# DC Electrical Motors Applications

## AEL-DCEMT

## INTRODUCTION

DC motors were the first type widely used, but the advent of power electronics has made replacement of DC motors with AC motors in many applications on account of economic issues. However, due to their wide operating range, flexibility and great accuracy, DC motors are still used in many applications such as propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills.

The DC Electrical Motors Applications, "AEL-DCEMT", has been designed by Edibon to carry out electrical/mechanical tests for a great variety of DC motors. Such tests allow obtaining the most significant electrical and mechanical characteristics of these motors .In addition, it is advisable to acquire the Control and Data Acquisition System Software for Electrical Machines, ''EM-SCADA'', with which the user will be able to obtain the characteristic curves for the tested electric motors and fulfill reports and comparisons of the obtained curves for each electric motor to study its advantages and application fields.

The "AEL-DCEMT" allows the user to learn in depth the behavior of a great range of DC motors, such as DC Independent excitation Motor, DC Series excitation Motor, DC Shunt excitation Motor- Generator, DC Compound excitation Motor-Generator, etc.

For this purpose, the application includes a servomotor, an overcurrent relay and a series of measurement devices, such as an analog ammeter , an analog voltmeter, a multimeter  and an optical speed meter. All these included elements are essential to study the AC motors characteristics. Dynamic braking tests can be carried out through the servomotor while parameters such as speed, electrical current, the voltage, the power factor or the active and reactive powers are measured.

For the fulfillment of electric motors advanced tests, it is advisable to acquire the Control and Data Acquisition System Software for Electrical Machines, ''EM-SCADA''. This advanced software allows monitoring the waveforms for current, voltage, torque and speed to study in depth the electric machines.

The AEL-DCEMT application includes the following elements:

- N-ALI01. Industrial Main Power Supply.
- N-MED17. DC Voltmeter (0-200 V).
- N-MED05. DC Ammeter (0-1.5 A).
- MED65. Digital Multimeter.
- N-REL60. Single-Phase Under / Overcurrent Relay.
- N-SERV1K. 1 kW Servomotor Module.
- TECNEL/TM. Hand Tachometer.

Recommended elements:

- N-VVCC. Advanced DC Motors Speed Controller.
- N-DMC01. Double Measurement and Control Module 1.

Required elements. At least one kit is required:

### DCEMT-K1: DC independent excitation motor-generator Kit.

- EMT1. D.C. Independent Excitation Motor-Generator.
- N-REV. Single Phase Variable Resistor.
- N-VVCC/M. DC Motor Speed Controller (intermediate option). 2 units.
- N-MED17. DC Voltmeter (0-200 V).
- N-MED05. DC Ammeter (0-1.5 A).

### DCEMT-K2:  DC series excitation motor-generator Kit.

- EMT2. D.C. Series Excitation Motor-Generator.
- N-REV. Single Phase Variable Resistor.
- N-VVCC/M. DC Motor Speed Controller (intermediate option).

### DCEMT-K3: DC shunt excitation motor-generator Kit.

- EMT3.DC Shunt excitation Motor-Generator.
- N-REV. Single Phase Variable Resistor.
- N-VVCC/M. DC Motor Speed Controller (intermediate option).
- N-MED17. DC Voltmeter (0-200 V).
- N-MED05. DC Ammeter (0-1.5 A).

### DCEMT-K4: DC compound excitation motor-generator Kit.

- EMT4. DC Compound excitation Motor-Generator.
- N-REV. Single Phase Variable Resistor.
- N-VVCC/M. DC Motor Speed Controller (intermediate option).
- N-MED17. DC Voltmeter (0-200 V).
- N-MED05. DC Ammeter (0-1.5 A).

### DCEMT-K5: DC shunt/series/compound excitation motor-generator Kit.

- EMT5. D.C. Shunt-Series Compound Excitation Motor.
- N-REV. Single Phase Variable Resistor.
- N-VVCC/M. DC Motor Speed Controller (intermediate option). 2 units.
- N-MED17. DC Voltmeter (0-200 V).
- N-MED05. DC Ammeter (0-1.5 A).

Recommended SCADA software:

- EM-SCADA. Control and Data Acquisition System Software for Electrical Machines, with SCADA.

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

Option A:

This application needs the following racks:

- 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.

- N-ALI01. **Industrial Main Power Supply.**

    Supply voltage: 400 VAC, 3PH+N+G.

    ON-OFF removable key.

    Output voltage connections:

    Three-Phase + Neutral: 400 VAC.

    Single-Phase: 230 VAC.

    Three-Phase supply hose with IP44 3PN+E 32A 400V connecting plug.

    Differential magnetothermal, 4 poles, 25 A, 300 mA AC 6 KA.

N-ALI01

- N-MED17. **DC Voltmeter (0-200 V).**

    Measurement range: 0-200 VDC.

    Terminals:

    Measurement terminals.

    Ground terminals.

N-MED17

- N-MED05. **DC Ammeter (0-1.5 A).**

    Measurement range: 0-2 ADC.

    Terminals:

    Measurement Terminals.

    Ground Terminal.

    Fuse: 3 A.

N-MED05

- MED65. **Digital Multimeter.**

    This module has a digital multimeter of about 3 ½ digits, with double-jack ending cables of about 4 mm to facilitate interconnections.

    With this digital multimeter we will be able to measure:

    Voltage.

    Current.

    Resistance.

    Capacitors capacity.

    Temperature.

MED65

- N-REL60. **Single-Phase Under / Overcurrent Relay.**

    Overcurrent electronic relay.

    Range: 0, 05-10 A.

    Reset and test function.

    One NONC contact.

    Timing.

N-REL60

- N-SERV1K. **1 kW Servomotor Module.**

    Dynamic and static four-quadrant operation.

    Speed and torque displays.

    Four-quadrant monitor.

    Thermal monitoring of the machine under test.

    Testing for the presence of a shaft cover.

    Connection voltage: 400 V.

    Frequency: 50 Hz.

    Maximum power output: 10 kVA.

    Maximum speed: 4000 r.p.m.

    Maximum torque 30 Nm.

    Temperature monitoring.

N-SERV1K

Specifications

- TECNEL/TM. **Hand Tachometer.**

  Two AA batteries.

  Three Positions switch to choice the measurement method.

  Speed recording push button.

  Speed measurement push button.

  Disassemble pieces for different shafts.

  Speed digital display.


TECNEL/TM

- N-VVCC. **Advanced DC Motor Speed Controller.**

  Supply voltage: 230 VAC (PH+N+G).

  Three ON-OFF switches:

   ON-OFF power switch.

   Star-Stop control activation switch.

   Internal tacho dynamo feedback switch.

  Two potentiometers:

   Speed control.

   Torque control.

  Terminals:

   Rotor terminals.

   Excitation terminals.

   Tacho dynamo terminals.

  Three driver status leds: (red, yellow and green).

  Variable output voltage: 0-300 VCC.

  Fuses:

   One of 1 A.

   One of 2 A.


N-VVCC

- 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-VVCC/M. **DC Motor Speed Controller (intermediate option).**

  Supply voltage: 230 VAC.

  Variable output voltage: 0-300 VCC.

  Fuse: 2 A.


N-VVCC/M

- N-DMC01. **Double Measurement and Control Module 1.**

  Power supply: 230 VAC.

  Analog inputs:

   Torque signal: 0-10 VDC.

   Speed signal: 0-10 VDC.


N-DMC01

- EMT1. **D.C. Independent Excitation Motor-Generator.**

  Nominal power: 250 W.

  Armature voltage: 200 VDC.

  Excitation voltage: 190 VDC.

  Armature current: 1,5 A.

  Excitation current: 0,3 A.

  RPM: 3000 r.p.m.

EMT1

- EMT2. **D.C. Series Excitation Motor-Generator.**

  Nominal power: 300 W.

  Armature voltage: 200 VDC.

  Armature current: 1,5 A.

  RPM: 7500 r.p.m.

EMT2

- EMT3. **D.C. Shunt Excitation Motor-Generator.**

  Nominal power: 300 W.

  Nominal voltage: 200 V.

  Nominal current: 1,5 A.

  RPM: 3400 r.p.m.

EMT3

- EMT4. **D.C. Compound Excitation Motor-Generator.**

  Nominal power: 250 W.

  Armature voltage: 200 VDC.

  Armature current: 1,5 A

  Excitation current: 0,3 A.

  RPM: 3000 r.p.m.

EMT4

- EMT5. **D.C. Shunt-Series Compound Excitation Motor.**

  Nominal power: 300 W.

  Armature voltage: 200 VDC.

  Excitation voltage: 230 VDC.

  Armature current: 1,5 A.

  Excitation current: 0,4 A.

  RPM: 3400/7500 r.p.m.

EMT5

- **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

DCEMT-K1: D.C. Independent Excitation Motor-Generator Kit.

1.- Wiring of the DC independent excitation motor.

2.- Starting and speed and torque control with the speed controller.

3.- Braking test with the servomotor.

4.- Measurement of the armature current and resistance.

5.- Computation of the counter-electromotive force (CEMF).

6.- Computation of the electromagnetic power and losses of the DC independent excitation motor.

7.- Obtaining of Torque vs. Speed curve for the DC independent excitation motor.

8.- Overcurrent protection calibration and testing.

DCEMT-K2: DC series excitation motor-generator Kit.

9.- Wiring of the DC series excitation motor.

10.- Starting and speed and torque control with the speed controller.

11.- Braking test with the servomotor.

12.- Measurement of the armature current and resistance.

13.- Computation of the counter-electromotive force (CEMF)

14.- Computation of the electromagnetic power and losses of the DC series excitation motor.

15.- Obtaining of Torque vs. Speed curve for the DC series excitation motor.

16.- Overcurrent protection calibration and testing.

DCEMT-K3: DC shunt excitation motor-generator Kit.

17.- Wiring of the DC shunt excitation motor.

18.- Starting and speed and torque control with the speed controller.

19.- Braking test with the servomotor.

20.- Measurement of the armature current and resistance.

21.- Computation of the counter-electromotive force (CEMF)

22.- Computation of the electromagnetic power and losses DC shunt excitation motor .

23.- Obtaining of Torque vs. Speed curve for the DC shunt excitation motor.

24.- Overcurrent protection calibration and testing.

DCEMT-K4: DC compound excitation motor-generator Kit.

25.- Wiring of the DC compound excitation motor.

26.- Starting and speed and torque control with the speed controller.

27.- Braking test with the servomotor.

28.- Measurement of the armature current and resistance.

29.- Computation of the counter-electromotive force (CEMF).

30.- Computation of the electromagnetic power and losses of the DC compound excitation motor.

31.- Obtaining of Torque vs. Speed curve for the DC compound excitation motor.

32.- Overcurrent protection calibration and testing.

DCEMT-K5: DC shunt/series/compound excitation motor-generator Kit.

33.- Desired wiring of the DC motor excitation; independent, series, shunt or compound.

34.- Starting and speed and torque control with the speed controller.

35.- Braking test with the servomotor.

36.- Use of the motor as a generator.

37.- Measurement of the armature current and resistance.

38.- Computation of the electromotive force (EMF)

39.- Computation of the electromagnetic power and losses of the DC generator.

40.- Obtaining of Torque vs. Speed curve for the DC generator.

41.- Overcurrent protection calibration and testing.

Practical exercises with the recommended Control and Data Acquisition System Software for Electrical Machines, with SCADA, "EM-SCADA":

42.- Real time torque measurement.

43.- Real time speed measurement.

44.- Real time current and voltage RMS values.

45.- Real time current and voltage waveforms measurement.

46.- Electrodynamical study of the motor.

47.- Obtaining characteristic curves (torque-speed curve, torque-current curve etc).

48.- Obtaining the saved results.

49.- Manual and automatic braking test and real time monitoring of the results.

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

## REQUIRED SERVICES

- Electrical supply: three-phase, 380V/50 Hz or 208V/60 Hz, 2 kW.

## DIMENSIONS AND WEIGHTS

AEL-DCEMT:

- Dimensions: 1380 x 840 x 660 mm. approx.

(54.33 x 33.07 x 25,98 inches approx.).

- Weight: 75 Kg. approx.

(165 pounds approx.).

## RECOMMENDED SOFTWARE

- EM-SCADA. Control and Data Acquisition System Software for Electrical Machines, with SCADA. (For more information see catalogue.Click on the following link: http://www.edibon.com/en/files/equipment/EM-SCADA/catalog

## AEL-DCEMT/ICAI. Interactive Computer Aided Instruction Software System:
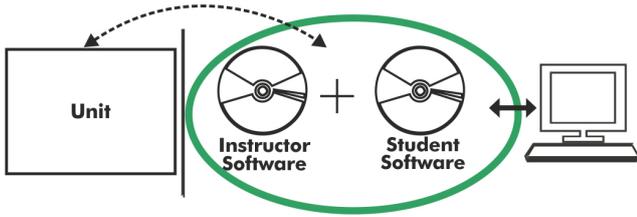


With no physical connection between unit and computer, **this complete software package consists of an Instructor Software (EDIBON Classroom Manager -ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft -ESL-SOF).** Both are interconnected so that the teacher knows at any moment 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.
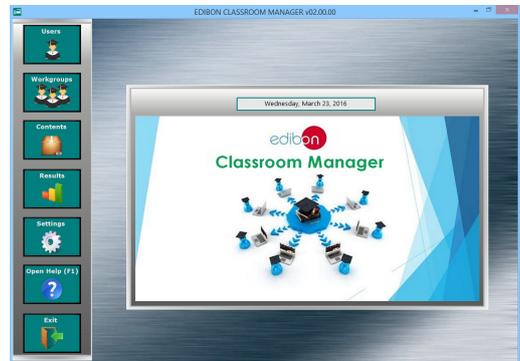


ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen
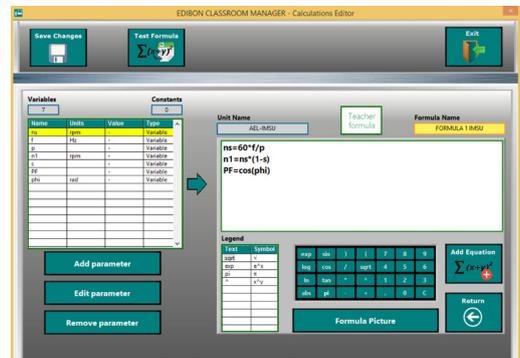


ECAL. EDIBON Calculations Program Package - Formula Editor Screen
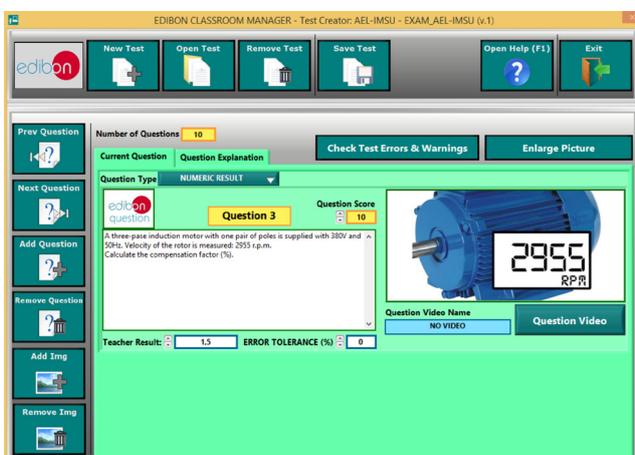


ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question



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

## 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
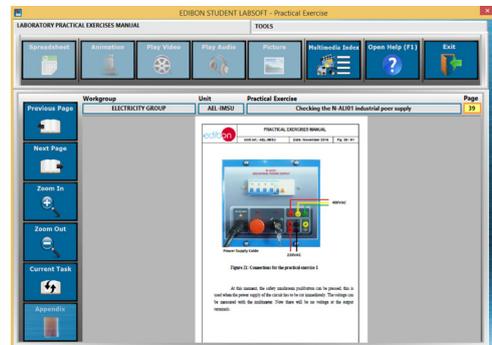

EPE. EDIBON Practical Exercise Program Package Main Screen
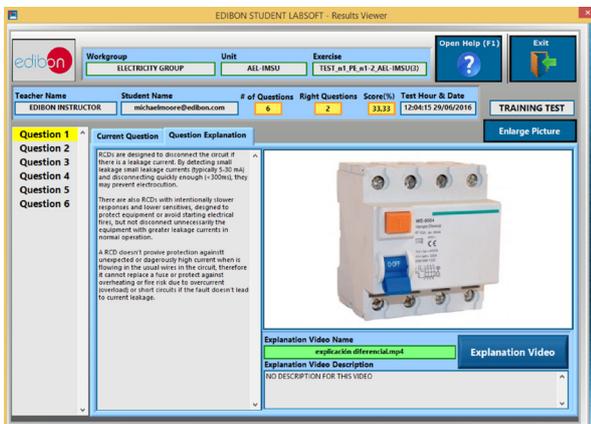

ERS. EDIBON Results & Statistics Program Package - Question Explanation
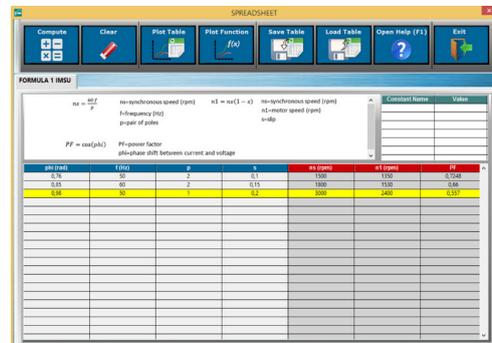

ECAL. EDIBON Calculations Program Package Main Screen

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



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Edition: ED01/18
Date:    October/2018

REPRESENTATIVE: