edibon

Engineering and Technical
Teaching Equipment

Configuration example of AEL-ACEMA application

INTRODUCTION

The usage of A.C. motors is much more prevalent than D.C. motors due to several practical reasons. A.C. Motors are playing a vital role in everyday life, right from pumping water to overhead tank to modern robot's maneuvering arm. The main factor which leads to the adoption and wide usage in various fields is its flexibility and its huge variety, which can be matched with almost any kind of demand.

The A.C. Electrical Motors Application, "AEL-ACEMA", has been designed by EDIBON to show the students A.C. electric motors wirings, development of logic control circuits and different starting methods such as direct starting, star-delta starting, run investment, soft starting and many other possibilities.

This AC Electrical Motors Application, "AEL-ACEMA", consists of a base equipment which is formed by several modules such as power supplies, push buttons, three-phase autotransformer, A.C. ammeter, circuit breakers, timers, flywheel, etc. In addtion, this base equipment is complemented by different options. Each option includes a different motor with its specific modules to carry out properly operations.

With this application, the user will take a complete experience about the most important operations carried out with several industrial machines such as Asynchronous three-phase motor of squirrel cage, asynchronous three-phase motor of wound rotor, Dahlander three-phase motor, asynchronous three-phase motor of two independent speeds, asynchronous single-phase motor with starting capacitor, Universal Motor, asynchronous single-phase motor with starting and running capacitor, Asynchronous single-phase motor with split phase, three-phase reluctance motor, three-phase AC synchronous generator, etc.

The AEL-ACEMA application includes the following elements:

- N-ALI01. Industrial Main Power Supply.
- N-ALI03. AC Auxiliary Power Supply.
- N-PUL48. Three Double Chamber Push-Buttons Module.
- N-CON01. 3-pole Contactor (24V AC). (4 units).
- N-REL30. Synchronization Relay Module. (3 units).
- N-TRANS03. Three-Phase Autotransformer Module.
- N-LAM02. Three Auxiliary Lamps Module.
- N-MED09. AC Ammeter (0-2.5 A).
- N-ARR13. Direct Starter with Inversion Module.
- N-MED65. Digital Multimeter.
- FLYW. Flywheel.

Required elements. At least one option is required:

Option 1: Study of Three-Phase Asynchronous Motor of Squirrel cage.
- EMT7. Asynchronous three-phase motor of squirrel cage.
- N-ARR01.   Manual Star-Delta Starter.

Option 2: Study of Three-Phase Asynchronous Motor of wound rotor.
- EMT8. Asynchronous three-phase motor of wound rotor.
- N-ARR01.   Manual Star-Delta Starter.
- N-REFTI.   Three-phase Independent Resistor Module (3 units).

Option 3: Study of Three-Phase Dahlander Motor.
- EMT9. Dahlander three-phase motor.
- N-ARR07.   Manual Dahlander Commutator, 2 Speeds.

Option 4: Study of Asynchronous three-phase motor of two independent speeds.
- EMT10. Asynchronous three-phase motor of two independent speeds.
- N-ARR09.   Manual Independent Windings Commutator, 2 speeds.

Option 5: Study of Asynchronous single-phase motor with starting capacitor.
- EMT11. Asynchronous single-phase motor with starting capacitor.

Option 6: Study of Universal Motor:
- EMT12. Universal motor (single-phase).
- N-REV. Single phase variable resistor.
- N-VVCC/M. DC Motor Speed Controller (intermediate option).

Option 7: Study of Asynchronous single-phase motor with starting and running capacitor.
- EMT16. Asynchronous single-phase motor with starting and running capacitor.

Option 8: Study of Asynchronous single-phase motor with split phase.
- EMT20. Asynchronous single-phase motor with split phase.

Option 9: Study of Three-Phase Reluctance Motor.
- EMT21. Three-phase reluctance motor.

Option 10: Study of Three-phase synchronous generator:
- EMT6. A.C. Synchronous Three-Phase Motor Alternator.
- N-VVCC/M. DC Motor Speed Controller (intermediate option).
- EMT7. Asynchronous three-phase motor of squirrel cage.
- N-VVCA/M. AC Motor Speed Controller (intermediate option).
- N-REFTI.   Three-phase Independent Resistor Module.

The application AEL-ACEMA can be mounted on rack (option A) or on rail (option B):

Option A:
    This application needs the following racks.
        - N-RACK-A.
        - N-RACK-M.
    Optionally the AEL-WBR. Electrical Workbench (Rack) can be supplied to place the rack/s.

Option B:
    This application can be mounted on rail.
    Optionally the AEL-WBC. Electrical Workbench (Rail) can be supplied to mount the modules.

The AEL-ACEMA application includes the following elements:

- **N-ALI01. Industrial Main Power Supply.**
  Supply voltage: 400V AC, 3PH+N+G.
  ON-OFF removable key.
  Output voltage connections:
    Three-Phase + Neutral: 400V AC.
    Single-Phase: 230V AC.
  Three-Phase supply hose with IP44 3PN+E 32A 400V connecting plug.
  Differential magnetothermal, 4 poles, 25A, 300mA AC 6KA.

N-ALI01

- **N-ALI03. AC Auxiliary Power Supply.**
  Supply voltage (Single-Phase): 230V AC PH+N+G.
  Output voltage:
    Single-Phase 24 VAC/12V AC.
  24V DC.
  0-24V DC through potentiometer.

N-ALI03

- **N-PUL48. Three Double Chamber Push-Buttons Module.**
  Two independent chambers.
  Nominal voltage: 24V AC.
  Three double chamber push-buttons (green and red).
  Contacts:
    Three Normally Open Contacts (NO) for green switch.
    Three Normally Close Contacts (NC) for red switch.
  Ground terminal.

N-PUL48

- **N-CON01. 3-pole Contactor (24V AC). (4 units).**
  Nominal voltage for power contacts: 400V AC.
  Nominal voltage for control contacts: 24V AC.
  Nominal voltage for the control coil: 24V AC.
  Contacts:
    One three-phase Normally Open Contact (NO) for power circuit.
    Three Normally Open Contacts (NO) for control circuit.
    Two Normally Close Contacts (NC) for control circuit.
  Ground terminal.

N-CON01

- **N-REL30. Synchronization Relay Module. (3 units).**
  Nominal voltage for power contacts: 400V AC.
  Nominal voltage for control contacts: 24V AC.
  Nominal voltage for the control coil: 24V AC.
  Contacts:
    One three-phase Normally Open Contact (NO) for power circuit
    Three auxiliary contacts:
      One instantaneous Normally Open Contact (NO).
      One time Normally Open Contact (NO).
      One time Normally Close Contact (NC).
  Ground terminal.

N-REL30

- **N-TRANS03. Three-Phase Autotransformer Module.**
  Three-phase autotransformer.
  Nominal supply voltage: 400V AC (3PH).
  Nominal output voltage: 3 x 230V AC (3PH+N).
  Nominal power: 1 kVA.
  Transformer connection: YY0.
  Start/stop commutator for instantaneous connection/disconnection of the grid transformer.
  Fuses: 3 x 5 A.

N-TRANS03

Specifications

- N-LAM02. **Three Auxiliary Lamps Module.**
  - Nominal voltage: 24V AC.
  - Three lamps (red, yellow and green).
  - Ground terminal.

N-LAM02

- N-MED09. **AC Ammeter (0-2.5 A).**
  - Measurement range: 0-2.5 A
  - Terminals:
    - Measurement Terminals.
    - Ground Terminal.

N-MED09

- N-ARR13. **Direct Starter with Inversion Module.**
  - Nominal voltage: 400V AC.
  - Maximum contacts current: 10A.
  - Three positions commutator:
    - 0: Open circuit.
    - 1: Direct connection.
    - 2: Reverse connection.

N-ARR13

- N-MED65. **Digital Multimeter.**
  - This module has a digital multimeter of 3 ½ digits, with double-jack ending cables of 4 mm to facilitate interconnections.
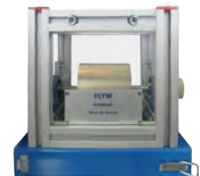 - With this digital multimeter we will be able to measure:
    - Voltage.
    - Current.
    - Resistance.
    - Capacitors capacity.
    - Temperature.

N-MED65

- FLYW. **Flywheel.**
  - Weight: 2 kg.
  - Maximum recommended speed: 4000 r.p.m.
  - Moment of inertia: 0,0025 kgm^2

Required elements:
- N-ARR01. **Manual Star Delta Starter Module.**
  - Nominal voltage: 400V AC.
  - Maximum contacts current: 10A.
  - Star-Delta three positions commutator:
    - 0: Open circuit.
    - Y: Star connection.
    - Δ: Delta connection.

FLYW

N-ARR01

- N-ARR07. **Manual Dahlander Commutator Module.**
  - Nominal voltage: 400V AC.
  - Maximum contacts current: 10A.
  - Three positions commutator:
    - 0: Open circuit.
    - 1: Low speed.
    - 2: High speed.

N-ARR07

- N-ARR09. **Manual Independent Windings Commutator Module.**
  - Nominal voltage: 400V AC.
  - Maximum contacts current: 10A.
  - Three positions commutator:
    - 0: Open circuit.
    - 1: Winding 1.
    - 2: Winding 2.

N-ARR09

- N-VVCC/M. **DC Motor Speed Controller (intermediate option)**
    Supply voltage: 230V AC.
    Variable output voltage: 0-300V CC
    Fuse: 2 A

N-VVCC/M

- N-REV. **Single phase variable resistor.**
    Variable resistor of 150 Ohm.
    Maximum power: 500 W.
    Potentiometer.
    Terminals:
      Three terminals to choose all resistance or variable resistance.
    Fuse: 2 A.

N-REV

- N-REFTI. **Three-phase Independent Resistor Module.**
    Nominal voltage: 400V AC.
    Resistor value: 3x150 Ohms.
    Nominal power: 3x352 W.
    Manual commutator to switch on/off the resistors.
    Fuses: 3 x 5 A.
    Terminals:
      Three input terminals (3PH).
      Three output terminals (3PH).
    Ground terminal.

N-REFTI

- EMT6. **A.C. Synchronous Three-Phase Motor Alternator.**
    Nominal power: 250 W.
    Nominal output voltage: 3 x 400V AC.
    Frequency: 50/60 Hz.
    RPM:3000 r.p.m.
    Nominal output current: 1 A.
    Nominal excitation current: 0,25 A.

EMT6

- EMT7. **Asynchronous Three-Phase Motor of Squirrel Cage.**
    Nominal power: 370 W.
    Nominal voltage: 3x 230/400V AC Δ/Y.
    Frequency: 50/60 Hz
    Number of poles: 2.
    RPM: 2730 r.p.m.
    Nominal current: 1,67/ 0,97 A.

EMT7

- EMT8. **Asynchronous Three-Phase Motor with Wound Rotor.**
    Nominal power: 300 W.
    Nominal voltage: 3x 230/400 VAC Δ/Y.
    Frequency: 50/60 Hz.
    Number of poles: 2.
    RPM: 2870 r.p.m.
    Nominal current: 1/ 0,5 A.

EMT8

- EMT9. **Dahlander three-phase motor.**
    Nominal power: 370 W.
    Nominal voltage: 3x 400V AC.
    Frequency: 50/60 Hz.
    Number of poles: 4.
    RPM: 1400/2800 r.p.m.
    Nominal current: 1,2 / 1,55 A.

EMT9

- EMT10. **Asynchronous three-phase motor with two independent speeds.**
  Nominal power: 240/370 W.
  Nominal voltage: 3x 400V AC.
  Frequency: 50/60 Hz.
  RPM: 900/1420 r.p.m.
  Nominal current: 1,05 / 1,35 A.

EMT10

- EMT11. **Asynchronous single-phase motor with starting capacitor.**
  Nominal power: 370 W.
  Nominal voltage: 3 x 230V AC.
  Frequency: 50/60 Hz
  RPM: 2780 r.p.m.
  Nominal current: 2,53 A.

EMT11

- EMT12. **Universal motor (single-phase).**
  Supply voltage: 110-240V AC/ V DC.
  Power: 230 W.
  Speed: 9000 r.p.m.

EMT12

- EMT16. **Single-phase capacitor motor.**
  Supply voltage: 110-220V.
  Power: 370 W.
  Speed: 2780 r.p.m.
  Frequency: 50/60Hz
  Armature current: 1,85 A

EMT16

- EMT20. **Asynchronous Single-phase motor with split phase.**
  Supply voltage: 220V
  Power: 370 W.
  Speed: 2780 r.p.m.
  Frequency: 50 Hz.
  Armature current: 2,53 A.

EMT20

- EMT21. **Three-phase reluctance motor.**
  Nominal power: 300 W.
  Nominal voltage: 3 x 400V AC
  Frequency: 50/60 Hz
  RPM: 3000 r.p.m.
  Nominal current: 1,4 A

EMT21

- N-VVCA/M. **AC Motor Speed Controller (intermediate option).**
  Supply voltage: 230V AC.
  On/Off power switch.
  PWM output voltage connections:
    Three-Phases: 230V AC.
  Wheel to regulate the frequency.
  Setting and visualization display of the machine parameters.

N-VVCA/M

- **All necessary cables to realize the practical exercises are included.**

Cables and accessories, for normal operation.

Manuals:

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

EXERCISES AND PRACTICAL POSSIBILITIES

Some practical possibilities with Option 1: Study of Three-Phase Asynchronous Motor of Squirrel cage.

1.- Checking the main power supply.

2.- Wiring the Three-Phase Asynchronous Motor of Squirrel cage.

3.- Study of the control parameters of the Three-Phase Asynchronous Motor of Squirrel cage.

4.- Study the direct starting of the Three-Phase Asynchronous Motor of Squirrel cage.

5.- Manual star-delta starting circuit of the Three-Phase Asynchronous Motor of Squirrel cage.

6.- Manual reversing operations of the Three-Phase Asynchronous Motor of Squirrel cage.

7.- Automatic star-delta starter of the Three-Phase Asynchronous Motor of Squirrel cage.

8.- Automatic star-delta reversing circuit of the Three-Phase Asynchronous Motor of Squirrel cage.

9.- Autotransformer starting.

10.- Comparison of the operations with other acquired motors.

Some practical possibilities with Option 2: Study of Three-Phase Asynchronous Motor of wound rotor.

11.- Checking the main power supply.

12.- Wiring the Three-Phase Asynchronous Motor of wound rotor.

13.- Study of the control parameters of the Three-Phase Asynchronous Motor of wound rotor.

14.- Study the direct starting the Three-Phase Asynchronous Motor of wound rotor.

15.- Manual starting with rotor resistor.

16.- Manual star-delta starting circuit of the Three-Phase Asynchronous Motor of wound rotor.

17.- Manual reversing operations of the Three-Phase Asynchronous Motor of wound rotor.

18.- Automatic starting with rotor resistor.

19.- Automatic star-delta starting of the Three-Phase Asynchronous Motor of wound rotor.

20. Automatic star-delta reversing circuit of the Three-Phase Asynchronous Motor of wound rotor.

21.- Autotransformer starting.

22. Comparison of the operations with other acquired motors.

Some practical possibilities with Option 3: Study of Three-Phase Dahlander Motor.

23.- Checking the main power supply.

24.- Wiring the Three-Phase Dahlander Motor.

25.- Study of the control parameters of the Three-Phase Dahlander Motor.

26.- Study the direct starting of the Three-Phase Dahlander Motor.

27.- Manual speed variation of a Dahlander motor.

28.- Manual reversing operations of the Three-Phase Dahlander Motor.

29.- Autotransformer starting.

30.- Comparison of the operations with other acquired motors.

Some practical possibilities with Option 4: Study of Asynchronous three-phase motor of two independent speeds.

31.- Checking the main power supply.

32.- Wiring the Asynchronous three-phase motor of two independent speeds.

33.- Study of the control parameters of the Asynchronous three-phase motor of two independent speeds.

34.- Study the direct starting ot the Asynchronous three-phase motor of two independent speeds.

35.- Manual speed variation of a motor with two independent speeds.

36.- Manual reversing operations of the Asynchronous three-phase motor of two independent speeds.

37.- Automatic speed variation of a motor with two independent speeds.

38.- Autotransformer starting.

39.- Comparison of the operations with other acquired motors.

Some practical possibilities with Option 5: Study of Asynchronous single-phase motor with starting capacitor.

40.- Checking the main power supply.

41.- Wiring the Asynchronous single-phase motor with starting capacitor.

42.- Study of the control parameters of the Asynchronous single-phase motor with starting capacitor.

43.- Study the direct starting the Asynchronous single-phase motor with starting capacitor.

44.- Manual reversing operations of the Asynchronous single-phase motor with starting capacitor.

45.- Direct and time-delay control of a single phase motor.

46.- Comparison of the operations with other acquired motors.

Exercises and practical possibilities

Some practical possibilities with Option 6: Study of Universal Motor.

47.- Working of Universal Motor in AC.

48.- -Working of Universal Motor in DC.

49.- Checking the main power supply.

50.- Wiring the Universal Motor.

51.- Study of the control parameters of the Universal Motor.

52.- Study the direct starting of the Universal Motor.

53.- Manual reversing operations of the Universal Motor.

54.- Direct and time-delay control of a single phase motor.

55.- Comparison of the operations with other acquired motors.

Some practical possibilities with Option 7: Study of Asynchronous single-phase motor with starting and running capacitor.

56.- Checking the main power supply.

57.- Wiring the Asynchronous single-phase motor with starting and running capacitor.

58.- Study of the control parameters of the Asynchronous single-phase motor with starting and running capacitor.

59.- Study the direct starting the Asynchronous single-phase motor with starting and running capacitor.

60.- Manual reversing operations of the Asynchronous single-phase motor with starting and running capacitor.

61.- Direct and time-delay control of a single phase motor.

62.- Comparison of the operations with other acquired motors.

Some practical possibilities with Option 8: Study of Asynchronous single-phase motor with split phase.

63.- Checking the main power supply.

64.- Wiring the Asynchronous single-phase motor with split phase.

65.- Study of the control parameters of the Asynchronous single-phase motor with split phase.

66.- Study of the direct starting of the Single-phase Asynchronous Motor of split phase.

67.- Manual reversing operations of the Asynchronous single-phase motor with split phase.

68.- Direct and time-delay control of a single phase motor.

69.- Comparison of the operations with other acquired motors.

Some practical possibilities with Option 9: Study of Three-Phase Reluctance Motor.

70.- Checking the main power supply.

71.- Wiring the Three-Phase Reluctance Motor.

72.- Study of the control parameters of the Three-Phase Reluctance Motor.

73.- Study the direct starting of the Three-Phase Reluctance Motor.

74.- Manual reversing operations of the Three-Phase Reluctance Motor.

75.- Comparison of the operations with other acquired motors.

Some practical possibilities with Option 10: Study of Three-Phase Synchronous Generator.

76.- Checking the main power supply.

77.- Wiring of the AC Synchronous generator.

78.- Study of the parameters to be controlled in AC Synchronous generator.

79.- Study of speed VS output voltage of synchronous generator at current excitation constant.

80.- Study of current excitation VS output voltage of synchronous generator at frequency constant.

81.- Study of drop voltage of synchronous generator with load.

82.- Comparison of the operations with other acquired motors.

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

REQUIRED SERVICES

- Electrical supply: three-phase, 380V/50 Hz or 208V/60 Hz., 20 Kw.

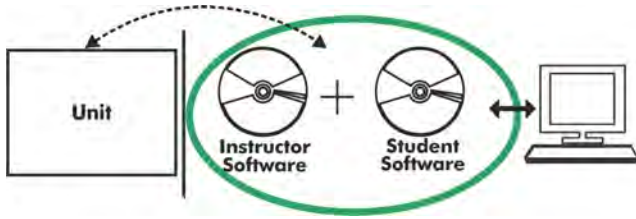## DIMENSIONS AND WEIGHTS

AEL-ACEMA:
  -Dimensions: 1380 x 840 x 2010 mm approx.
                   (54.33 x 33.07 x 79.13 inches approx.).
  -Weight: 80 Kg approx.
                   (176 pounds approx.).

Optional

AEL-ACEMA/ICAI. Interactive Computer Aided Instruction Software System.

Whit 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.
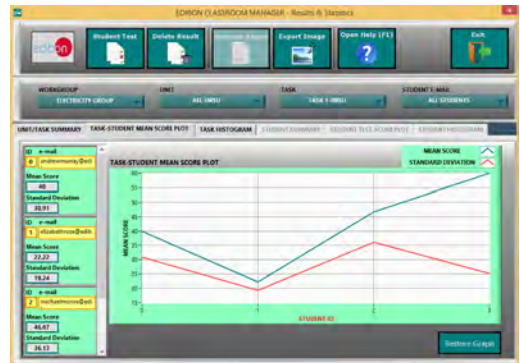
Instructor Software

-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 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.**

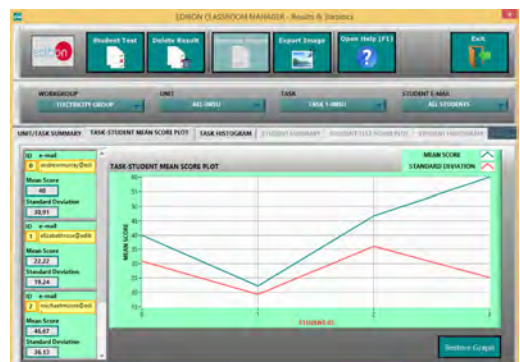- **Report generation, User Progression Monitoring and Statistics.**

ECM-SOF. EDIBON Classroom Manager (Instructor Software)
Application main screen
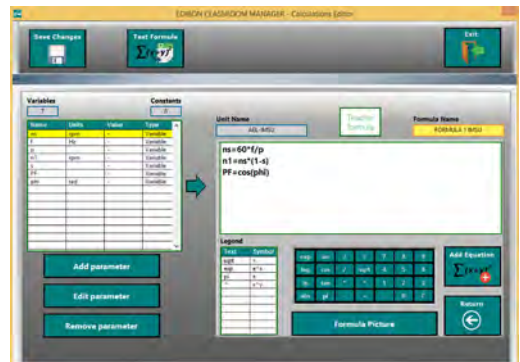
ECAL. EDIBON Calculations Program Package - Formula Editor Screen
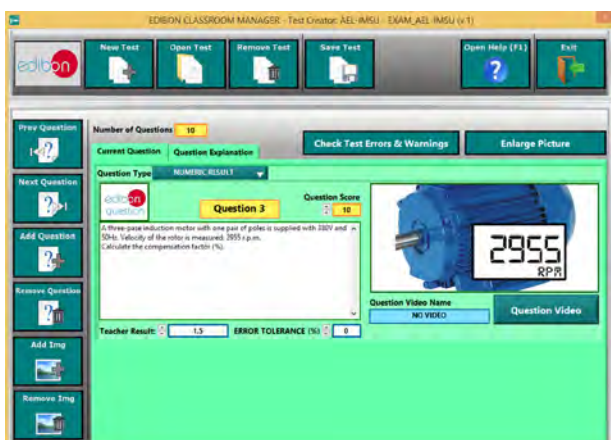
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

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

9   www.edibon.com

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:

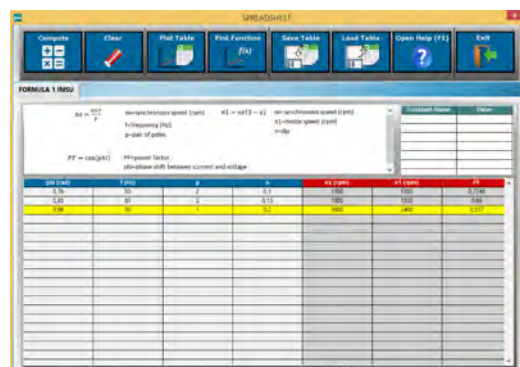www.edibon.com/en/files/expansion/ICAI/catalog

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.