tightness. It has defined slopes upstream and downstream.

CFVEN. Venturi Flume

In the same way that the Venturi meter in tubes is used to measure the flow in closed flows, the Venturi flume is used to measure the flow in open channels.

It consists of a base plate and two side pieces, producing a throttling in the section of the channel.

It is made of a transparent material that enables to visualize the flow inside.

It can be fixed to any part of the bottom of the channel and has flexible lateral reinforcements to assure water-tightness.

CFSDS. Air Regulated Syphon

One way to regulate the water level in a channel is by using syphons.

Syphon weirs are part of fixed weirs. They are installed as spillways in reservoirs and have a high specific discharge capacity.

When the level exceeds a specific height water flows through the syphon, being the upstream level regulated.

The self-regulating syphon designed by EDIBON can be fixed to any part of the bottom of the channel and it is made of PVC with walls made of PMMA to visualize flow lines. It has flexible lateral reinforcements to assure water-tightness.

CFFS. False Floor Sections

The flow behavior in a river depends particularly on slopes and the roughness of the base of the channel.

The "CFFS" accessory consists of PVC plates with different material of different roughness that allow for simulating in the fluids channel a riverbed of three different roughness. They can be fixed to any part of the bottom of the channel.

Additional recommended elements (Not included)

CFPLR. Artificial Roughened Bed

The flow behavior in a river depends particularly on slopes and the roughness of the base of the channel.

The "CFPLR" accessory consists of PVC plates with different elements (three different sizes) that allow for simulating in the fluids channel a riverbed of three different slopes. They can be fixed to any part of the bottom of the channel.

CFFD. Flow Divider

A flow divider is an essential element in hydraulic engineering that divides a liquid stream into multiple parts. This device is crucial in contexts requiring equitable and controlled flow distribution, such as wastewater treatment, agricultural irrigation and other hydraulic systems.

The Flow Divider "CFFD", designed by EDIBON, facilitates this task by allowing the study of how flow division occurs at different angles for comprehensive analysis.

CFAS. Sediment Feeder

The "CFAS" accessory transports and measures out sediments of different grain size.

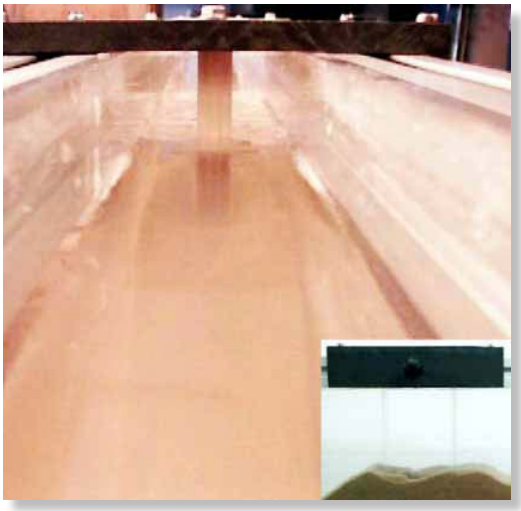
It consists of a vibrating hopper of 10 l and an arm that enables to distribute the sediments in the channel uniformly. It is mounted on a rail to facilitate its motion along the whole channel.

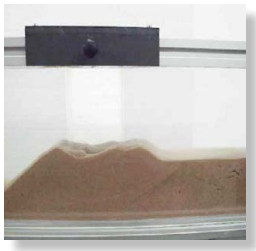
This accessory requires the sediment trap, "CFTS", and the sediment recirculation system for CF, "CFSRS".

CFDI. Digital Inclinometer

Accessory for measuring tilt in channels, 0-360°, resolution 0.05°.

Detail of some bedforms and effects on beds of different structures





EXERCISES AND PRACTICAL POSSIBILITIES

Flow over a mobile sand bed:

Bedforms associated with increasing flow intensity and sediment transport rate:

1.- Lower regime (bedforms exhibed):
- Plane bed (no motion).
- Ripples and dunes.
- Washed out dunes.
- Ripples.
- Dunes.

2.- Upper regime (bedforms exhibed):
- Plane bed (with motion).
- Chutes and pools.
- Anti dunes.
- Breaking anti dunes.
- Standing waves.

Flow over fixed, gravel bed:

3.- Although the channel can not transport gravel, this can be used to investigate flow resistance in gravel and polder bed rivers.

4.- We can calculate the flow resistance coeficients, using equations such as those of Bray, Limerinos, Hey, Lacey, Thompson and Campbell and Bathurst and the results compared to the actual values obtained by observation.

Flow structures:

5.- We can examine the structure of turbulence in the flow using dye injection, interesting for the dune bedform configuration and clearly demonstrates separation on the lee face.

Fixed, smooth bed flow:

The channel may be used without sediment on the bed to demonstrate several flow phenomena and equations:

6.- Rapid, super critical flow dominance of intertial over gravity forces, shock waves from flow obstructions.

7.- Turbulence.

8.- Governing equations of open channel flow Reynold's number, Froude number, continuity, Bernoulli's equation, weir equations.

9.- Tranquil, sub critical flow movement of surface waves upstream against flow.

10.-Hydraulic jump transition from super to sub critical flow, air entrainment, mixing.

11.-Flow measurement using sharp crested weirs.

Bedform hysteresis:

12.-If the discharge in the channel changes quickly, there is no sufficient time for bedforms to adjust to the new flow regime. Hence, if a flood hydrograph is simulated by increasing and then decreasing the discharge, different depths will occur for the same discharge on the rising and falling limbs.

Data collection and numerical evaluation (computational work):

13.-In addition to illustrating flow and sediment phenomena, we can use the channel for basic data collection and numerical evaluation of the following:
- Flow resistance:
  Manning, Chezy and Darcy-Weisbach fricion factors for several bedform configuration.
- Bedform prediction:
  Velocity Hjulstrom diagram.
  Suspended load movement by suspension.
  Shields parameter Bogardi diagram.
  Stream power Simons and Richarson charts.
  Boundary shear stress Leeder chart.
- Initiation of motion:
  Shields diagram.
  Hjulstrom's curve.

Mechanics of sediment transport:

14.-We can observe the movement of grains, starting from a plane bed with no motion, on the following:
- Initiation of motion.
- Trajectory of initial motion.
- Movement by rolling and sliding (contact load).
- Movement by hopping (saltation load).
- Movement by suspension.

Depositionary features and facies:

15.-We can observe the deposition of sediment load and the resulting patterns of grains within the sand body may be identified.

Local scour:

16.-Scour under boils and vortices in the flow is observed under both the lower and upper regime bedforms. Obstructions may be introduced to represent bridge piers, sills, revetments, etc, and the resulting pattern of scour examined.

Additional practical possibilities:

17.-Behaviour study of the connection to the drain of a channel with sendiment.

18.- Turbulence study by means coloration.

19.- Calculation of water flow.

REQUIRED SERVICES

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

DIMENSIONS AND WEIGHTS

CAS:
- Dimensions: 3600 x 1000 x 1700 mm approx.
  (141.73 x 39.37 x 66.92 inches approx.)
- Weight: 250 kg approx.
  (551 pounds approx.)

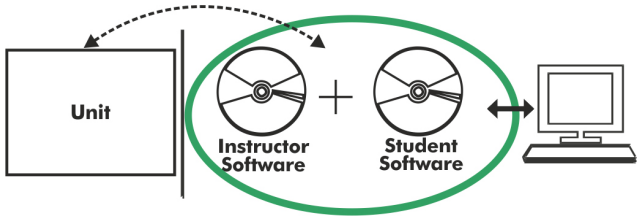
ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- CFTP. Pitot Tube with Tubes Manometer Board.
- CFVDG. Broad and Thin Crested Weirs.
- CFCVR. Vertical Flat Gate and Radial Gate.
- CFSDL. Syphon Spillway.
- CFPVP. Dams Spillway and Flow Splitters.
- CFCA. Culvert Fitting.
- CFVC. Crump Weir.
- CFVEN. Venturi Flume.
- CFSDS. Air Regulated Syphon.
- CFFS. False Floor Sections.
- CFPLR. Artificial Roughened Bed.
- CFFD. Flow Divider.
- CFAS. Sediment Feeder.
- CFDI. Digital Inclinometer.

REQUIRED CONSUMABLES (Not included)

- Sand and gravel.

CAS/ICAI. Interactive Computer Aided Instruction Software:



With no physical connection between unit and computer, **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.

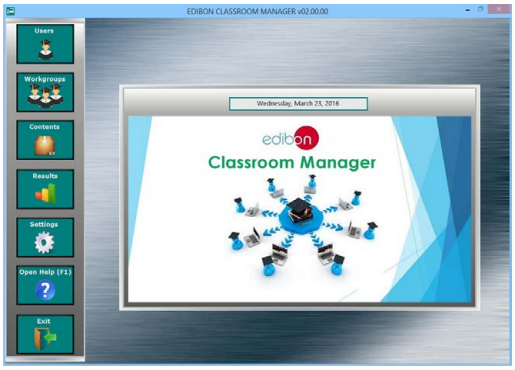
Instructor Software

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

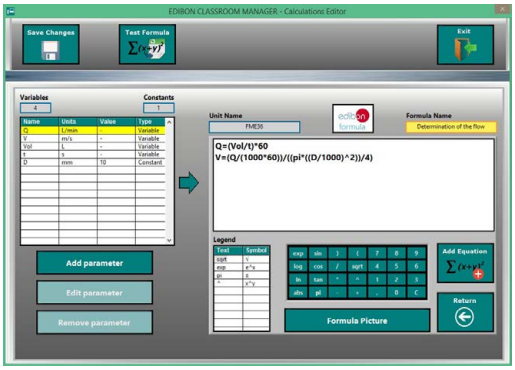
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual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

Innovative features:

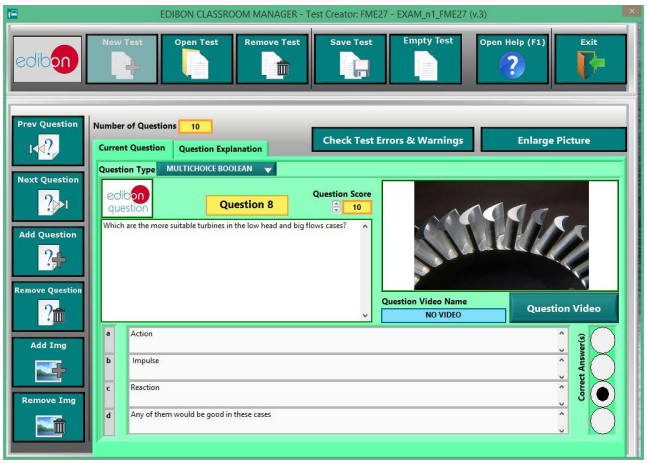
- **User Data Base Management.**
- **Administration and assignment of Workgroup, Task and Training sessions.**
- **Creation and Integration of Practical Exercises and Multimedia Resources.**
- **Custom Design of Evaluation Methods.**
- **Creation and assignment of Formulas & Equations.**
- **Equation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



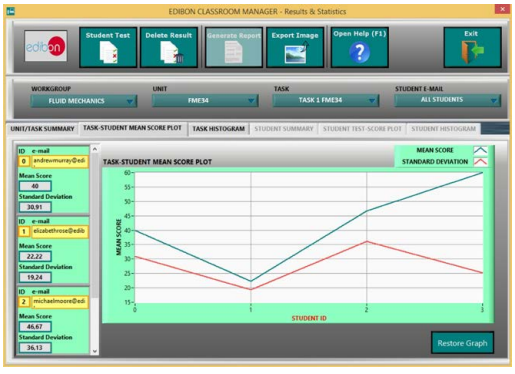
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



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

Optional

Student Software

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

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

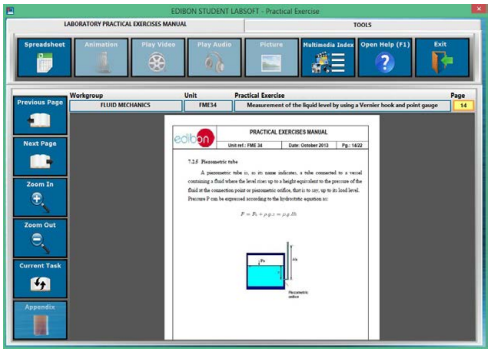
Innovative features:

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

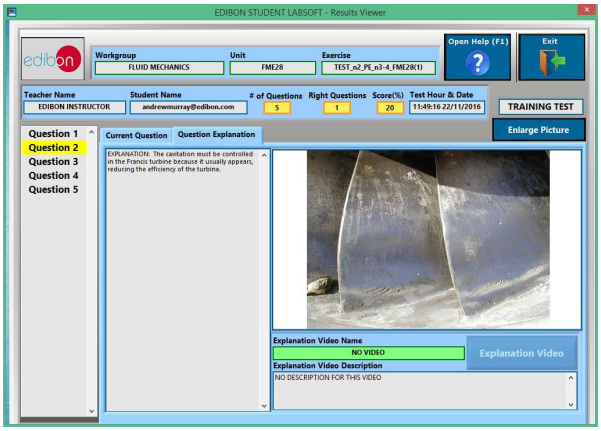
For more information see **ICAI** catalogue. Click on the following link:

www.edibon.com/en/interactive-computer-aided-instruction-software

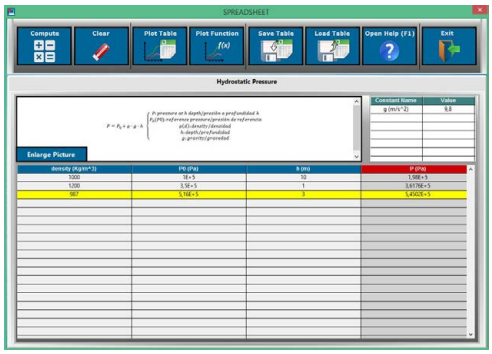
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

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

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REPRESENTATIVE: