# Virtual Electric Machines Laboratory, Requirements and Practical Realization

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# Virtual Laboratory

Virtual Laboratory
Why do you need this?

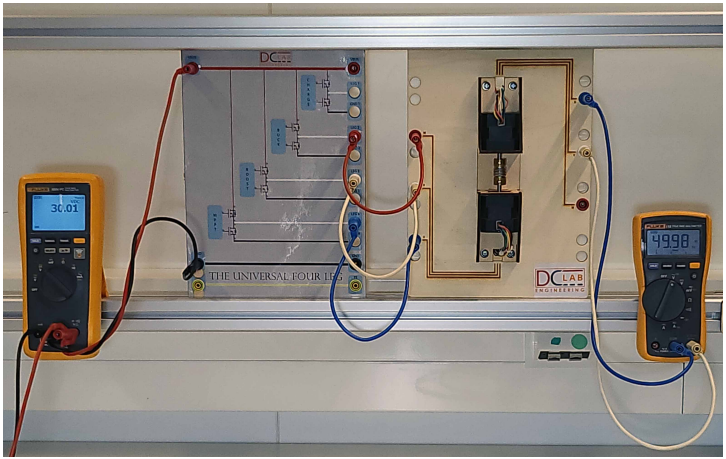
- Cheaper
- More students at the same time
- Safe
- You prepare them for the real laboratory

# Virtual Laboratory

Virtual Laboratory
what is it?

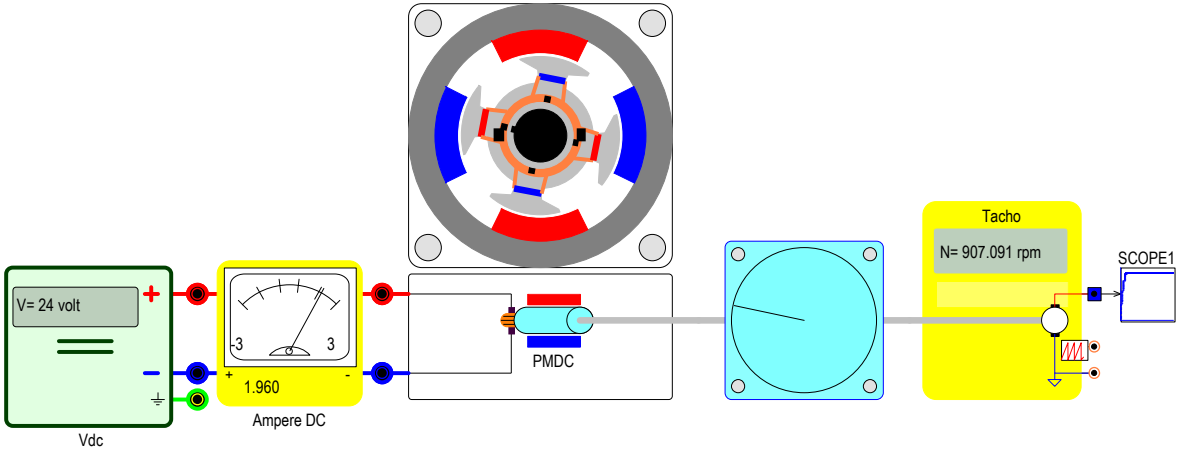
- Motivation
  Low entry-level access, freedom
- Challenges/Risks
  Cheaper/ will there be a real laboratory?
- Results
  Experiments are safe, so you can do much more
- Outcomes
  Students get a deeper understanding of the operation of electric machines

# Objectives




Physical laboratory set-up, of three phase inverter U4L with brushless DC motor and DC motor acting as tachometer.

# Objectives



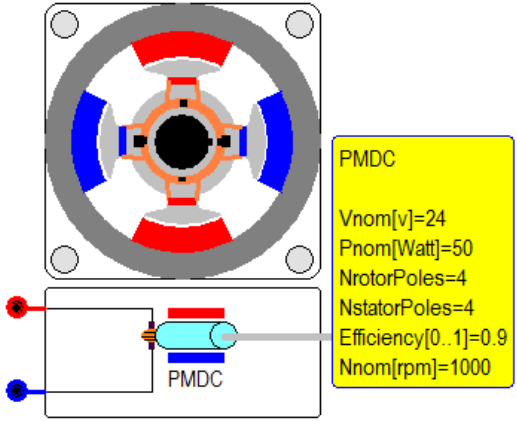

Permanent Magnet DC motor driving a fan. Current is measured using an analog current meter, while a tachometer measures the speed of the rotor.

# Requirements

Requirements

- Connecting the components via wires with banana-plugs.
- Set parameters and/or choose the size/power rating of a component.
- Connect measuring devices like analog voltage or current meters, or digital multimeters.
- Start the experiment, instead of turning on the power supply, the simulation/animation has to be started.
- Observation of the results from the measuring devices.
- Change parameters(power/size rating) and observe their influence on the results.
- Validate the observation of the results.

# Objectives

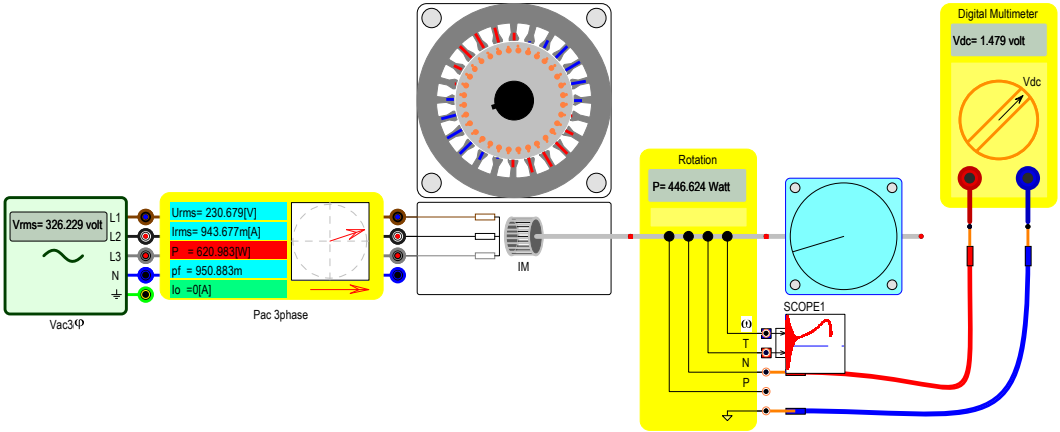



Name plate parameters of the Permanent Magnet DC motor, including the number of rotor and stator poles for the animation of the motor.

# Structure

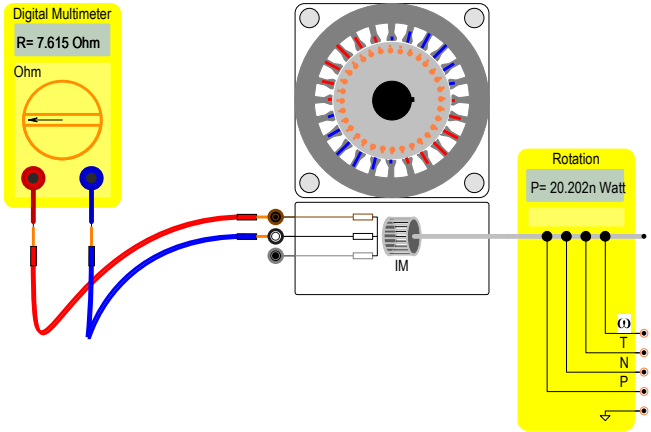
- *Conceive: Theory*
  A short introduction on the theory behind the experiment from the textbook. Here the basics of the functioning should be outlined, without going into detail on the operation.
- *Design: Simulation*
  Simulation or animation, with simple model to explore working principle using simulation or online tooling. This will reveal the operation as explained in the theory.
- *Implement: Set-up*
  Virtual laboratory set-up, with virtual components and animation. Select and place components and interconnect them.
- *Operate: Validation*
  Run the experiment. Validation of the virtual laboratory results, with the theoretical and/or simulation results. Comparison with expectations, and explanation of the observed laboratory results.

# Example Induction Machine



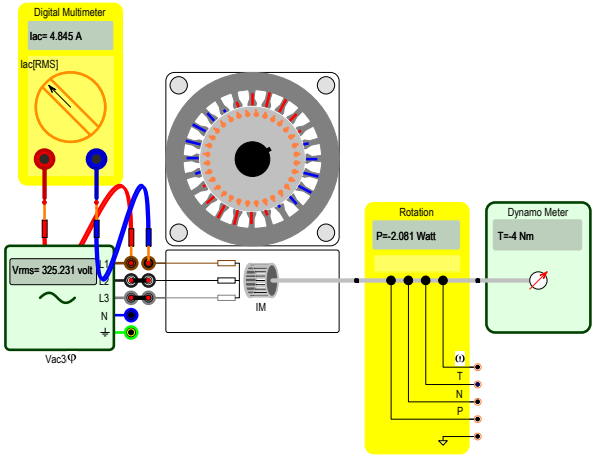

Simulation of the torque-speed characteristic of an induction machine driving a fan.

# Example Induction Machine



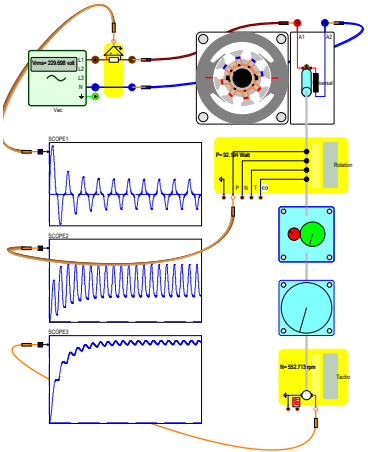

Measuring the winding resistance using a multimeter.

# Example Induction Machine



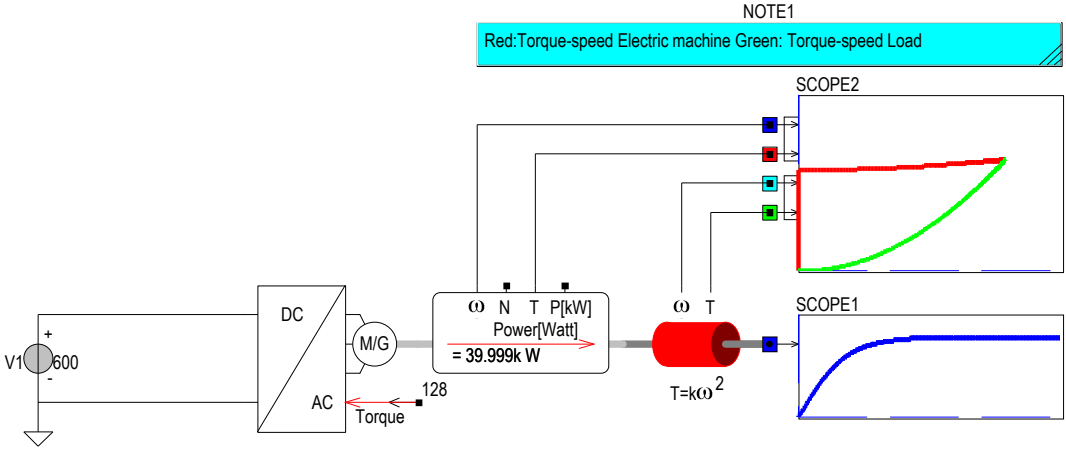

Application of a dynamometer to measure the slip of the induction machine for varying load.

# Example Universal Motor



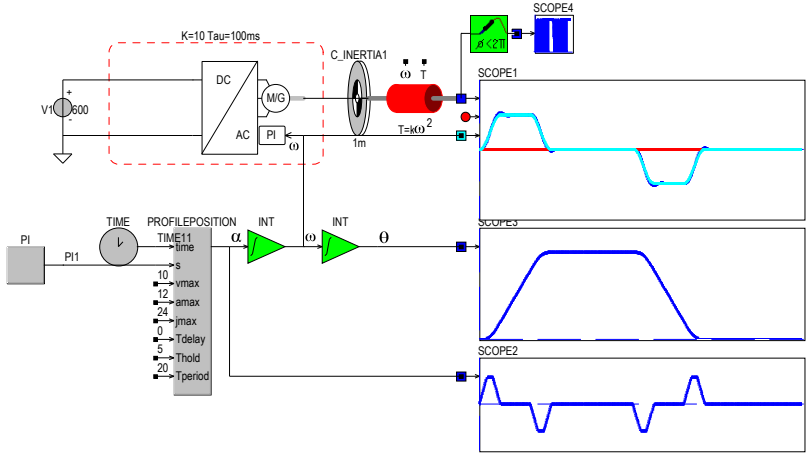

Universal motor driving a fan, showing the typical torque harmonics.

# Example Drive system




Variable speed drive with quadratic load.

# Example Drive system




Variable speed drive, where the angular speed of the machine is set by a defined speed profile.

# Conclusion

- Same Look and Feel
- Simple set-up, same as in real lab
- Only nameplate parameters
- Animation, so also inside details can be shown

Thank you!
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