

**Product Name :**  
Dissectable Rotating Machines Semi-Automatic System-  
Didactic Equipment

**Product Code :**  
LIM-CAT-L0043-00002



**Description :**

Dissectable Rotating Machines Semi-Automatic System- Didactic Equipment

**Technical Specification :**

Dissectable rotating machines semi-automatic system- didactic equipment

This equipment is an "open" structure, where rotor windings, stator windings and brushes are completely exposed to perform didactic experiences such as the analysis of magnetic fluxes and magnetic fields. The students could learn in detail the internal construction and assembly of different types of electrical machines and carry out practical tests for the acquisition of their operating characteristics.

The trainer is a complete set of components for the assembling many rotating electric machines, for DC and AC. With this trainer, it is possible to learn and to assemble at least the following rotating machines:

Shunt, series, and compound excited DC motor

Shunt, series, and compound excited DC motor

Induction motors: three-phase slip ring and squirrel cage, single- phase repulsion and with capacitor

Dahlander motor

Synchronous motor

The power of the machines is of about 200W.

It is possible to perform the following experiments:

Flux produced by the poles

Main magnetic field

Intensity of the magnetic field

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Induced voltage  
Inter pole effect  
No-load magnetic neutral axis  
Rotating magnetic field  
3-phase squirrel cage motor, 2 poles, 24V?  
3-phase squirrel cage motor, 2 poles, 42V?  
3-phase squirrel cage motor, 2 poles, 24V??  
3-phase squirrel cage motor, 2 poles, 42VYY  
3-phase squirrel cage motor, 4 poles, 24V?  
3-phase squirrel cage motor, 4 poles, 42V?  
3-phase Dahlander motor, 4/2 poles, 42V?/ YY  
Split Phase Motor  
Capacity Start and run motor  
3- phase motor with round rotor, 2poles, 42VYY  
Phase shifter  
Induction regulator  
3-phase synchronous motor, 2 poles, 24V?  
3-phase synchronous induction motor, 2 poles, 24 VAA  
DC motor with separate excitation  
DC motor with shunt excitation  
DC motor with series excitation DC motor with compound excitation, long shunt  
DC motor with compound excitation, short shunt  
Single phase series motor  
Repulsion motor Synchronous motor winding resistance  
Synchronous motor no-load test  
Synchronous motor short-circuit characteristics  
Synchronous motor short-circuit test  
Synchronous motor Behn - Eschenberg's method  
Synchronous motor load test  
Synchronous motor conventional efficiency  
Parallel connection of the alternator with the mains  
Alternator as synchronous motor  
DC generator winding resistance  
DC generator test of the no-load motor (Swinburne)  
DC generator no-load e.m.f.  
DC generator excitation characteristics  
Separate excitation dynamo  
Shunt excitation dynamo  
Series excitation dynamo  
Compound excitation dynamo  
DC motor with permanent magnet  
DC generator with permanent magnet  
It is composed of the following modules: fully dissectible system, power supply module, electrical and speed measurement module. loads and rheostat module, adapter bracket, locking and rotatable device, pole changing unit, parallel board, electromagnetic brake, star/delta starter and starting and synchronization unit.  
Fully dissectible system  
It is include the following elements:  
Base plate  
Supports with bearing  
Coupling joints  
Flexible coupling  
Electronic speed transducer  
Assembling screws

## Wrenches

DC stator: it is composed of a metal frame supporting the laminated magnetic circuit, with 2 main poles and 2 interpoles, and the electrical windings. The sheet iron pack is 60 mm long, with internal diameter of 80 mm. On the poles, the coils are wound whose terminals are shown on a suitable educational terminal board.

AC stator: it is composed of a metal frame supporting the laminated magnetic circuit, because interested by a flux variable in time and the electrical winding. The sheet iron pack is 60 mm long, with internal diameter of 80 mm and external one of 150 mm and it presents 24 half-closed slots inside of which there is a double 3-phase winding: the beginnings and the ends of the different phases are shown outside the stator on a suitable educational terminal board. The winding is a double layer one of the long coil lap type, with winding span 6 ( $1 \div 7$ ). Every slot contains two coils of 19 turns each of enameled wire of diameter 1.12 mm.

A permanent magnet stator

DC Rotor with commutator: it is composed of a shaft to which the segment commutator is fixed and of a magnetic sheet iron pack where 20 semi-closed slots suitable to contain the electrical winding are set. The sheet iron pack is 60 mm long, with external diameter of about 80 mm. The winding is a double layer one of the long coil lap type, with winding span 9 ( $1 \div 10$ ). Every slot contains two coils with two sections of 5+5 turns carried out with enameled wire of diameter 1.12 mm. The winding is subordinate to the 40 segments of the commutator on which two brushes supported by a brush holder graze.

The brushes are subordinate to terminals set on two external boards that show the synoptic of the rotor winding. Brush holder with 2 brushes.

AC Cage motor: the squirrel cage rotor is composed of a shaft to which a pack of magnetic sheet irons is fixed, where the slots suitable to contain the rotor winding are set. The sheet iron pack is 60 mm long, with external diameter of about 78 mm. To avoid the phenomenon of the motor crawling in starting phase and to reduce the noise, the slots are inclined as regards the stator ones.

The rotor winding is composed of the squirrel cage. The cage is carried out by setting in every rotor slot some conducting bars that are closed in short-circuit at both ends by means of some conducting rings.

The rotor winding can be therefore considered a multiphase winding, with a single conductor for pole-phase, so it does not present its proper pole number, but it assumes one that is equal to the stator winding one.

AC Ring motor: the ring rotor is composed of a shaft to which the collector rings and a magnetic sheet iron pack are fixed: the iron pack has 21 semi-closed slots suitable to contain the winding. The sheet iron pack is 60 mm long, with external diameter of about 78 mm. To avoid a noisy mechanical running the rotor slots are inclined as regards the stator ones.

The rotor winding is composed of coils and it is two-pole three-phase. The winding is a double layer one of the long coil lap type, with winding span 9 ( $1-10$ ). Every slot contains two coils of 8 turns each of enameled wire of diameter 1.5 mm.

The winding is star connected and it is subordinate to the collector rings while the star center is internal and not accessible. The terminals of the rotor winding are accessible by means of the collector rings on which the brushes supported by a brush holder graze. The brushes are two for each phase and they are subordinate to an external terminal board that shows the synoptic of the rotor winding.

Brush holder with 6 brushes.

A magnetic probe is foreseen to display the magnetic fields and for the operator safety, a transparent covering is provided preventing from the accidental contact with the rotating parts.

A transparent Plexiglas screen for protection.

Power supply module

It has the following features:

AC Outputs:

Three-phase voltage 24V/14A

Three-phase voltage 42V/10A

Variable single-phase voltage  $0 \div 48V/5A$

Variable single-phase voltage  $0 \div 10V/12A$

DC Outputs:

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Rectified voltage with three-phase bridge 32V/14A  
Rectified voltage with three-phase bridge 42V/10A  
Rectified voltage with variable single-phase bridge from 0÷40V/5A  
Rectified voltage with variable single-phase bridge from 0 ÷ 8V/12A

On the front panel the following elements is included:

Mains supply indicator lamp inserted

Indicator lamps of the voltage range

Fixed voltage selector

DC fixed voltage output switch

Three-phase fixed voltage output switch

Variable voltage selector

DC/AC voltage variator

Variable voltage output magnetothermic protection.

On the back panel the following elements will be included:

Speed protection connector

General differential magnetothermic switch

Fixed voltage output magnetothermic switch

Supply cable

Three-phase power supply from mains and complete with over-speed protection.

Electrical measurement module

The metering module is designed to carry out all the basic measurements in the electrical machine's laboratory.

The module include three identical multifunction digital instruments to perform electrical measurements.

Each multimeter provide the voltage, current, and power values, in both DC and AC, available in three selectable display modes:

AC and DC voltage and current

AC rms voltage, current and power

DC voltage, current and power.

It has the following technical features:

Power supply: 100÷240 Vac, 50/60 Hz

Vac/Vdc measurement range:0-65V

Iac/I dc measurement range:0+20A

Communication: Modbus RTU Protocol.

This didactic panel is installed on a vertical frame.

Mechanical power digital measuring unit

Suitable for direct measurement of motor output torque through load cell and of rotating speed through optical transducer, with mechanical power display. The module is composed of:

Digital readout by LCD 20x2 of the measured quantities (Torque, speed, and temperature).

Connector for over speed protection of the motors through the connection to the power supply module.

Ambient temperature sensor and probe for measuring the temperature of the motor.

Communication: RS485 with MODBUS RTU protocol.

Power supply:single-phase from mains: 100÷240 Vac,50/60 Hz

Buttons for switching scaling-International System/UK System.

It has the following technical features:

Torque: suitable for measuring the torque of the laboratory through the load cell

Speed: suitable for measuring the speed of the machines of the laboratory

Power: suitable for measuring the power of the machines of the laboratory

Power supply: single-phase from mains

On the front panel the following elements is included:

Connector for speed protection connection

Connector for speed transducer connection

Connector for temperature probe

Load cell connector

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1LCD display for mechanical parameters

1 LCD display for thermal parameters

This didactic panel is installed on a vertical frame.

Load cell

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  $\pm 0.05\%$  and IP65 compliant.

It has the following technical Features:

Rated output:  $3mV/V \pm 5\%$

CREEP at nominal load in 30 minutes:  $0.05\%$

Max supply voltage without damage: 10 Volt

Input resistance:  $410 \pm 40$

Output resistance:  $350 \pm 5$

Zero balance:  $\pm 2\%$

Insulation resistance:  $> 2000 M\Omega$

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:  $-10^\circ/+40^\circ$

Operating temperature range:  $-20^\circ/+60^\circ$

Loads and rheostat module

This module is planned to carry out resistive and capacitive loads suitable for the generators of the electrical machine laboratory.

Besides the same loads, it is possible to use it as starting rheostat both for the three-phase asynchronous motors with winded rotor and for the direct current motors and as starting and running capacitors for the induction single phase motor. This module contain both a load rheostat and an excitation rheostat to adjust the field current.

It has the following technical features:

Resistive load R with three fixed resistances:  $15\Omega/90W$

Capacitive load C with three fixed capacitors:  $80\mu F/150V$

Load rheostat: fixed resistance from  $1\Omega$  in series to a variable resistance from 0 to  $2\Omega$ ; Current:  $8,5A (S0W)$

Excitation rheostat: variable resistance from 0 to  $80\Omega$ ; current:  $1A$ .

Adapter bracket

This module is suitable to connect the locking device, the brake, or the drive motor.

Locking and rotatable device

This module is suitable for locking and for rotating the rotor of slip-ring induction motors to obtain an induction regulator and phase transformer.

Pole changing unit

This module consist in a switch to change the number of poles on Dahlander motors. It has 9 terminals + 1 PE.

A schematic diagram allow an easy operation of the unit.

Parallel board

This module consist in a rotating light synchronoscope to perform the parallel connection between synchronous generators or between the alternator and the mains.

It has 3 lamps, 5 terminals, 1 switch and 1 PE.

A schematic diagram allow an easy operation of the unit.

This didactic panel is installed on a vertical frame.

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### Electromagnetic brake

This module include a smooth roil rotor and a salient pole stator. It is provided with water level, arms, weights, and balance weight form mmeasuring the output torque of the motor.

There is the possibility of assembling a load cell.

It is possible to couple this machine with other electrical machines through a hub and spider elastic gear ring in polyurethane. It is supplied with a hooked module in aluminium and safety terminals for the electrical connection. A schematic diagram is shown on the hooked module .It 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.

### Star/delta starter

This module is suitable for three-phase squirrel cage induction motors. It has 9 bushes +1 PE. A schematic diagram allow an easy operation of the unit.

It has 9 terminals, 1 switch and 1 PE.

### Starting and synchronization unit

This module consist in a rotor starter for three-phase slip ring motors and excitation device for synchronization with the mains. A schematic diagram allow an easy operation of the unit. Power supply: 220Vac, 50/60 Hz.

### Data acquisition and processing software

This software permit to execute, in an automatic or semi-automatic mode, under the control of the computer, all the tests that is normally executed inside the Electrical Machines Laboratory.

It is designed to measure electrical machines parameter in many working conditions, through dedicated instruments; it allow the data export.graphs tracing and the computation of main parameters not directly acquirable.

It is possible to perform the following experiments for asynchronous machines:

No load test of the Three-phase Asynchronous Motor

Short circuit test of the Three-phase Asynchronous Motor

Measurement of the internal resistance of a Three-phase Asynchronous Motor

Measurement of the transformation ratio of the Three-phase Asynchronous Motor

Direct test of the Three-phase Asynchronous Motor

It is possible to perform the following experiments for synchronous machines:

Magnetization Characteristic of a Synchronous Machine

Short-circuit Characteristic of a Synchronous Machine

Measurement of the Winding Resistance of a Synchronous Machine

External Characteristics of the Synchronous Machine

Regulation Characteristic of a Synchronous Machine

No load Test of a Synchronous Machine as a Motor

"V" curve plot of a Synchronous Machine

It is possible to perform the following experiments for direct current machines:

Measurement of the internal resistance of a Direct Current Machine

Computation of the conventional efficiency of a DC Generator

Magnetization characteristic of a DC Generator

External characteristics of the DC Generator

Regulation characteristic of the DC Generator

No load test of the Direct Current Motor

Direct test of the Direct Current Motor

### Smart Simulator for Electric Machines Training

This software simulate a real electric motor's workbench so that the student is able to perform the experiments in the virtual environment in a simple and almost real way, in a way very close to what he/she would do on a real equipment.

It is conceived as a complete course in electric machines to make the student able to solve practical and real assembling problems and to work on several experiments in the virtual equipment and then perform them by submitting the electric assembled machine to different working conditions. The software has a 3D environment

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composed by a workbench with electric motor components, power modules, sensors, actuators, and instruments, and all the components have and look like real ones, with texture and lightening.

It includes a frame with base to fix the modules and the machines and has a set of electric machine components, including but not limited to rotors suitable for AC and DC motors, stators suitable for AC and DC motors, electromagnetic brake, brake support with load cell for measuring the torque, coupling joint for mechanically connecting the rotor to the electromagnetic brake or other components, speed transducer for measuring the motor

speed, block with rotation system to lock the motor or turn it manually by means of a crank, brush with brush holder, and supports.

The software also provides the student with the theoretical content that is necessary to perform the experiments, and every experiment has detailed instructions on how to assemble, wire and to perform it.

It also includes the typical modules used in electric machines experiments, including but not limited to:

AC three-phase source,

AC single-phase source,

DC source,

Wattmeter's,

Speed Meter,

Torque Meter,

Amperemeters,

Voltmeters,

Starting Rheostat with Resistive Load,

Pole Changing Unit,

Excitation Rheostat with Capacitive Load,

Rotating light synchronoscope,

Pole changing unit,

Star/Delta starter,

Starting rheostat and synchronizer,

Oscilloscope.

Besides the mechanical assembly, the software allows the student to perform the wiring, including the wiring between power supplies and the electric motor, brake, sensors and/or other devices used in each experiment, the connections on the electric motor itself, and the connections between the devices and the measurement modules.

The software has at least 45 different experiments, including but not limited to the following topics:

Basics concepts of an electric machine:

Flux produced by the poles-Main poles

Flux produced by the poles-Interpoles

Main magnetic field - Concurrent series

Intensity of the magnetic field

Induced voltage

Interpole Effect

Rotating magnetic field-three-phase and single-phase rotating fields

Induction motors:

Three-phase squirrel cage motor, 2 poles, 24V ?

Three-phase squirrel cage motor, 2 poles, 42V Y

Three-phase squirrel cage motor, 2 poles, 24V ??

Three-Phase squirrel cage motor, 2 poles, 42V YY

Three-Phase squirrel cage motor, 4 poles, 24V ?

Three-Phase squirrel cage motor, 4 poles, 42V Y

Three-Phase Dahlander motor, 4/2 poles, 42V ?/YY

Split phase motor

Capacitor start and run motor

Three-phase motor with wound rotor, 2 poles, 42V YY

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Phase shifter  
Induction regulator  
Three-Phase synchronous induction motor, 2 poles, 42V?  
Three-Phase synchronous induction motor, 2 poles, 24V??  
Direct current motors:  
DC motor with separate excitation  
DC motor with shunt excitation  
DC motor with series excitation

DC motor with compound excitation, long shunt  
DC motor with differential excitation, long shunt  
DC motor with compound excitation, short shunt  
DC motor with differential excitation, short shunt  
Commutator motors for alternating current:  
Single-phase series motor  
Repulsion motor  
Synchronous machines:  
Winding resistance  
No-load test, mechanical losses of the DC motor  
No-load test, mechanical and iron losses of the alternator  
Short-circuit characteristic  
Short-circuit test  
Load test  
Parallel connection of the alternator with the mains  
Alternator as synchronous motor  
Direct current generators:  
Winding resistance-Armature winding  
Winding resistance-Series and interpole windings  
Winding resistance-Inductor winding  
Test of the no-load motor (Swinburne)  
No-load E.M.F.  
Excitation characteristic  
Separate excitation dynamo  
Shunt excitation dynamo  
Series excitation dynamo  
Compound excitation dynamo.

The software guide the student through the learning process automatically by providing the above experiment proposals and, for each experiment, it automatically verify if the student has performed the mechanical assembly and the wiring correctly, and then if so, it allow to perform the simulation and measurement by comparing the student's measurements with the expected values for the experiment.

When the student finishes an experiment, the software register the progress locally and in a cloud system so that the student can start the experiment using one computer, and continue somewhere else, using the same or another computer synchronizing the student's progress.

The software has a detailed online help with text and videos made from screen recordings with the software, so that the instructions on how to use it are clear and easy to understand. The software is delivered always in full version with feature unlock through a cloud system so that any user can download the software from the internet where the school may provide access to users to the software features.

It is possible to select an interface language between English, French, Spanish, and Portuguese.

Three level work frame

This three-level work metal frame is supplied to assemble the modules of the laboratory.

The trainer is supplied with a set of cables and tools for conducting experiments and tests and manuals in English language.



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Dissectable Rotating Machines Semi-Automatic System- Didactic Equipment, Dissectable Rotating Machines Semi-Automatic System- Didactic Equipment Bulk Suppliers, Dissectable Rotating Machines Semi-Automatic System- Didactic Equipment Tools, Dissectable Rotating Machines Semi-Automatic System- Didactic Equipment Dissectable Rotating Machines Semi-Automatic System- Didactic Equipments, Dissectable Rotating Machines Semi-Automatic System- Didactic Equipment Manufacturers, Dissectable Rotating Machines Semi-Automatic System- Didactic Equipment Suppliers from India, China, Kenya.



## Laboratory instruments manufacturers India