SMARTSIM

DL OPENLAB-SSEM

SMART SIMULATOR FOR ELECTRIC MACHINES TRAINING

DE LORENZO

SMART SIMULATOR FOR ELECTRIC MACHINES TRAINING

The DL OPENLAB SMARTSIM is a software that has been developed to teach main topics related to electric machines in a unique and effective way.

With this software, students can improve their individual experience studying electric machines in practice.

Students will be able to carry out several experiments dealing with the following topics:

- ✓ Mechanical assembly;
- ✓ Wiring
- ✓ Tests and measurements.

This software will be able to reproduce the features and behaviours of DE LORENZO Electric Machines Laboratory – DL OPENLAB.
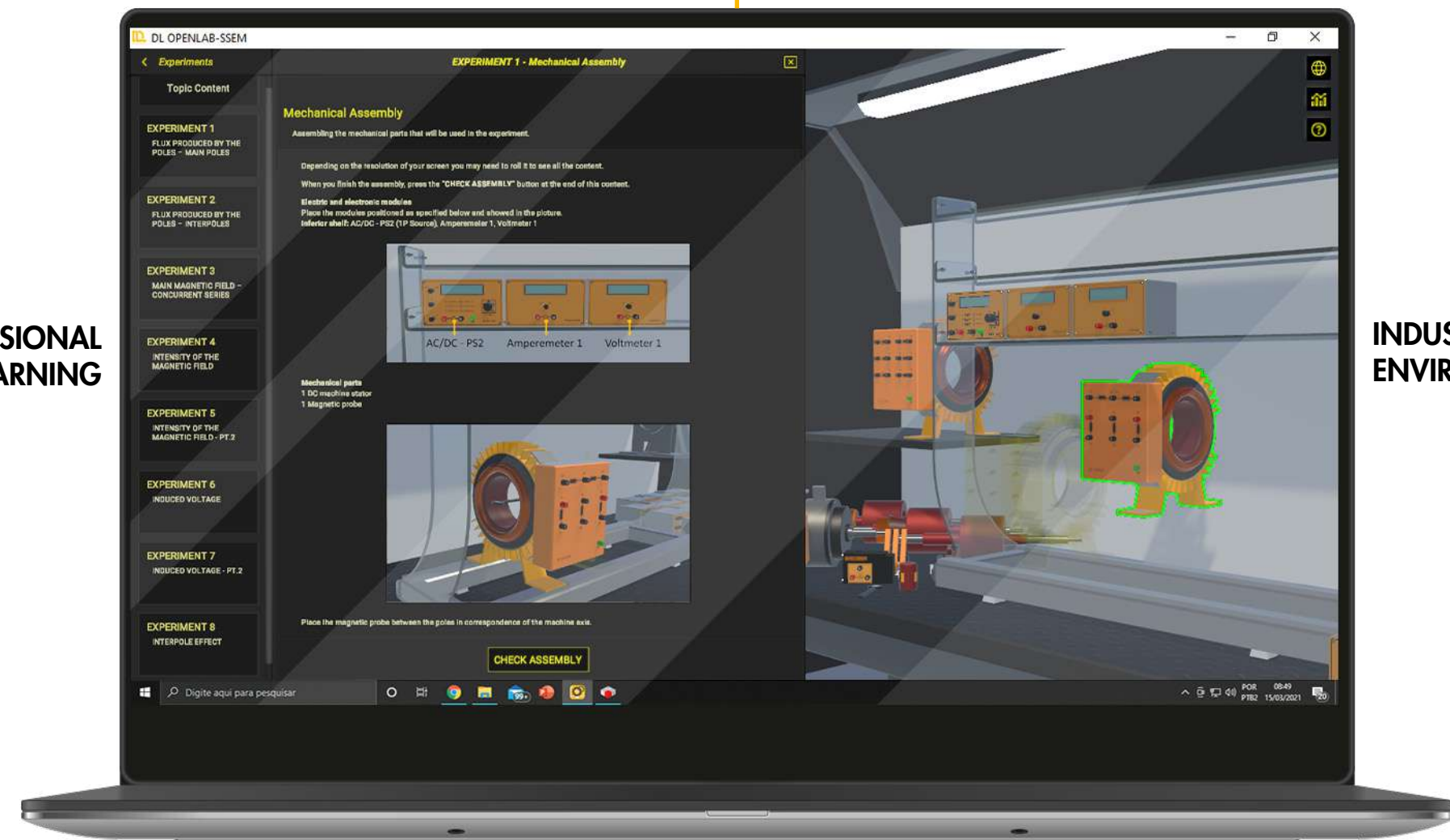
With this type of software developed by DE LORENZO, students can learn in their own rhythm and teachers have more time to support the class, manage and improve the process because - unlike any other simple simulator - it grants the following benefits:

INDUSTRIAL TOOLS | POWERFUL 3D SIMULATOR

PROFESSIONAL LEARNING
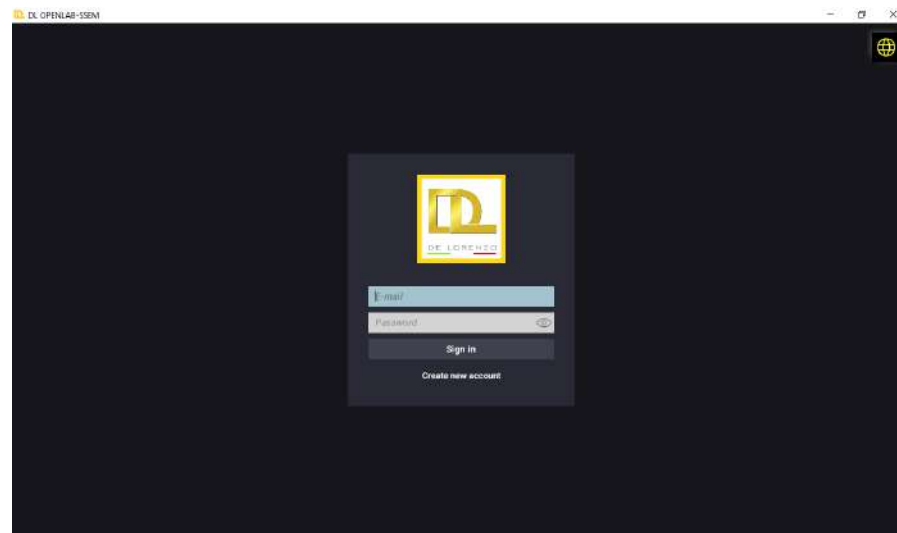
INDUSTRIAL REALISTIC ENVIRONMENTS
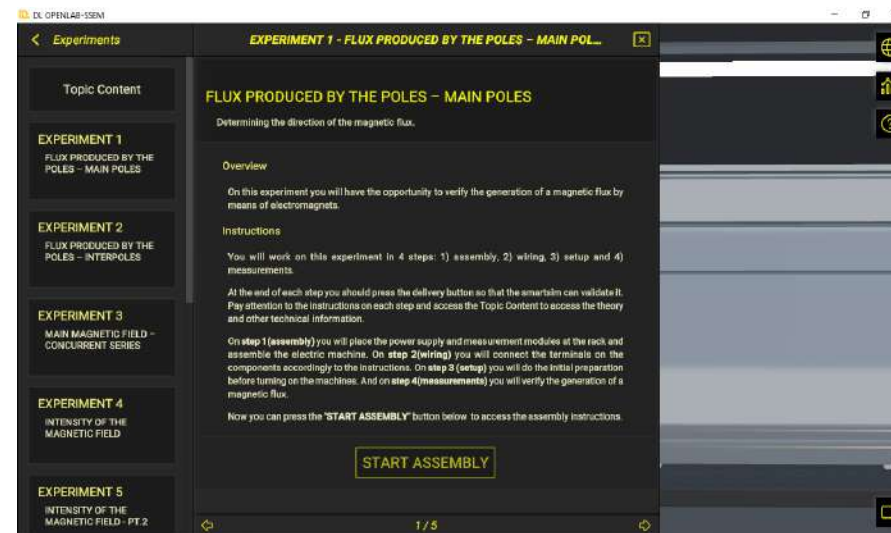
PROFESSIONAL EXPERIENCE | REAL-LIFE SITUATIONS
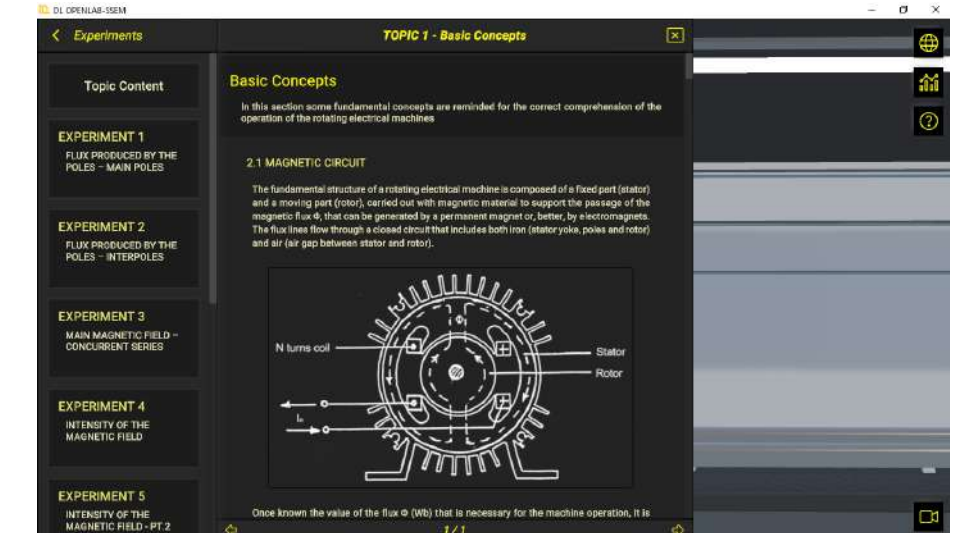
1. EFFECTIVE GUIDE FOR STUDENT

Possibility to access learning topics, with theory, instructions and experiment proposals. The software includes a virtual version of the DL OPENLAB system;

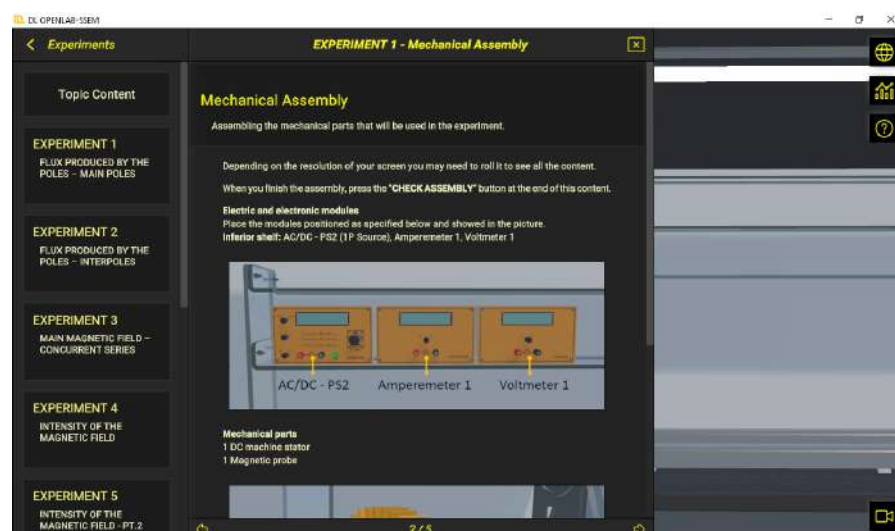Student logs in, so his progress can be tracked.
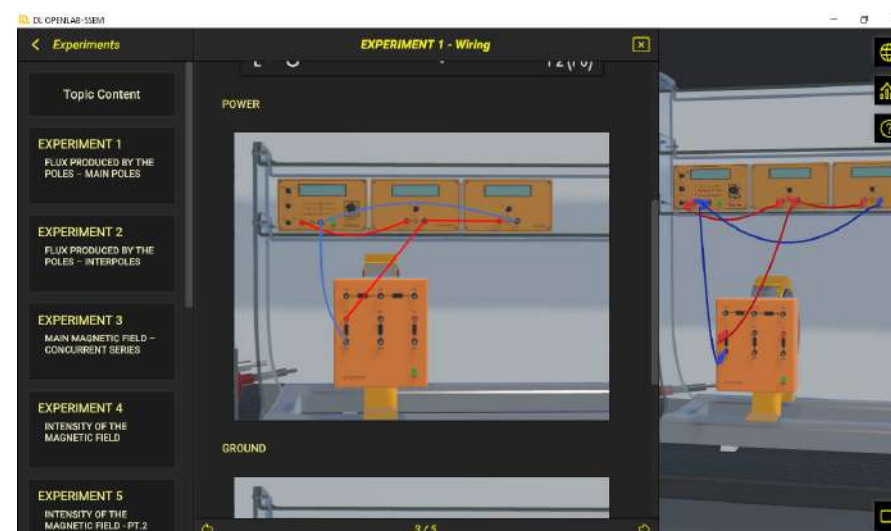

...choose one of the learning topics

...accesses theory, experiments proposals and instructions.

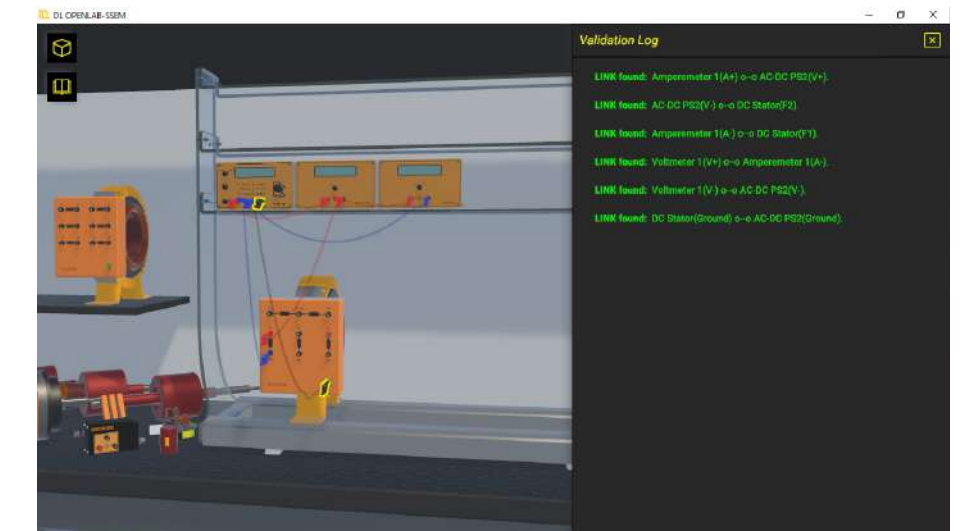# 2. AUTOMATIC VALIDATION OF STUDENTS' TASKS

The software automatically verifies if the student completed successfully each task in order to allow him/her to go ahead with the next one;

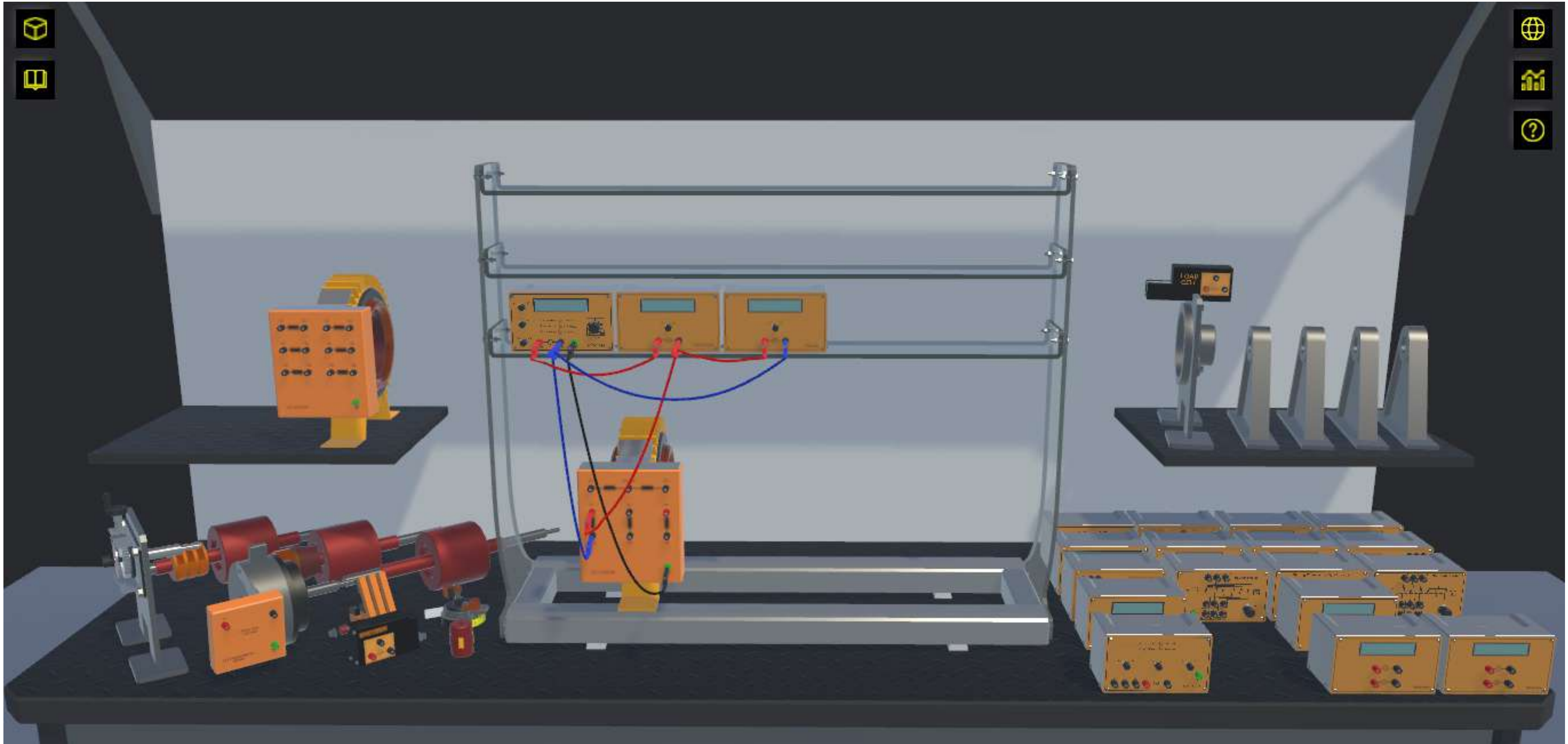Student works on the assembly of the electrical machine

...then makes the electrical connections

...and with all that correctly done, runs the experiment.

3D ENVIRONMENT TO PROVIDE
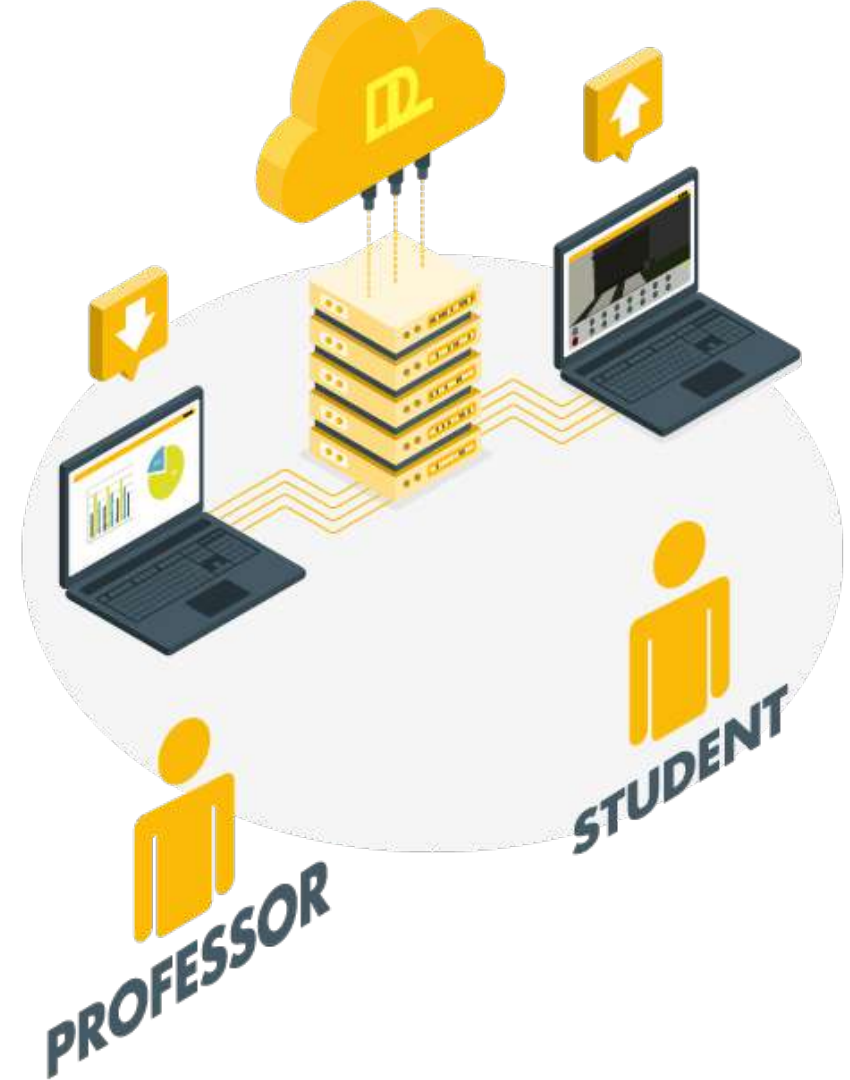## REAL PRACTICAL EXPERIENCE TO STUDENTS

WHY IS IT A SMARTSIM?

IT CONNECTS PROFESSOR, STUDENT AND SCHOOL

COMPATIBLE WITH THE DL SMART-DASHBOARD (SOLD SEPARATELY)

De Lorenzo´s cloud server receives students activities and provides reports and analytics to professors and institutions. Besides, a student can start working at school and continue at home or vice-versa.

That means that the professors can monitor the students and based on the report that De Lorenzo´s cloud provides, the professors can give the support that a specific student might be needing.

PROFESSORS CAN FOLLOW STUDENTS PROGRESS

The professor can do and access everything the student can. Besides, he/she can also access the dashboard's portal.
It includes interesting reports and analytics that help the professor to monitor the group in real time, as well as to identify students who are doing very well, as well as those who need help, who are not working at all and who seem to be "cheating".

Tasks report

This is an important tool since it provides evidence of the activities a student worked on. That means the school has evidence of the practical activities the distance learner has done with detailed information about it.

TRIALS PER TASK

This chart helps the teacher to understand which task may be the most difficult and which one may be the easiest in order to adjust the deadlines.
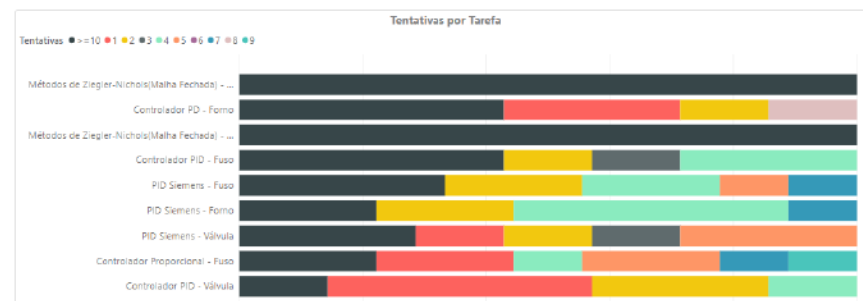
RHYTHM

This other dashboard shows the number of activities the students did daily and weekly. The professor may decide to verify it regarding a whole group/class or a specific student.

Curso	Tarefa	Timestamp	IsDon
Scripts	1.1 - Abrindo uma tela modal	3/9/2020 6:33:37 PM	False
Desenvolvimento de sistemas supervisórios	2.6 - Implementar Gráficos	11/22/2019 7:14:00 PM	False
Desenvolvimento de sistemas supervisórios	2.5 - Montar interface principal	11/18/2019 5:04:15 PM	True
Desenvolvimento de sistemas supervisórios	2.4 - Construindo os objetos da aplicação	11/18/2019 4:28:54 PM	True
Desenvolvimento de sistemas supervisórios	2.3 - Explorando Recursos	11/15/2019 5:35:44 PM	True
Desenvolvimento de sistemas supervisórios	2.2 - Conhecendo o Elipse E3	11/15/2019 5:10:00 PM	True
Desenvolvimento de sistemas supervisórios	2.1 - Comunicação OPC	11/14/2019 12:57:42 PM	True
Desenvolvimento de sistemas supervisórios	1.8 - Comandos pelo supervisório	11/14/2019 11:25:14 AM	True

PROFESSOR CAN SEE WHICH STUDENTS ARE ON SCHEDULE

With this interface, the professor may choose which groups he/she wants to monitor, to verify who is on schedule, who is pending and so on. It is possible to define the expected progress percentage in relation to the tasks available in the course.

Atividades feitas nas últimas 25 semanas

SUMMARY OF FEATURES
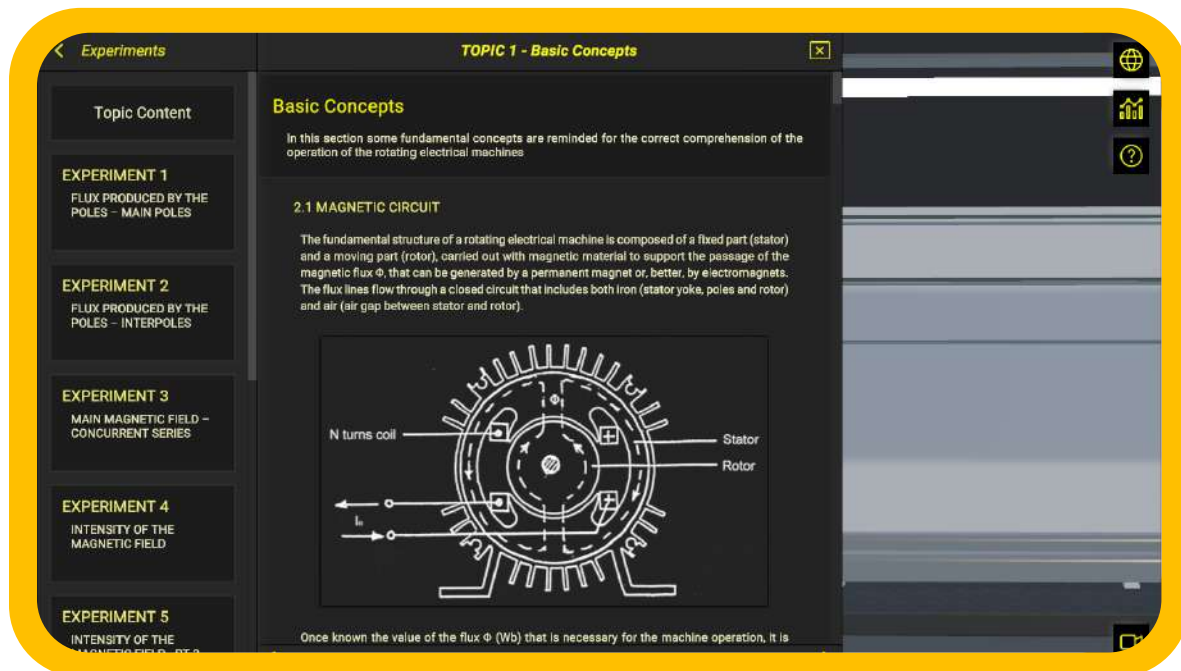
IT'S A 3D SIMULATOR

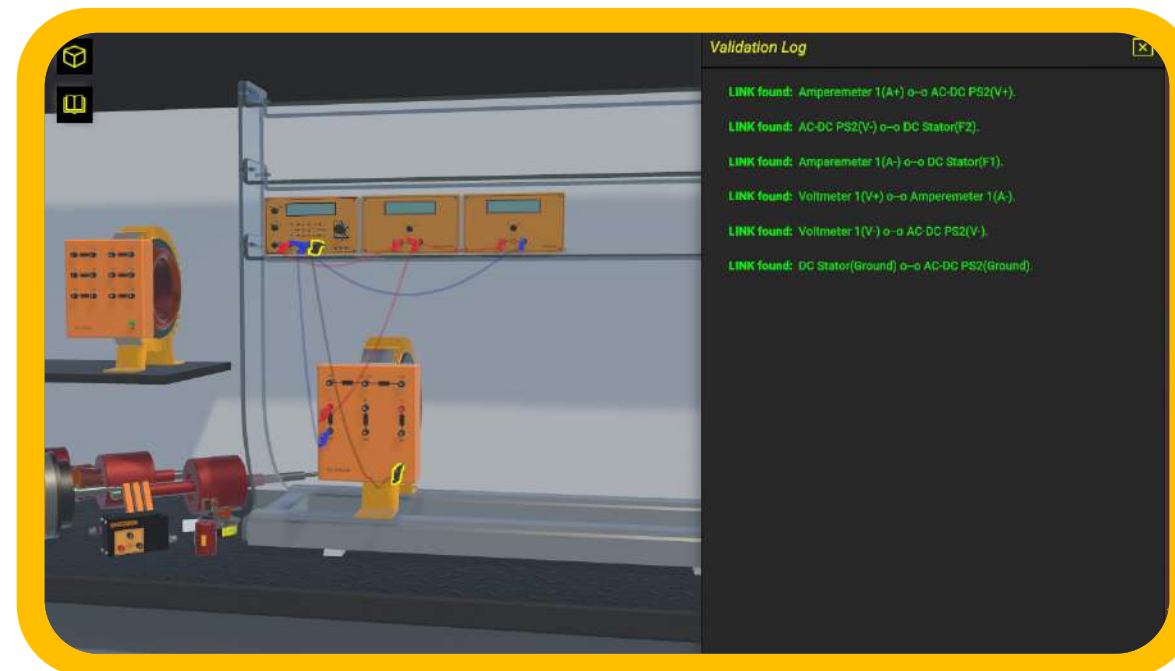## IT HAS BUILT-IN EXPERIMENTS
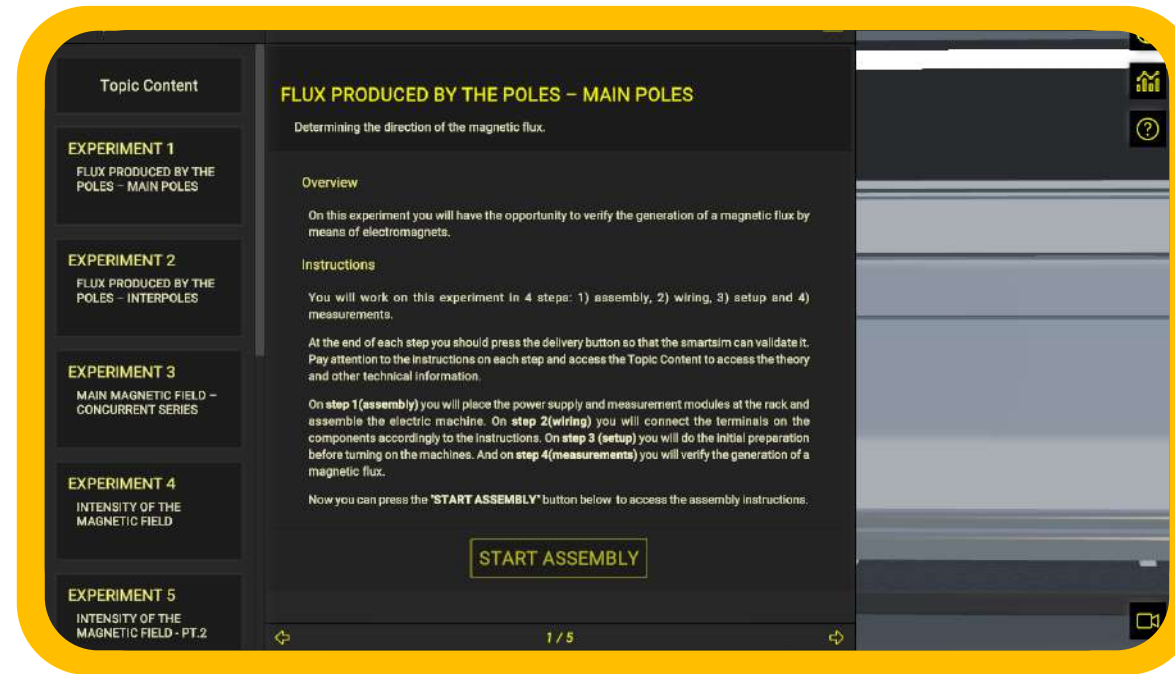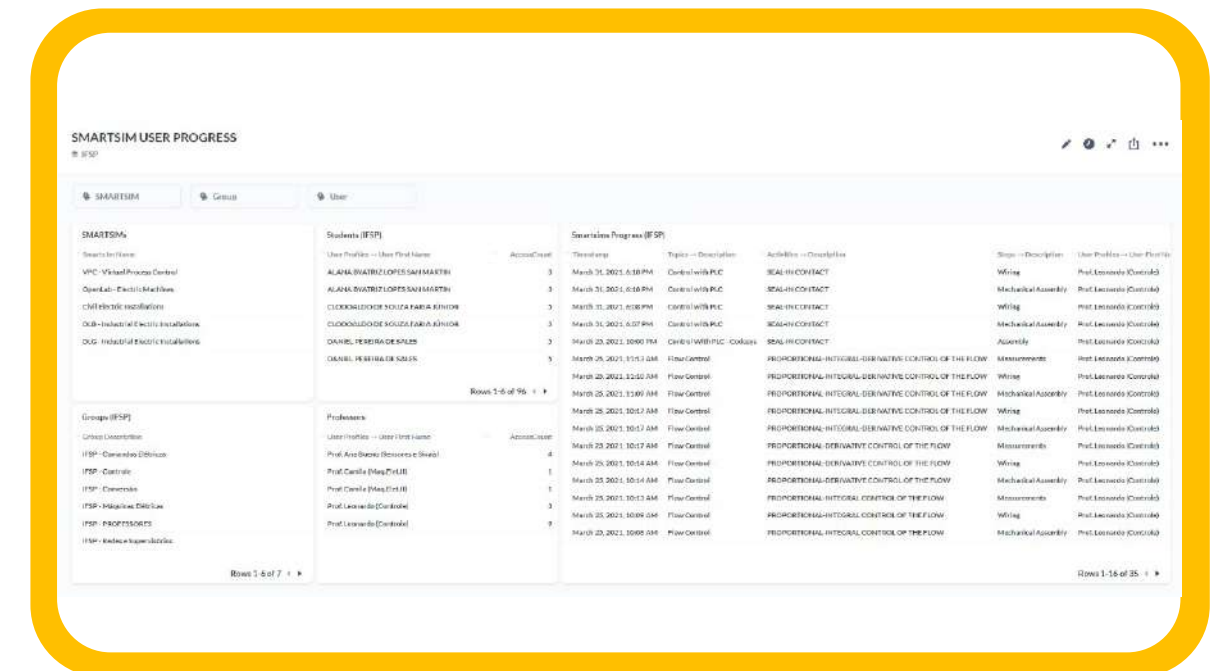

THE PROJECTS INCLUDE GUIDANCE
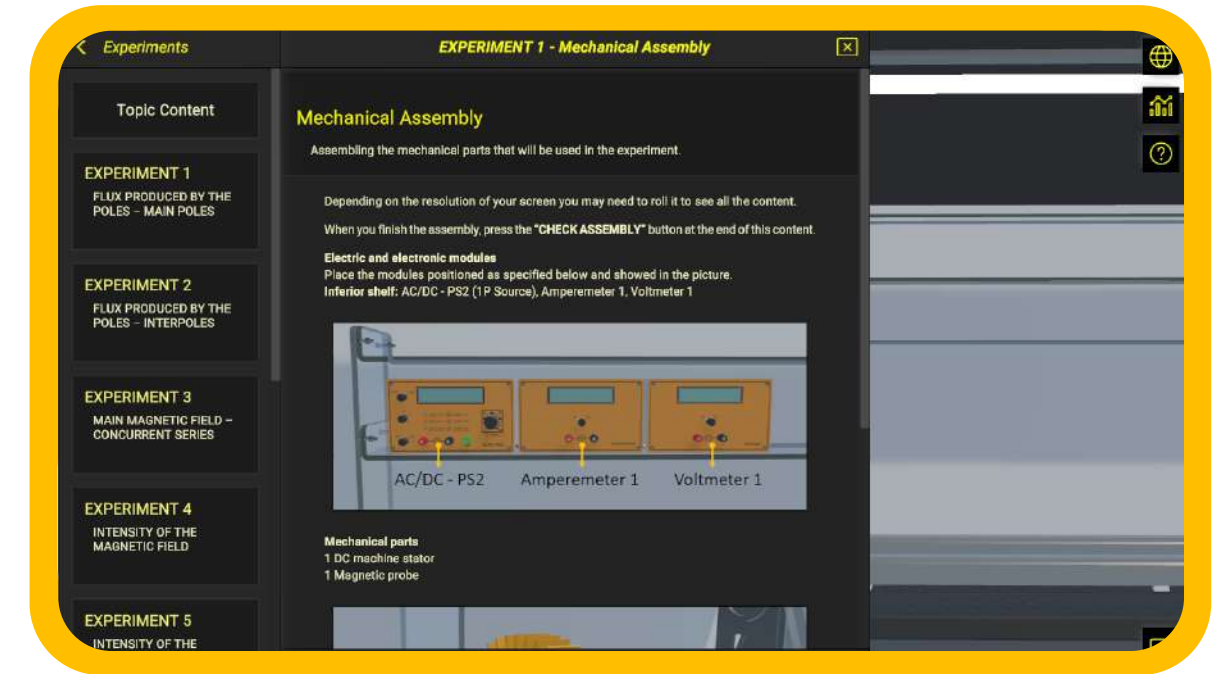
+ CONTENTS AND SUPPORT MATERIALS, SO THEY CAN LEARN BY THEMSELVES

IT AUTOMATICALLY CHECKS STUDENT ACTIVITIES TO LET THEY MOVE ON, LIKE IN GAME

PROFESSORS CAN MONITOR STUDENTS AND VERIFY WHICH POINT THEY NEED HELP(Option available with the Dashboard)

COMPLETE CONTENTS

## HOW DOES IT HELP THE PROFESSOR?

With this software, the teacher spends less time explaining topics, verifying students' activities and helping students to identify mistakes that do not allow the successful completion of the experiment.

That means that the professor has more time to manage the class, make improvements and help students who need more attention. The two following points grant such benefits:

1) The software automatically verifies the experiments carried out by the students and it gives relevant feedbacks:

Like in a game that has different phases with challenges and missions, the DL OPENLAB-SSEM software includes practical experiments that need to be successfully completed to let the student access the next one.

The teacher does not need to verify continuously if the student carried out the experiment. Moreover, many questions students would make about "what could be wrong" are automatically "answered" by the software when the student does not perform the experiment successfully. The image below summarizes this process.

CHALLENGE

Experiment instructions → Student develops a solution → Job done? → Next experiment

Feedback hints
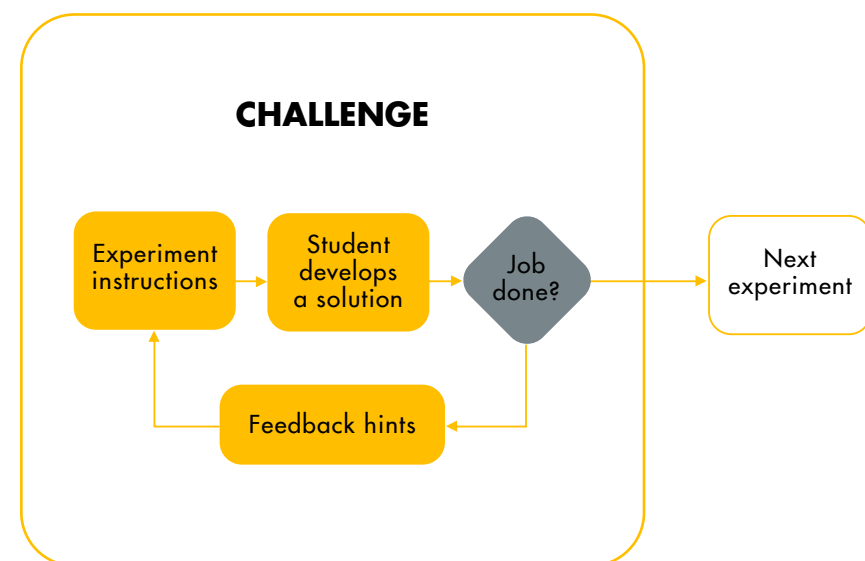
2) The software tracks the students' progress and it allow exporting reports:

At any time, the professor may verify how many and, specifically, which experiments the student has completed. That report can be used to track students' activities and it can be considered as an evaluation tool. This report can be generated and displayed directly in the system or it can be exported to a spreadsheet (see image below).

Timestamp	Student	Topic	Experiment
20-04-2020 10:15	Da Vinci	Basic Ideas	1. Flux produced by the poles
20-04-2020 10:28	Da Vinci	Basic Ideas	1.2 Main poles
20-04-2020 10:38	Da Vinci	Basic Ideas	1.3 Interpoles

DIDACTIC EXPERIENCE AND APPLICATION

The software guarantees a complete experience in the field of electrical machines. Students can approach this topic starting from the basic concepts, such as the analysis of magnetic fields and fluxes, up to advanced experiments based on characterization of machines and efficiency analysis.

Through this system, it is possible to assemble a relevant number of electric machines to carry out the following didactic experiences:

- Study of the magnetic field;
- Principles of the electromagnetic induction;
- Separately shunt, series and compound excited DC motors;
- Separately shunt, series and compound excited DC generators;
- Induction motors: three-phase slip ring and squirrel cage, single-phase repulsion and with capacitor;
- Dahlander connection;
- Synchronous three-phase motor, induction regulator and phase shifter, alternator, universal motor.

SET OF ASSEMBLED MACHINES

The system is based on a set of components that allow the assembly of the rotating machines. The set consists of the following components:

1. Base plate
2. Supports with bearing
3. Coupling joints
4. Flexible coupling
5. Electronic speed transducer
6. Assembling screws
7. Wrenches
8. DC stator
9. AC stator
10. Rotor with commutator
11. Brush holder with 2 brushes
12. Squirrel cage rotor
13. Slip-Ring rotor
14. Brush holder with 6 brushes

The system also includes adjustable DC and AC power supplies, instruments, loads, starting devices, etc., in order to perform all the experiments of the electric machines.

LEARNING TOPICS

This software covers 6 topics and proposes 43 experiments for the students. The experiments are listed below, grouped by learning topics.

|	GENERAL CHARACTERISTICS AND BASIC CONCEPTS
1	Flux produced by the poles
2	Main magnetic field
3	Intensity of the magnetic field
4	Induced voltage
5	Inter pole effect
6	No-load magnetic neutral axis
7	Rotating magnetic field
	INDUCTION MOTOR
8	3-phase squirrel cage motor, 2 poles, 24 VΔ
9	3-phase squirrel cage motor, 2 poles, 42 VY
10	3-phase squirrel cage motor, 2 poles, 24 VΔΔ
11	3-phase squirrel cage motor, 2 poles, 42 VYY
12	3-phase squirrel cage motor, 4 poles, 24 VΔ
13	3-phase squirrel cage motor, 4 poles, 42 VY
14	3-phase Dahlander motor, 4/2 poles, 42 VΔ/YY
15	Split phase motor
16	Capacitor start and run motor
17	3-phase motor with wound rotor, 2 poles, 42 VYY
18	Phase shifter
19	Induction regulator
20	3-phase synchronous induction motor, 2 poles, 24 VΔ
21	3-phase synchronous induction motor, 2 poles, 24 VΔΔ

DESCRIPTION OF PERFORMABLE EXPERIMENTS

A short description of some of the performable experiments:
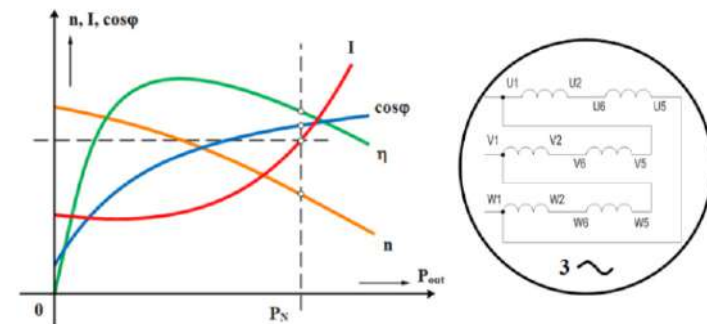
Three-phase squirrel cage motor, 2 poles, 24 VΔ

This experiment studies the behavior of the three-phase squirrel cage motor in load condition with the stator windings connected in delta.
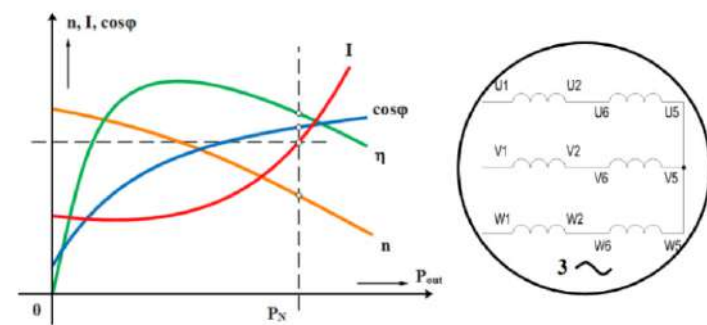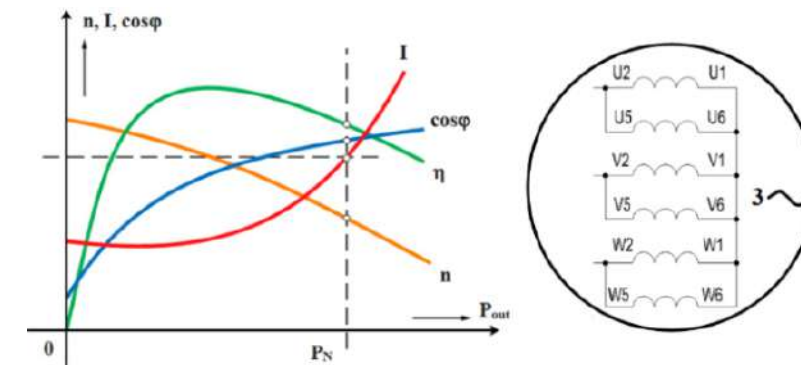

Three-phase squirrel cage motor, 2 poles, 42 VY

The main objective of this experiment is to study the characteristic curve of a three-phase squirrel cage motor with the stator winding connected in star by performing a direct test using an electromagnetic brake.
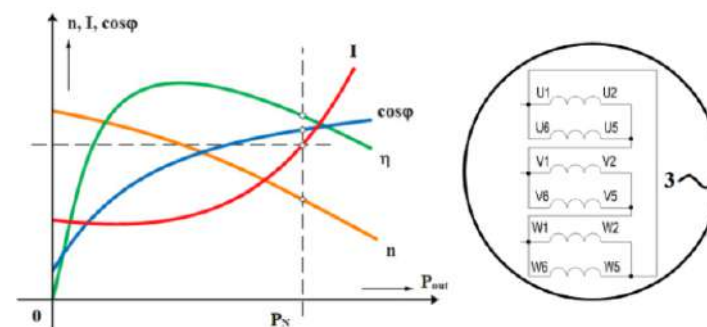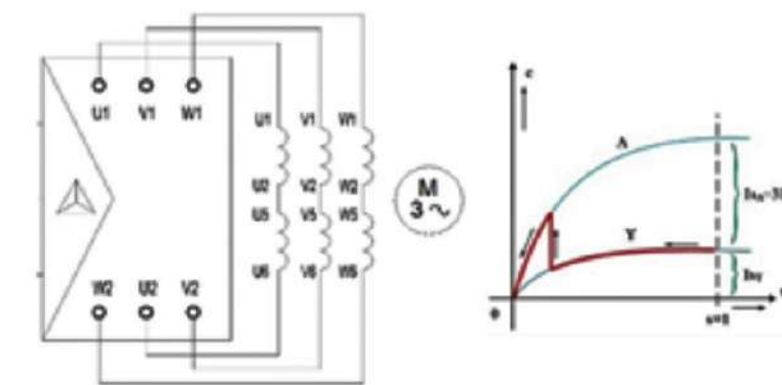

Three-phase squirrel cage motor, 2 poles, 24 VΔΔ

Applying the same concepts studied up to this point, the student can plot the load characteristics of the three-phase squirrel cage motor connected in double delta.
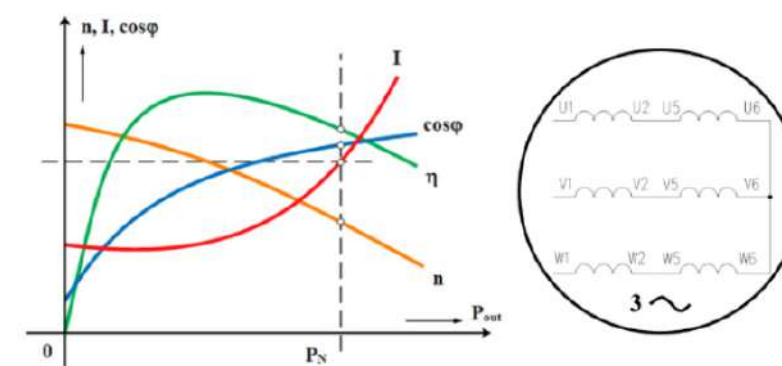

Three-phase squirrel cage motor, 2 poles, 42 VYY

Following the same procedure with the stator winding connected in double star, the student will trace the curves for the absorbed current I, the power factor cosj, the speed n and the efficiency h as a function of the output power P.
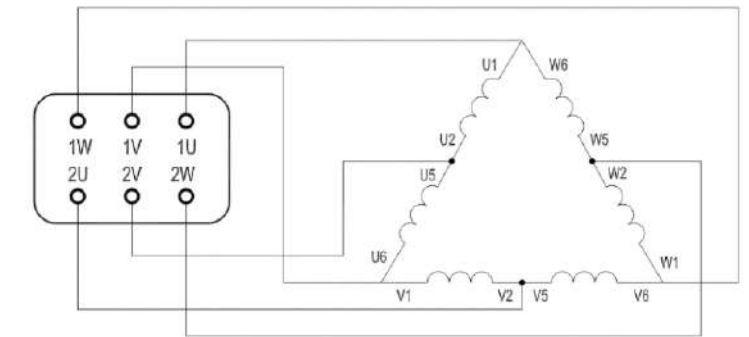

Three-phase squirrel cage motor, 4 poles, 24 VΔ

In addition to recording the operation characteristics of the motor, the student will learn how to start the motor using a star-delta starter.


Three-phase squirrel cage motor, 4 poles, 42 VY

In this experiment, the student will learn the load operation of a three-phase motor with 4 poles.


Three-phase squirrel cage motor, 4/2 poles, 42V D/YY

In previous experiments, it has been demonstrated that by changing the number of poles it is possible to vary the speed of a squirrel cage motor. The student will learn about two-speed Dahlander motor configuration and its operation.
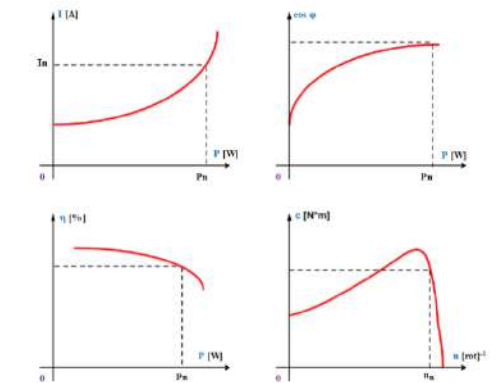

Split phase motor

The split phase motor, also known as a resistance start motor, has a single cage rotor and its stator has two windings known as main winding and starting winding. The main objective of this experiment is to study the characteristics of the motor with the main winding only, and to draw the curves of current I, efficiency η, torque C, output power P and power factor.
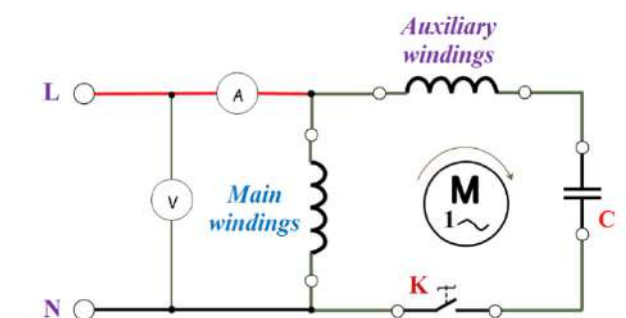

Capacitor start and run motor

The objective is to study the characteristics of the motor with permanently connected capacitor. The student will learn how to properly select and connect a capacitor to the auxiliary windings so that the current through the main winding lags behind the current of the auxiliary windings by an angle of 90°.
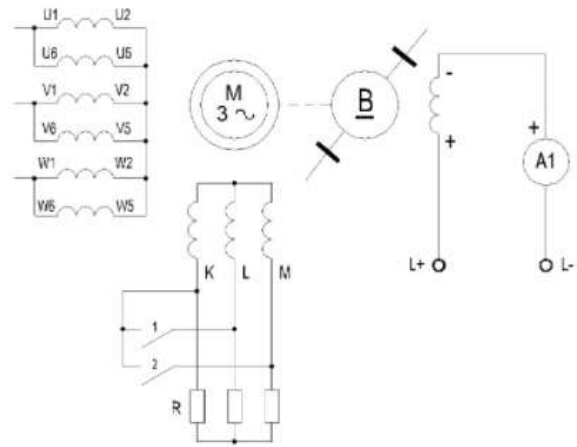
Three-phase motor with wound rotor, 2 poles, 42 VYY

The student will record the load characteristics of the motor with a wound rotor and the stator connected in double star. With the knowledge acquired up to this point, it will be easy to draw the diagram of the mechanical characteristic M = f(n) and to observe the behavior of an induction motor with a different type of rotor.
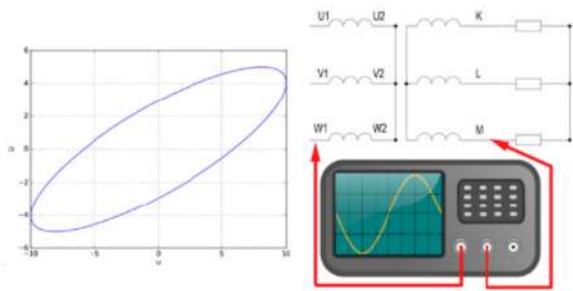

Phase shifter

The objective is to study how the phase between the stator and rotor voltages varies as a function of the rotating angle and to identify the null phase shift condition using Lissajous' ellipse by setting the oscilloscope to XY mode.
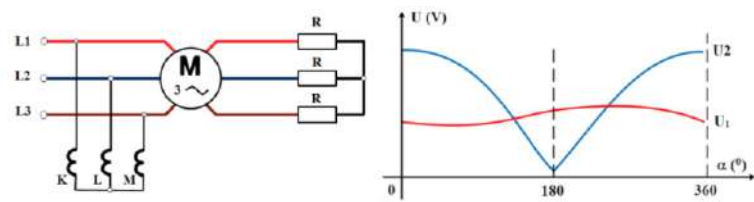

Induction regulator

The objective is to study the operation of a three-phase voltage regulator. By using a locking and rotating module with a graduated disc, the rotor can be turned by means of the hand-wheel until the load current results null with minimum indication of the voltmeter. The student will measure the absorbed current at constant load and draw the current and voltage curves as a function of the angular phase shift.
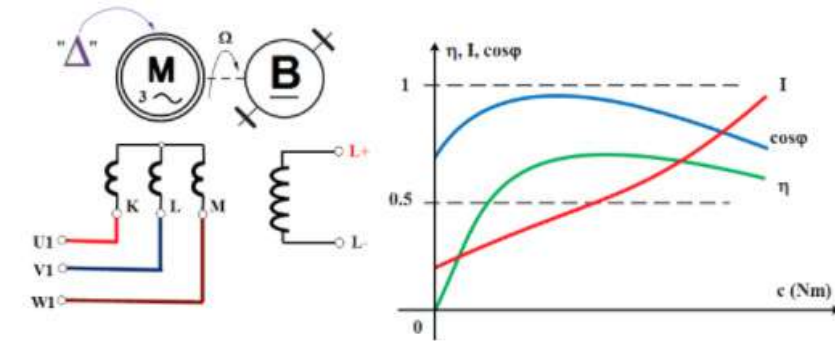
Three-phase synchronous induction motor, 2 poles, 42V D

This experiment studies how to start and synchronize the induction motor using the starting rheostat and studies the load characteristics of the motor at synchronous speed.
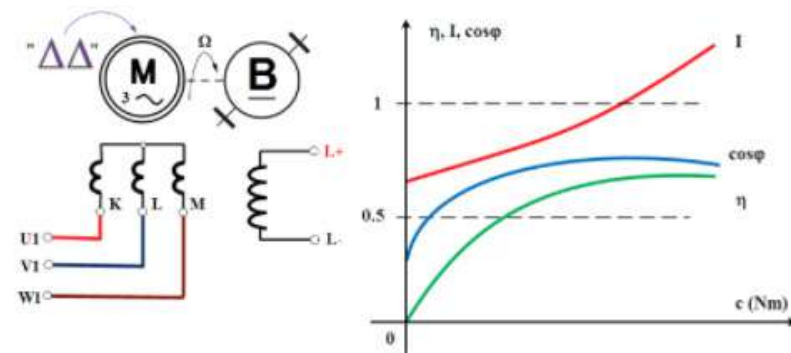

Three-phase synchronous induction motor, 2 poles, 24V DD

Following the same procedure as in previous experiment, the diagram of the absorbed current I, the power factor cosj and the efficiency h as a function of the output torque C will be traced with the stator wired in delta-delta configuration.
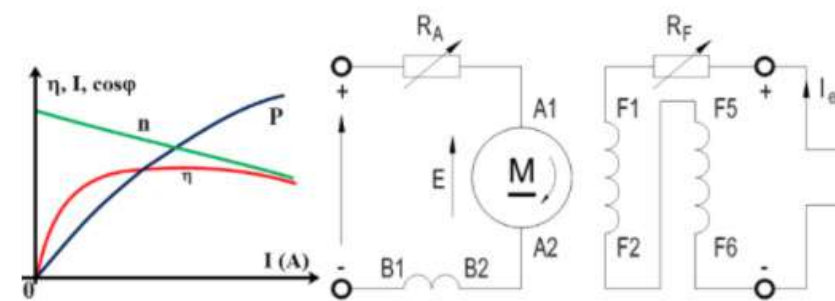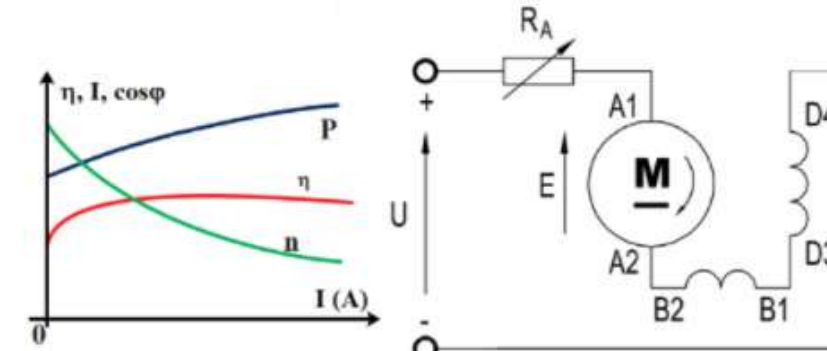

DC motor with separate excitation

Now, it is time to work with DC motors. The first application refers to a separately excited DC motor, where the field winding is powered by an external independent source. The DC motor operation characteristics will be studied as a function of the excitation voltage.
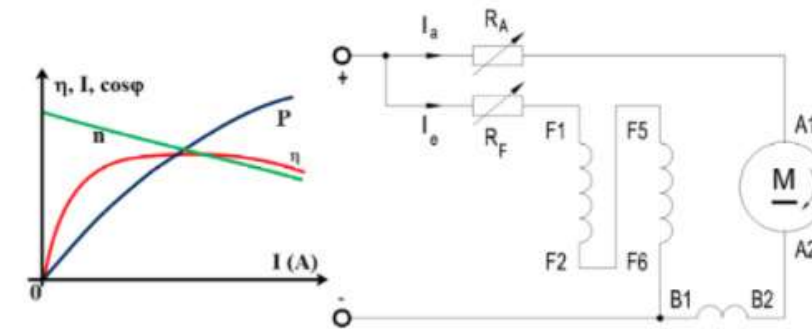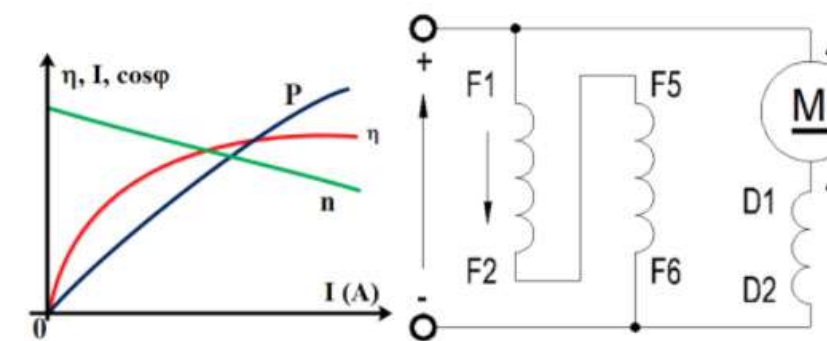

DC motor with shunt excitation

By performing this experiment, the student will learn how to connect the armature and field windings in parallel and compare the behavior with the previous experiment.
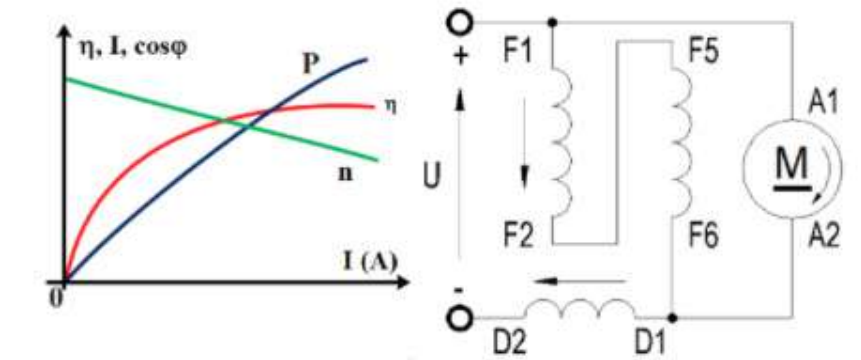

DC motor with series excitation

Unlike in the DC shunt motor, the DC series motor has very poor speed regulation. The main objective of the experiment is to draw the characteristics of the output power P, the speed n, and the efficiency h as a function of the absorbed current I.


DC motor with compound excitation, long shunt

By combining the operational characteristic of both the shunt and series excited DC motor, we obtain the DC compound excitation motor. The operation of the motor is studied with cumulative and differential excitation.
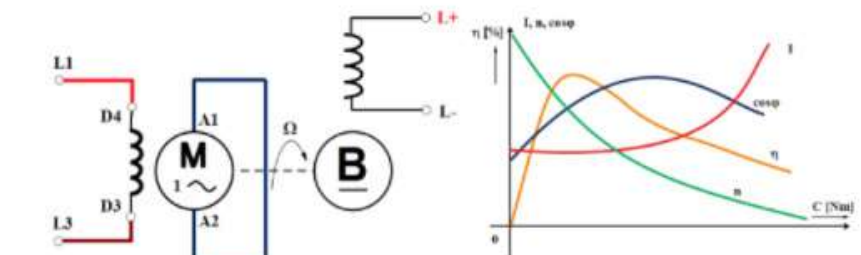
DC motor with compound excitation, short shunt

This experiment shows why the compound motor responds better to heavy load changes than a shunt motor.
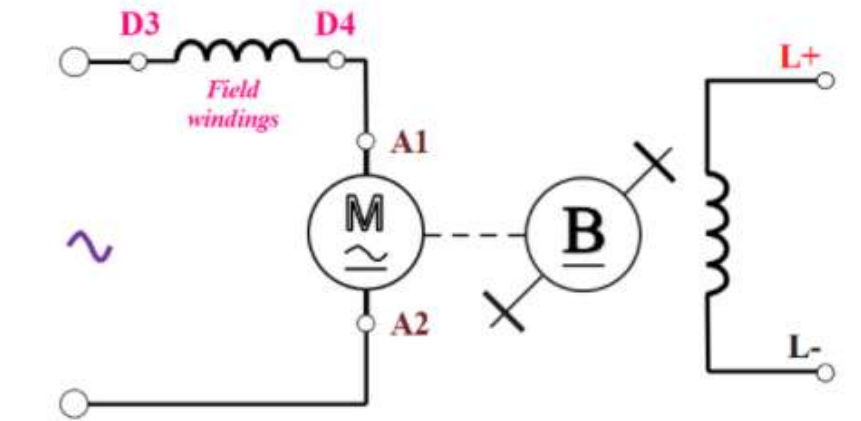

Single-phase series motor

The single phase series motor, also known as a universal motor, is a rotating machine similar to a DC motor, but designed to operate either from DC or single-phase AC.


Repulsion motor

The repulsion motor combines a stator of a single-phase motor with a rotor similar to that of a DC motor. The main benefit of the repulsion motor is that the armature is separated from the line. The main objective of this experiment is to record its operation characteristics.
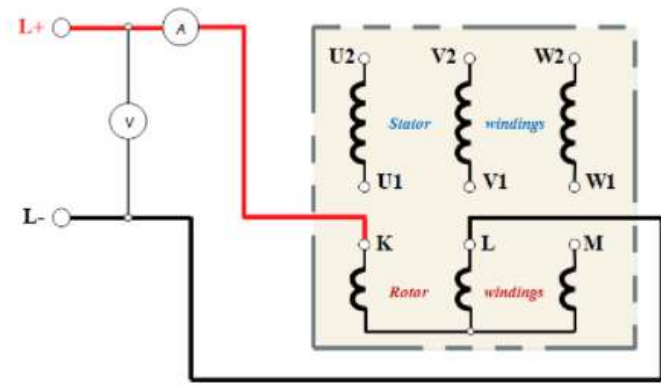
Measure the windings resistance of the alternator

This experiment calculates the voltage drops across the rotor winding resistance of an induction motor using the Ohm's law. The winding resistance value of the alternator is useful to calculate the conventional efficiency.
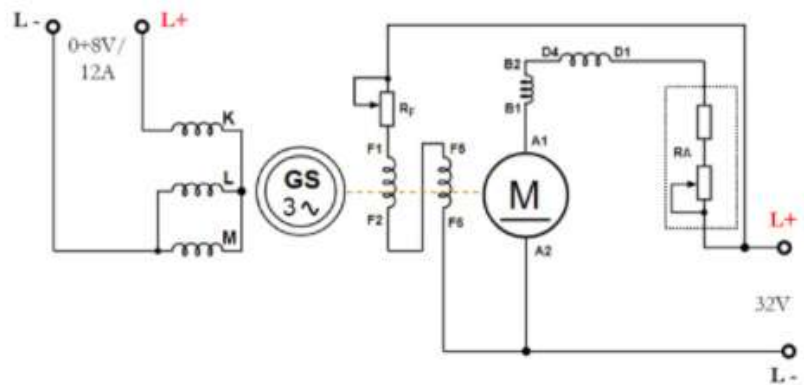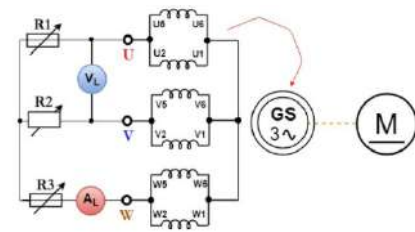

No-load test of the alternator

The main objective of this experiment is to determine the mechanical and iron losses of the alternator and to record its magnetization characteristic using a DC motor as prime mover.
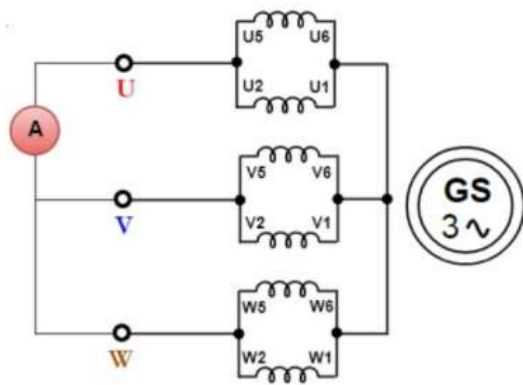

Short-circuit characteristic of the alternator

The short-circuit test of the synchronous generator provides information about its current capabilities. It is performed by driving the generator at its rated speed while the terminals of the armature winding are shorted.
This characteristic diagram is essential for the application of the indirect testing method of the alternator.

Load test of the alternator

This test compares the behavior of a synchronous generator connected to a variable external load with its no-load operation.
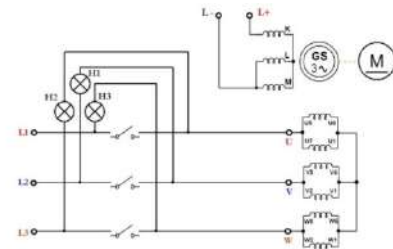

Parallel connection of the alternator with the mains

This experiment studies an operation which is frequently performed in a power station. The synchronization of a generator consists of electrically coupling the generator output to another source of electric energy and operating the generator such that its output adds to the other source.
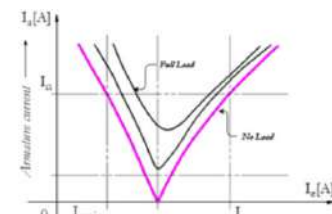

"V" curve of the synchronous motor

The V-curve of a synchronous machine shows its performance in terms of variation of the armature current with the field current when the load and the input voltage of the machine are maintained constant.
The student will trace different V curves for particular resistant torque applied to the motor axis.
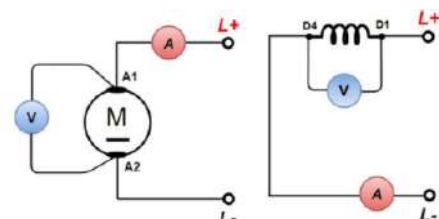

Measure the windings resistance of the DC generator

This experiment demonstrates how measuring the internal resistance of a DC machine can be used to establish the integrity of the machine windings and internal connections.
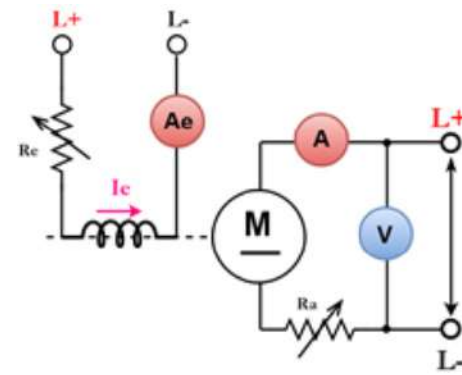

Test of the no-load motor (Swinburne)

In order to design rotating DC machines with higher efficiency, it is important to study the losses occurring in them. Swinburne's method consists of operating a dynamo as a DC motor with no load to determine its mechanical and iron losses. This is done by increasing the armature voltage U while measuring the armature current Ia and the excitation current Ie.
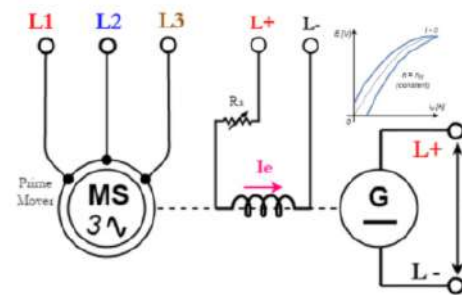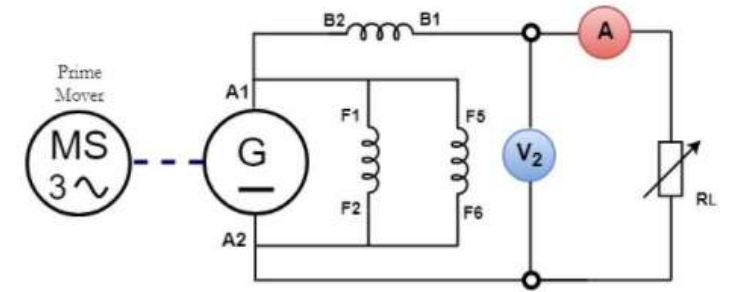

Magnetization characteristic of a DC Generator

This experiment studies the magnetization characteristic of a separately excited DC generator using a three-phase synchronous motor as prime mover.
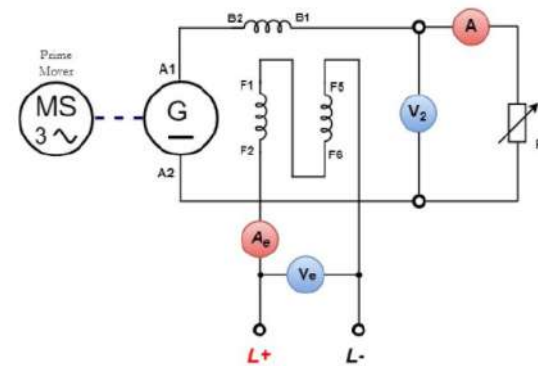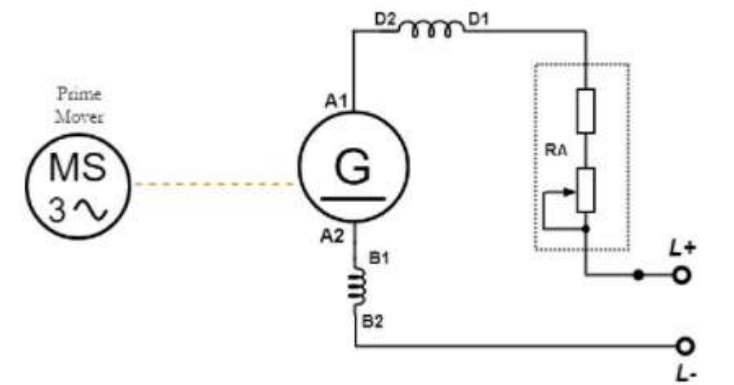

Separate excitation dynamo

The main objective of this experiment is to record the external and regulation characteristics of a separate excitation generator to determine its conventional efficiency.
This is done by measuring the output voltage U as a function of the load current, with constant excitation current Ie.
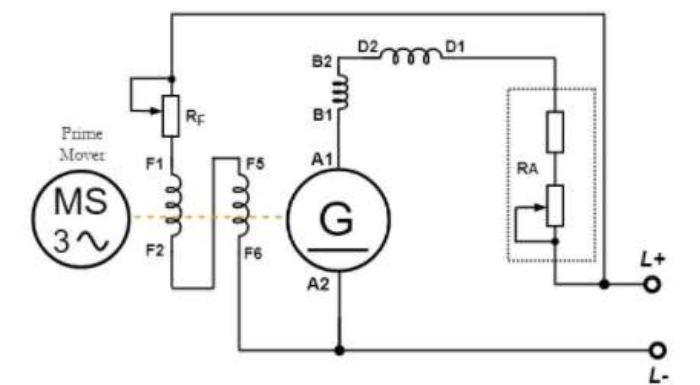

Shunt excitation dynamo

The previous experiment is replicated with a different configuration of the DC generator. Using the results from the previous experiments, the student will plot the external and regulation characteristic of the generator connected in shunt.

Series excitation dynamo

Determining the external characteristic of a DC generator connected in series is to observe how the voltage slightly drops as the load increases.
The student will use these results to calculate the conventional efficiency of the dynamo.

Compound excitation dynamo

This experiment follows the same procedure as the previous ones with the generator in compound excitation connection. After performing this last experiment, the student will be able to make comparative analyses between all the different DC generator configurations.

SYSTEM REQUIREMENTS

MINIMUM REQUIREMENTS

OPERATIONAL SYSTEM
64-BIT WINDOWNS 10

DIRECTX VERSION
DIRECTX 11

PROCESSOR
INTEL i5 9400F OR AMD RYZEN 5 3600

MEMORY
8GB

GHRAPHIC CARD

STORAGE
HDD (1GB)

RECOMMENDED REQUIREMENTS

OPERATIONAL SYSTEM
64-BIT WINDOWNS 10 PRO

DIRECTX VERSION
DIRECTX 12

PROCESSOR
INTEL i7 9700 OR AMD RYZEN 7 3700X

MEMORY
16 GB

GHRAPHIC CARD
NVIDIA GTX 1050 TI 4GB OR RX 550 4GB

STORAGE
HDD (1GB)

DE LORENZO