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Product Name :	**Product Code :**
Power Electronics Laboratory-Didactic Equipment	LIM-CAT-L0043-00004

Description :

Power Electronics Laboratory-Didactic Equipment

Technical Specification :

Power Electronics Laboratory-Didactic Equipment
This Power Electronics trainer has a modular structure and consist of didactic panels that is installed on a vertical frame.
It is developed as a comprehensive hands-ontraining solution to study all the main devices and the power conversion techniques commonly used inthe industry.
It is thought as a gradual course starting from the study of the power semiconductors and the main conversion strategies to the study of theirapplication as power supplies and drives.
It cover the following main sections:
AC to DC conversion (Rectifiers),
AC to AC conversion (AC voltage controllers),
DC to DC conversion (Choppers),
DC to AC conversion (Inverters),
Electrical drive applications for DC and AC machines.
The digital controls signals is generated using the state of the art FPGA technology to give great flexibility and reliability to reconfigure thelaboratory according to the type of converter under study.
It provide all the signalling while simultaneously acquiring the experiment data and waveform.
It is supplied with a software with intuitive user interface, to give access to the main parameters of the system, and the morphing interface isadapted to the type of the converter under study.

The SW guide the students through different proposed experiments with clear schematics, wiring diagrams, and instructins providing feedback ateach step.
With this trainer, the students is able to learn and to develop skills about:
The knowledge of power semiconductors,
The working principles of classic power converters under different conditions,
The classical control technology for electrical drive,
How to conduct measurement of high-voltage and high-current signals safety,
The modulation methods and control strategies for power converters,
The working principle of a complete power conversion system such as a frequency converter,
The knowledge of DC and induction machines,
The advanced control strategies for electrical drives,
The PID tuning,
The advanced power converters with their control,
The drivers of switching devices,
The analysis of signals in both time and frequency domains,
The expansion of applications in their own environment.
To analyze the properties of the AC squirrel cage motors and to learn how to control their speed.
It is supplied wvith a theoretical and practical manual.
The modularity of these didactic system grant to the students a direct and immediate approach to the topics, offering the opportunity to study varioussubjects and performing several experiments as following:
FOR AC-DC CONVERSION (RECTIFIERS)
Diodes and uncontrolled rectifiers
Silicon diode
Uncontrolled single-phase half-wave rectifier
Uncontrolled single-phase centre-tapped full-wave rectifier
Uncontrolled single-phase bridge rectifier
Uncontrolled three-phase half-wave rectifier
Uncontrolled three-phase centre-tapped full-wave rectifier
Uncontrolled three-phase bridge rectifier
SCR and controlled rectifiers
SCR
Controlled single-phase half-wave rectifier
Controlled single-phase centre-tapped full-wave rectifier
Half controlled single-phase bridge rectifier
Fully controlled single-phase bridge rectifier
Controlled three-phase half-wave rectifier

Controlled three-phase centre-tapped full-wave rectifier
Dual three-phase centre-tapped half-wave rectifier
Half controlled three-phase bridge rectifier
Fully controlled three-phase bridge rectifier
FOR AC-AC CONVERSION (AC VOLTAGE CONTROLLERS)
Thyristors and AC voltage controller
TRIAC
Fully controlled single-phase AC voltage controller
Fully controlled single-phase AC voltage controller with TRAIC
Half controlled single-phase AC voltage controller
Fully controlled three-phase AC voltage controller
Half controlled three-phase AC voltage controller
Two-phase controlled three-phase AC voltage controller
Light dimmer fault simulator
Phase control for the regulation of lighting with fault simulation
Double time-constant standard light dimer circuit consisting of TRIAC,DIAC,two control potentiometers, resistors,

and capacitors
Twenty faults can be switched on using switches located behind a cover with typical faults such as interruptions, short-circuit, faulty components.
and faulty design
FOR DC-DC CONVERSION (CHOPPERS)
Choppers
Switching devices (SCR with turn-off circuit,MOSFET,IGBT)
Buck converter with SCR with turn-off circuit, PWM
Buck converter with IGBT,PWM
Buck converter with MOSFET,PWM
Buck converter with MOSFET,PFM
Buck converter with MOSFET,TPC
Boost converter with IGBT,PWM
Boost converter with IGBT,TPC
Inverting converter with IGBT,PWM
Isolated switching mode power supply
Flyback converter with IGBT,PWM
Forward converter with IGBT,PWM
Asymmetric half-bridge forward converter with IGBT,PWM
FOR DC-AC CONVERSION (INVERTERS)
Inverters
Fundamentals of inverter:
1 -ph half-bridge inverter

1-ph bridge DC chopper, PWM Single-phase inverter:
1-ph bridge inverter, 180° conduction
1-ph bridge inverter, sinusoidal PWM
1-ph bridge inverter, square-wave PWM
Three-phase inverter:
3-ph bridge inverter, 180° conduction
3-ph bridge inverter, sinusoidal PWM
Multi-level inverter:
1-ph neutral point clamped (NPC) 5-level inverter, unchopped
1-ph neutral point clamped (NPC) 5-level inverter, PWM
FOR DC & AC MOTOR DRIVES
DC motor drive
DC motor drive by single-phase rectifiers:
Single-quadrant drive with 1-ph controlled rectifier
Single-quadrant drive with 1-ph controlled rectifier for closed loop armature voltage control
Single-quadrant drive with 1-ph controlled rectifier for closed loop armature voltage control with feedforward
Single-quadrant drive with 1-ph controlled rectifier for single closed loop speed control
Single-quadrant drive with 1-ph controlled rectifier for dual closed loop speed control
Two-quadrant drive (I-IV) with 1-ph controlled rectifier
Two-quadrant drive (I-III) with 1-ph controlled rectifier
Two-quadrant drive (I-III) with 1-ph controlled rectifier for dual closed loop speed control
Four-quadrant drive with 1-ph controlled rectifier
Four-quadrant drive with 1-ph controlled rectifier for dual closed loop speed control
DC motor drive by three-phase rectifiers:
Single-quadrant drive with 3-ph controlled rectifier
Single-quadrant drive with 3-ph controlled rectifier for dual closed loop speed control
Constant frequency drive - Slip ring motor
Stator voltage control:
Stator voltage control with variac

Stator voltage control with AC voltage controller
Speed control by stator voltage control with AC voltage controller
Rotor resistance control:
Rotor resistance control with rheostat
Rotor resistance control with pulsed resistor
Speed control by rotor resistance control with pulsed resistor
Rotor resistance control with Scherbius static drive
Speed control by rotor resistance control with Scherbius static drive
Variable frequency drive - Squirrel cage motor
Frequency converter:
Operation of the frequency converter
Input controlled rectifier
Output inverter
DC link brake chopper
Squirrel cage motor:
Preliminary investigation of the squirrel cage motor
Modulation methods of frequency converter:
Six-step modulation
Square wave PWM
Trapezoidal wave PWM
Sinusoidal wave PWM (SPWM)
Space vector PWM (SVPWM)
Induction motor control following U/f characteristic:
Motor magnetization for linear U/f characteristic
Extra start magnetization
IxR compensation
Operation in standard converter setting
Scaled-down operation in star connection
Speed control:
Slip compensation
Closed loop speed control.
The set of Power Electronics modules include the following:
CONTROL AND ACQUISITION MODULE - Didactic equipment
This unit is suitable to be used in conjunction with a Personal Computer as a Data Acquisition with a comprehensive control system based on a real- time processor and a high-performance FPGA, running NI Linux Real-Time.
It include a fast parallel multi-rate control algorithm with execution up to 40 MHz and high sampling rate up to 100 kHz.
It has the following technical features:
Fast data transfer via DMA, Technical Specifications
Interaction with users by graphical user interface,
Real-time control, data acquisition, and monitoring,
Ultra-wide range of potential free high-voltage and high-current measurement,
6 independent voltage-current measuring channels
Voltage range: -1000 V to 1000 V,
Current range: -25 A to 25 A,
Integrated low-pass filter BW: 15 kHz,

User-safe isolated low-voltage outputs for measuring voltages and currents with scale factors of 0.01 V/VHigh-voltage. 0.4 V/ AHigh-current,
Use with control software to realize real-time display and measurement, such as digital oscilloscope, digital meters, waveform math operation, and spectrum analyser,
6 analogue input channels with an input range of -10 V to 10 V:

Dedicated ground reference for optimum performance,
Sampling rate: 100 kHz,
Integrated anti-aliasing filter: 4th-order Butterworth low-pass filter, BW: 10 kHz,
2 analogue input channels with an input range of -20 V to 20 V:
Wide input range for different purposes,
Sampling rate: 100 kHz,
Integrated anti-aliasing filter: 4th-order Butterworth low-pass filter, BW: 10 kHz,
2 digital input channels compatible with 3.3 V and 5 V voltage levels,
2 digital output channels with 3.3 V and 5 V voltage levels,
Integrated with control software for PEL rectifiers, AC voltage controllers, DC/DC converters, inverters, and electric drives.
Power supply: from mains 100+ 240 V, 50/60 Hz and DC voltage ±15 V. It has on the front panel:
A power switch with lamp,
RJ45 connector to be wired to PC or to a router,
One male 15-pins connector and one male 25-pins connector suitable to be wired to other modules of the laboratory for control.
This module has isolated type front panel with the electrical schemes and 4 mm safety terminals for power signals and 2 mm terminals for control signals.
It is installed on a vertical frame.
It is supplied with manual in English language.
SCR AND TRIAC DRIVER - Didactic equipment
This SCR and TRIAC driver module is suitable for the triggering of SCR and TRIACs in single-phase and three-phase rectifier, inverter circuits as well as in AC controllers. It is digitally controlled by the control and acquisition module via D-sub connector.
It has the following technical features:
Power supply: '15 V (300mA),
Single-phase isolated outputs: 2 x 2,
Three-phase isolated outputs: 3 x 2,
Single pulse width: 50 ?s,
Output voltage: 0 ÷ 8 V,
Output current: ? 50 mA,
Withstand isolation voltage: 3100 VRMS.
This module has isolated type front panel with the electrical schemes and 2 mm terminals for control signals and DC power supply.

It is installed on a vertical frame.
It is supplied with manual in English language.
SINGLE MOSFET WITH DRIVER - Didactic equipment
This unit include an industrial N-channel enhancement mode power MOSFET with body diode, integrated driver, and RCD snubber.
It is possible to switch it on and off in two ways:
Non-isolated direct drive at the gate by an external signal,
Technical Specifications
Isolated digital drive by the control and acquisition module via D-sub connector (the driver is powered by ±15V).
It has the following technical features:
For MOSFET:
Drain-source voltage: UDS- 500 V,
Continuous drain current: ID= 29 A,
Drain-source on-state resistance: RDS (on) = 0.13?,
Max. Gate-source voltage: UGs=±15 V,
Total gate charge: 350 ns.
For RCD snubber:
R: 1 kW/2W,

C: 10 nF /250 VAC, 630 VDC
For Gate driver:
Input signal: 0/3.3 V, 0/5 V,
Output signal: 0/15 V,
Withstand isolation voltage: 5000 VRMS,
Peak output current: 2 A.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals for power signal and 2 mm terminals for control signal and DC power supply.
It is installed on a vertical frame.
It is supplied with manual in English language.
SINGLE IGBT WITH DRIVER - Didactic equipment
This unit include an industrial N-channel Insulated Gate Bipolar Transistor (IGBT) with body diode, integrated driver, and RCD snubber.
It is possible to switch it on and off in two ways:
Non-isolated direct drive at the gate by an external signal,
Isolated digital drive by the control and acquisition module via D-sub connector (the driver is powered by ±15V).
It has the following technical features:
For IGBT:
Collector-emitter voltage: UCES= 440 V,
Continuous collector current: Ic-50 A,

Collector- emitter saturation voltage: UCEsat= 1.5Vtyp
Max. gate-emitter voltage: UGE= ±15 V,
Low gate charge: 310 ns,
Integrated voltage spike suppression feedback to gate: > 440 V,
For RCD snubber:
R:1KW/2W,
C: 10 nF/250 VAC, 630 VDC.
For Gate driver:
Input signal: 0/3.3 V, 0/5 V,
Output signal: 0/ 13.5 V,
Desaturation voltage: 6.5 V,
Switch-on resistance: 50 W,
Switch-off resistance: 10 W,
Miller Clamping,
Fault protection with soft turn-off,
Self-locking digital fault report with indicator,
Fault clear button,
Withstand isolation yoltage: 3750 VRMS,
Peak output current: 1.5 A.
This module has isolated type front panel with the electrical schemes and, 4 mm safety terminals for power signal, 2 mm terminals for control signals and DC power supply.
It is installed on a vertical frame. Collector-emitter saturation voltage:
It is supplied with manual in English language
IGBT H-BRIDGE WITH DRIVER - Didactic equipment (2 units)
This unit include four industrial N-channel Insulated Gate Bipolar Transistor (IGBT) with body diode, integrated driver, and RCD snubber for each. It is powered by ± 15V.
It is possible to switch it on and off in two ways:
Non-isolated direct drive at the gate by an external signal,
Isolated digital drive by the control and acquisition module via D-sub connector.
It has the following technical features:
For each IGBT:
Collector-emitter voltage: UCES= 440 V,

Continuous collector current: Ic=50 A,
Collector-emitter saturation voltage: UcEsat = 1.5 Vtyp,
Max. gate-emitter voltage: UGE= ±15 V,
Low gate charge: 310 ns,
Integrated voltage spike suppression feedback to gate: > 440 V.
For each RCD snubber:
R: 1 kW/2W,

C: 10 nF/250 VAC, 630 VDC.
For Gate driver:
Input signal: 0/3.3 V, 0/5 V,
Desaturation voltage: 6.5 V,
Miller Clamping,
Fault protection with soft turn-off,
Self-locking digital fault report with indicator,
Fault clear button,
Withstand isolation voltage: 3750 VRMS,
Peak output current: 1.5 A,
Interlock circuit prevents the upper and lower IGBTs in the same column from switching on simultaneously to avoid short circuit.
This module has isolated type front panel with the electrical schemes and, 4 mm safety terminals for power signals, 2 mm terminals for control signals and DC power supply.
It is installed on a vertical frame.
It is supplied with manual in English language.
FREQUENCY CONVERTER - Didactic equipment
This module mainly consist of a half-controlled single-phase rectifier, a DC link and an IGBT-based three-phase voltage source inverter. The goal is to generate three-phase voltage with variable amplitude and frequency.
In conjunction with the control and acquisition module through 25-pins female D-sub connector, this device is used for the realization of a frequency converter for asynchronous motor drive.
It has the following technical features:
Output voltage: 3 x 0...230 V,
Output current: 3 x 8 A max.
Supply voltages: Power circuit, 1 x 255 V max, 50/60 Hz control circuit, single-phase from mains.
Single-phase rectifier:
Voltage input sockets L, N for 220 - 255 V, 50/60 Hz,
EMI filter,
EMI filter,
Half-controlled rectifier with integrated driver,
Smoothing choke 1 mH.
DC link:
DC link capacitor: 1880 mF,
DC link residual charge indicator,
Braking IGBT,
Internal braking resistor, 30 kW, always connected,

Internal braking resistor for overvoltage protection: 68 W,
Sockets for external resistor.
Three-phase inverter: .
Six-IGBT inverter with integrated driver.
Control system:
Power on switch,
Control power supply indicators,
Digital control and monitor via DSUB connector,

Self-locking error indicator for motor overtemperature and overcurrent,
Reset button to clear the reported error,
Main relay control and its status indicator, manual or digital,
DC link voltage control by knob or analog signal,
Braking IGBT control with indicator, manual or digital,
DC link overvoltage indicator,
DC link overcurrent indicator,
Inhibit inverter, manual or automatic in case of DC link overvoltage and IGBT shoot-through,
Single IGBT control with indicator, manual or digital,
Motor overtemperature detection with indicator,
Integrated tachometer through 5-pins connector.
All terminals for control signals are isolated from the electrical part.
This module has isolated type front panel with the electrical schemes and, 4 mm safety terminals for power signals, 2 mm terminals for control signals.
It is installed on a vertical frame.
It is supplied with manual in English language.
THREE-PHASE MOTOR POWER SUPPLY - Didactic equipment
This power supply unit is suitable for three-phase connection for motor protection.
It has the following technical features:
4-pole cam mains switch with lamp indicator,
Three-pole motor-protection circuit-breaker: 2.5 to 4 A,
Three-phase indicator lamps,
5 outputs through 4 mm safety terminals: L1, L2, L3, N and PE, included on the front panel for the electrical connection,
Power supply: three-phase with neutral and ground from mains.
It has isolated front panel with the electrical scheme.
This didactic panel is installed on a vertical frame.
It is supplied with manual in English language.
SILICON DIODE - Didactic equipment (4 units)
This module consist in a fast-acting silicon diode suitable to realize rectifying circuits.

It is possible to also use it as a freewheeling diode in the converters and contain an RCD snubber that could be included or excluded via a jumper. It has the following technical features:
Direct average current IFAV = 8 A max.,
Direct voltage drop: UF = 1.3V,
Repetitive peak reverse voltage, URRM = 1000 V,
Reverse recovery time t? = 47 ns max.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
DIODE STACK - Didactic equipment
This module consist in six fast-acting silicon diodes with RCD protection networks (Snubbers) suitable for realizing non-controlled rectifying circuits. Each of the six diodes has the following technical features:
Direct average current IF(AV) = 8 A max.,
Direct voltage drop: UF = 1.3V,
Repetitive peak reverse voltage, URRM = 1000 V,
Reverse recovery time t = 47 ns max.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
THREE-PHASE DIODE BRIDGE - Didactic equipment
This module consist in a non-controlled three-phase rectifier in six-pulse bridge connection for the generation of a DC voltage from three-phase mains. It has the following technical features:

Nominal alternating input voltage UVN = 400 V,
Direct output voltage U? = 540 V,
Nominal direct current IDN = 10 A.
Surge forward current IFSM = 300 A.
1^2t = 400 A^2s,
Voltage drop UF = 1 V per diode.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
SCR MODULE- Didactic equipment
This module consist in a silicon-controlled rectifier used in the control of power, in controlled rectifiers and in inverters.
It contain an RCD snubber that could be included or excluded via a jumper.
It has the following technical features:
On-state average current: IT(AV) = 8 A max.,
True rms value of the direct current: ITRMS 12 A,
Peak off-state repetitive voltage: UDRM /URRM 800 V,
Trigger current: IGT = 15 mA max.. 1.5 V max.,
Trigger voltage: UGT 1^2t = 72 A^2s.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals for power signal and 2 mm terminals for control signal. It is installed on a vertical frame.
It is supplied with manual in English language.
SCR STACK - Didactic equipment (2 units)
This module consist in six silicon-controlled rectifiers with RCD protection networks (snubbers) suitable for realizing controlled rectifiers and inverters.
Each of the six SCRs has the following technical features:
On-state average current: IT(AV) = 16 A,
True rms value of the direct current: ITRMS = 25 A,
Peak off-state repetitive voltage: UDRM /URRM 1200 VDC/440VAC
Trigger current: IGT 240 mA,
Trigger voltage: UGT = 1.3 V?
1^2t = 450 A^2s.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals for power signals and 2 mm terminals for control signals.
It is installed on a vertical frame.
It is supplied with manual in English language.
SCR WITH TURN-OFF CIRCUIT - Didactic equipment
This module consist in a SCR with turn off circuit with block and freewheeling diodes.
It has the following technical features:
Main SCR and auxiliary SCR, complete with RC suppressor circuits (snubbers),
On-state average current: IT(AV) = 8 A,
Peak off-state repetitive voltage: UDRM /URRM = 800 V,
Peak repetitive reverse voltage: URRM = 600 V,
Forward average current IF(AV) = 8 A,
Turn off capacitor: C = 2 µF, 1 mH,
Oscillation coil: L = mH
Shunt for the measurement of the currents in each branch: 4 x 0.1?
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals for power signals and 2 mm terminals for control signals.
It is installed on a vertical frame.

It is supplied with manual in English language.
TRIAC MODULE - Didactic equipment

This module consist in a bidirectional thyristor used for the control in alternated current. It is complete with RC suppressor network (Snubber). It has the following technical features:
True RMS value of the direct current: IT(RMS) = 8 A,
Repetitive peak off-state voltage: UDRM /URRM = 600 V,
Trigger gate current: IGT= 25 mA (all the quadrants),
Trigger voltage: UGT= 2.5 V (all the quadrants),
State keeping current: IH = 25 mA.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals for power signal and 2 mm terminals for control signal.
It is installed on a vertical frame.
It is supplied with manual in English language.
LIGHT DIMMER- FAULT SIMULATOR - Didactic equipment
This module is composed of a double time-constant standard light dimmer circuit.
It include:
One TRIAC,
One DIAC,
Two control potentiometers,
Resistors,
Capacitors,
Fuse holder: T6.3 A,
Ohmic load: 1.2 kW max.
A total of 20 faults is available using switches located behind a cover.
It is possible to insert typical failures such as interruptions, short-circuits, faulty components and faulty design.
Power supply: from mains 110-240 V, 47 ÷ 63 Hz.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals for power signals and 2 mm terminals for control signals.
It is installed on a vertical frame.
It is supplied with manual in English language.
FUSE BOX - Didactic equipment (2 units)
This module consist in three sectionable fuse-holders complete with super-fast fuses suitable for the protection of semiconductors.
It has the following technical features:
Nominal voltage: 660 Vac,
Nominal current (two types): 3 x 6.3 A; 3 x 10 A.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
EMI FILTER - Didactic equipment
This module consist in a line filter used to protect the mains network from the electromagnetic interference voltages generated by the switched-mode power supplies.
It has the following technical features:
Max.continuous operating voltage: 3x440/250 VAC,
Nominal current:10 A,
Operating frequency:DC to 400 Hz,
Inductances on the line: 0.4 mH,
Capacitors between conductors and neutral: 100nF,
Capacitor between neutral and ground: 4.7 nF.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
CAPACITORS MODULE - Didactic equipment
This module consist in two electrolytic high-performance capacitors.
It is suitable to be used as DC line capacitors in the switching power supplies.

It has the following technical features:
Nominal capacitor value: 2 x 1000 ?F,
Nominal voltage:385 V,
Protection against polarity inversion,
LED indication for residual charge,
Discharge resistance:20 k? (t =36 s),
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
SWITCHING TRANSFORMER-Didactic equipment
This high frequency isolation transformer is suitable for swwitching forward converters.
It also be suitable, in a restricted use, for flyback converters, but the rated values could not be guaranteed.
It has the following technical features:
Ferrite core N27 without air gap,
Primary:2 x 115 V,2 x 48 turns,
Secondary:2 x 15 V/4.5 A,2 x 7 turns,
Thermal protection: 2 x0.6 A
Interwinding shield,

Nominal power: 135 VA,
Nominal frequency:15 kHz.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
1? SHUNTS MODULE-Didactic equipment
This module include a support with 3 shunts, with different connection possibilities.
It has the following technical features:
Resistance:1?,
Accuracy:±1%,
Current: 2.5 A max.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
DC POWER SUPPLY-Didactic equipment
This module has two fixed DC voltage outputs and is protected against short-circuit.
It has the following technical features:
Output voltages: +15 V / 0 V / - 15 V,
Output current: 3 A (3.4 A for a short time),
Power supply:Single-phase from mains.
It is complete with mains switch with pilot lamp.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminal for PE and 2 mm terminals for DC voltage outputs.It is installed on a vertical frame.
It is supplied with manual in English language.
SINGLE-PHASE POWER SUPPLY-Didactic equipment
This module is suitable for connection to the single-phase mains power supply.
It has the following technical features:
Power supply: single-phase from mains,
Cam operated:2-pole mains switch 16 A,
Automatic magnetothermal circuit breaker:10 A,
RCCB:30 mA/F type,
Output terminals: L,N,and PE on safety 4 mm,
Power lamp: for presence of supply voltage,
False polarity lamp: for indication of false network polarity.

This module has isolated type front panel with the electrical scheme and is installed on a vertical frame.

It is supplied with manual in English language.
THREE-PHASE POWER SUPPLY-Didactic equipment
This module is able to supply single and three-phase voltages as well as a rectified voltage for the excitation of the Direct Current machines.
It has the following technical features:
Power supply:three-phase from mains,
An ON/OFF knob on the front panel for switching the module,
Protection on the rear side through:
1. three-pole magnetothermal switch,0.63...1A,
2. a pure four-pole differential module for protection against electrocution (Ia=30mA),
Three pilot lamps for signaling the mains voltage (1 lamp for each phase),
AC output through isolation transformer: 3 x 90 V/1.5 A with 3 intermediate sockets at 45 V,
Switch with pilot lamp on the front panel, for DC output, non-isolated from mains: 1 x 220 V/1 A, with magnetothermal protection of 1 A.This module has isolated type front panel with the electrical schemes and 4 mm safety terminals.
It is supplied with manual in English language.
R-L-C LOAD-Didactic equipment
This module consist in an ohmic, inductive and capacitive load suitable for the experiments in the Power Electronics Laboratory.
It has the following technical features:
1. Load resistors: 3 x 100 ?/1 A,
Protection with fuses: 3 x T1.25 A,
2. Load inductors:2 x(12.5+37.5)mH/2.5 A,
Possibility of connecting in series, in parallel, or in Star and Delta configuration.
Possibility of connecting in series and in parallel.
3. Load capacitors: 4/8/16 ?F-450 VAC,
Possibility of connecting in parallel.
4. Discharge resistor: 1 k?/0.22 A.
This module has isolated type front panel with the electrical schemes and 4 mm safety terminals.
It is supplied with manual in English language.
Stabilized power Supply Unit
This module consist in a DC motorized power supply for measuring with constant voltage the characteristics of the electrical machines.
It has the following technical features:
Regulated variable voltage section, used to supply the armature of DC motors with output: 0÷240 Vpc,5 A.
Constant voltage section used to supply the excitation circuit of DC machines with output:220 Vpc,1 A,

Drive: manual or external via 0 ÷ 10 Vpc signal.
It also include:
Mains switch with mains pilot lamnp, with automatic magnetothermal circuit breaker: 10 A,
Power switch with lamp for regulated section,
Drive mode changeover switch: “MAN” (manual) or “EXT” (external via DC voltage),
Output regulated voltage meter,
Manual voltage control knob,
Current limiting control knob,
Regulated voltage output safety terminals,4 mm,
Red LED for current limiting indication,
Green LED for external control indication,
Input for external control voltage,2 mm,
Power switch with lamp for constant section,
Magnetothermal protection for constant section,

Constant voltage output safety terminals, 4 mm.
This module has isolated type front panel and is supplied with manual in English language.
TRUE RMS METER-Didactic equipment (2 units)
This unit is a demonstration meter for measuring the true RMS, on a single circuit branch, of voltages and currents in AC and DC.
The RMS value of the voltage and current is visualized on LCD display.
It has a function button, which allows switching and visualizing the different parameters.
The user could communicate with the device through the RS485 serial port using Modbus protocol.
It has the following technical features:
Voltage:
0...1000VDc
0...1000VAc(peak-to-peak)
0...750VAc(RMS)
Current:
0...20Adc
0...28AAc(peak-to-peak)
0...20AAc(RMS)
Accuracy:±0.5%,
Resolution:16bits,
Refresh rate:0.5s,
Power supply: 90÷260 VAc-50/60 Hz,

Power consumption:3 VA.
It has a continuous overload protection in all ranges.
This module has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
LOAD MANAGER -Didactic equipment
This load management module consist in three independent single-phase outputs for the dynamic study of different load types.
The outputs is switchable either via Modbus RTU protocol using RS485 serial port or through the front panel using dedicated switches.
It is used to connect 3 different loads to a single phase or to manage 3 phases independently.
It has the following technical features:
3 single phase outputs through sockets and 4 mm safety terminals, 110...230VAc - 500W max.,
4 mm safety terminals for jumpers and single-phase line,
2 ports RS485 (Male/Female) supporting Modbus RTU protocol and allowing the module to be connected to high-level acquisition software,
A power-on switch,
Power supply: 90÷260 VAc, 50/60 Hz.
It has isolated front panel and is installed on a vertical frame.
It is supplied with manual in English language.
VARIABLE THREE-PHASE TRANSFORMER - Didactic equipment
This variable transformer is suitable for fine adjustment of three-phase voltages from zero to value.
The voltage is set by means of a variable autotransformer with rotary knob and the output is floating by means of an isolating transformer withsubdivided secondary winding.
It include a magnetothermal motor circuit breaker with mains lamp.
It has the following technical features:
Power supply: three-phase from mains,
Nominal output power: 550 VA,
Secondary phase current:1.25 A,
Secondary voltage: 0 to 440 V.
Operating basics:

High voltage:
Secondary connection: Y (star),
Output voltage: 0 to 440V,
Output current:1.25 A.

Low Voltage:
Secondary connection:?(delta),
Output voltage: 0 to 127 V,
Output current:2.15 A.
This module has isolated type front panel with the electrical schemes and 4 mm safety terminals.
It is supplied with manual in English language.
BATTERY STACK-Didactic equipment
This module consist in two rechargeable batteries, and it is maintenance free.
It has the following technical features:
Nominal voltage: 12 V,
Capacity: 1.8 Ah.
This module has isolated type front panel with the electrical scheme and 4 mm. safety terminals.
It is installed on a vertical frame.
It is supplied with manual in English language.
TACHOMETER MODULE-Didactic equipment
This module is equipped with an analog meter that, coupled to an optical speed transducer, allow measuring the speed of theelectrical machines.
It has the following technical features:
Speed ranges: 1500/3000/6000 min-1 with selector,
Accuracy class: 1,5%,
Output voltage: 1V/1000 min-' on 2 mm terminals,
Circular scale: 240°,
Connector for speed transducer: 5-pins male,
Overrange LED: for overload speed detection,
Power on LED:for presence of supply voltage,
PE terminal:safety 4 mm,
Power supply: single-phase from mains.
This module has isolated type front panel and is installed on a vertical frame.
It is supplied with manual in English language.
SHUNT EXCITED DC MOTOR-Didactic equipment
This direct current motor with shunt excitation has the following technical features:
Power:200 W,
Voltage:220 V,
Current: 1.2 A,
Excitation: 150 V,0.06 A,
Speed:3000 min-'.
It is possible to couple this item with other electrical machines through a hub and spider elastic gear ring in polyurethane.

It is supplied with a hooked module with safety 4 mm terminals for the electrical connection with ground and 2 mm terminals for thermal protectionwith Normally Closed contact.
The module show a silk-screened diagram of the electrical circuits of the motor and is provided with:
a side plate to fix the unit with screws to the universal base through 4 holes where the machine remain suspended,
a coupling joint with reflecting strip and with diam. 40mm.
It is supplied with manual in English language.
SHUNT EXCITED DC GENERATOR-Didactic equipment
This direct current generator with shunt excitation has the following technical features:

Power: 160 W,
Voltage:220 V,
Current:0.73 A,
Excitation:220 V,0.084 A,
Speed:2850 min-1.
It is possible to couple this item with other electrical machines through a hub and spider elastic gear ring in polyurethane.
It is supplied with a hooked module with safety 4 mm terminals for the electrical connection with ground and 2 mm terminals for thermal protectionwith Normally Closed contact.
The module show a silk-screened diagram of the electrical circuits of the motor and is provided with:
a side plate to fixthe unit with screws to the universal base through 4 holes where the machine remain suspended
A coupling joint with refelection strip and with diam 40mm
SLIP RING 3-PHASE MOTOR-Didactic equipment
This slip ring three-phase induction motor, with both stator and rotor three-phase windings, has the following technical features:
Power:250 W,
Voltage:230/400 V?/Y,
Current:1/0.58 A?/Y,
Speed:2850 min',
Frequency:50 Hz.
It is possible to couple this item with other electrical machines through a hub and spider elastic gear ring in polyurethane.
It is supplied with a hooked module with safety 4 mm terminals for the electrical connection with ground and 2 mm terminals for thermal protectionwith Normally Closed contact.

module show a silk-screened diagram of the electrical circuits of the motor and is provided with:
a side plate to fix the unit with screws to the universal base through 4 holes where the machine remain suspended,
a coupling joint with reflecting strip and with diam. 40mm.
It is supplied with manual in English language.
Rotor RHEOSTAT MODULE - Didactic equipment
This module consist in a step operated starter for three-phase induction motor with slip ring rotor.
It has the following technical features:
Selector:5 positions,
Step resistance value: 3 x(12-6-3-1-0)?,
Current: 3 x 2.5 A max.
It has isolated type front panel with the electrical scheme and 4 mm safety terminals.
It is supplied with manual in English language.
POWDER BRAKE-Didactic equipment
This powder brake,suitable to couple the different motors in the laboratory, has the following technical features:
DC Voltage supply:0÷24 V,
Power:400 W,
Speed:4000min-1,
Braking torque:12 Nm,
Thermal protection: NC contact switch with break temperature 90°C (make 75°?).
Fan: supplied single-phase mains.
It also be equipped with the following:
Lever arms (2x300mm) and weights (2x1.5 N+2x2 N),
Holes for assembling the lever arms,
Flange for assembling to the base frame,
Coupling half-joint,
Threaded holes and bending pin for assembling the load cell.

It is possible to couple this item with other electrical machines through a hub and spider elastic gear ring in polyurethane.
It is supplied with a hooked module with safety 4 mm terminal for PE and 2 mm terminals for its power supply and for thermal protection.
The module show a silk-screened diagram of the electrical circuit of the brake and is provided with:
a side plate to fix the unit with screws to the universal base through 4 holes where the machine remain suspended,
a coupling joint with reflecting strip and with diam.40mm.

LOAD CELL-Didactic equipment
Resistance electronic strain gauge with 51N range is mounted on the braking system to measure the mechanical torque.
The load cell consist in a precise bridge transducer using special materials to get the best performances.
It work by flexure, and the outgoing electric signal is proportional to the applied force and to the supply voltage.
It is made up by special steel and is OIMLR60 directive compliant with combined error ?± 0.05% and IP65 compliant.
It has the following technical Features:
Rated output voltage: 3mV/V±5%,
CREEP at nominal load in 30 minutes: 0.05 %,
Max supply voltage without damage:10 V,
Input resistance:410?±40,
Output resistance:350?±5,
Zero balance:±2%,
Isolation resistance:>2000 M?,
Safe overload (% of Full Scale): 150 %,
Ultimate overload (% of Full Scale):>200%,
Deflection at nominal load: 0.5 mm.
For temperature:
Temperature effect on zero:0.005%?,
Temperature effect on span:0.005%?,
Compensated temperature range: -10°?/+ 40?,
Operating temperature range: -20°C/+ 60°C.
It is equipped with 5-pins connector.
It is supplied with manual in English language.
POWDER BRAKE CONTROL UNIT-Didactic equipment
This module, used in conjunction with the brake and the base with optical transducer, allow the measurement of the speed and the torque developedby an electric motor.
It supply the excitation voltage required by the brake in manual and automatic mode.
The speed and the torque is shown through analog meters and signals for X-Y recording also be available on the front panel.
It has the following technical Features:
Start/Stop button with Power On lamp,
Switch for MAN or EXT modes with 2 mm terminals for external voltage input (0 ÷10V),
For speed section:
1. Male connector with 5-pins for the speed transducer,
2. Circular scale three-range analog instrument: 1500/3000/6000 min-' with LED for under value indication,

Analog output available on 2 mm terminals: 1 mV/min-',
Potentiometer for fine speed adjustment: nmin 0+60%.
For torque section:
Female connector with 5-pins for the torque transducer,
Circular scale three-range analog instrument: 1.5/3/10 Nm with LED for over value indication,
Analog output available on 2 mm terminals:1 V/Nm,

Potentiometer for fine torque adjustment: M?Ax 40+ 100%.
Zero and Gain trimmers for fine adjustment of the instrument(only for initial calibration) with LED.
For brake control:
Output voltage on 2 mm terminals: 0 to 12 Vdc, 0.5 A,
Switch for: Manual,External,or Automatic regulation,
Knob for fine output voltage variation in manual mode.
Thermal protection with NC contact on 2 mm terminals with LED alarm indication and reset pushbutton,
Recorder pen control on 2 mm terminals,
Power supply: Single-phase from mains.
It has isolated front panel and is supplied with manual in English language.
BASE FOR MACHINES COUPLING-Didactic equipment
This item consist in a metallic structure, fire varnished and accurately treated, suitable for mounting the machines or the group under test throughholes available on both sides.
It is complete with optical transducer with 5-pins connector for rotating speed detection, and a plastic opening in the upper part to observe thecoupling, the joints, and the speed reading system.
It is equipped with highly sensitive shock absorbers, with anti-vibration rubber feet, adjustable in height for perfect support on the worktop.
It is supplied with manual in English language.
SQUIRREL CAGE ASYNCHRONOUS MOTOR-Didactic equipment
This module consist in an induction motor with three-phase stator windings and buried squirrel cage in the rotor.
It has the following technical features:
Nominal power: 370 W,
Nominal voltage:230/400 V ?/Y,
Nominal current: 1.9/1.1A ?/Y,
Coso:0.7,
Speed:2870 min-',50 Hz.
It is possible to couple this item with other electrical machines through a hub and spider elastic gear ring in polyurethane.

It is supplied with a hooked module with safety 4 mm terminals for the electrical connection with ground and 2 mm terminals for thermal protectionwith Normally Closed contact.
The module show a silk-screened diagram of the electrical circuits of the motor and is provided with:
a side plate to fix the unit with screws to the universal base through 4 holes where the machine remain suspended,
a coupling joint with reflecting strip and with diam. 40mm.
It is supplied with manual in English language.
FLYWHEEL-Didactic equipment
This item is used in deceleration tests on rotating machines for calculation of mechanical iron and copper losses at different excitations.
It has the following technical features:
Nominal force: 101 N,
Rotational inertia:0.0129 Kg?,
Speed:4000 min-'.
It is possible to couple this item with other electrical machines through a hub and spider elastic gear ring in polyurethane.
It is supplied with a hooked module and is provided with:
a side plate to fix the unit with screws to the universal base through 4 holes where the machine remain suspended,
a coupling joint with reflecting strip and with diam. 40mm.
It is supplied with manual in English language.
THREE-PHASE ISOLATION TRANSFORMER-Didactic equipment
Isolation transformer that is placed between the three-phase mains and the laboratories providing a three-phase

secondary voltage with isolatedneutral suitable for the module's operation.
It has the following technical features:
Three-phase mains input with +10%/-10% adjustment,
Output: 400V with +5%/-5% adjustment
1. 3 x three phase CEE sockets (3P+N+E),
2. 2 x single phase CEE sockets(2P+E),
3. 2 x single phase type F socket.
16 A,30 mA differential magnetothermal protection,
Motor-protection circuit-breaker: 6.3 to 10 A.
Mushroom emergencies stop push-button,
Output power: 3 KVA.
It is complete with 4 wheels, two of which with locking.
It is supplied with manual in English language.
THREE-LEVEL FRAME (2 units)

A metal frame suitable to assemble the modules of the laboratory.
It has the following characteristics:
Three levels with a LED strip on the top,
With PC holder.
It is mounted on the workbench and complete with a sheet for its installation.
PERSONAL COMPUTER
Supplied with the trainer and the necessary already installed software to perform most of the experiments.
120X90 WORKBENCH (2 units)
Workbench with melamine flatbed.
Two holes is present on the flatbed to allow the assembly of a three-level frame.
It has the following technical features:
Dimensions:80x120x90(HxWxL),
Complete with locking wheels.
It is equipped with 15 sockets protected by a magnetothermal circuit breaker.
It is supplied with a sheet for its installation.
60X90 WORKBENCH (2 units)
The multifunctional workbench is used as support for electrical machines.
It has the following technical features:
Dimensions: 80x60x90cm(HxWxL),
Complete with locking wheels.
It is supplied with a sheet for its installation.
HOLDER FOR LEADS
Realized in a rugged structure, this product is used to store and to organize the various connecting leads in the laboratory.
It is equipped with wheels at the base.
It is supplied with a sheet for its installation.
Kit of connecting leads ofdifferent lengths and colours with safety terminals.

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