UNITRAIN
SYSTEM

UNITRAIN MULTIMEDIA DESKTOP LAB

Learning – Experimenting – Understanding

CONTENTS

KNOWLEDGE AND PRACTICAL SKILLS

Jörg Sprengepiel
Product Manager, UniTrain

„UniTrain® with its diversity of experimental multimedia courses is unique in the field of technical training"

Training with our educationally optimized systems combines acquisition of knowledge with a high level of hands-on, vocational qualifications. This turns knowledge into skill and gives rise to the practical competence required by industry and trade in professional life.

Continuously being advanced and expanded, the UniTrain system has played a leading role here for almost 15 years, and has become one of the world's largest and most versatile multimedia training systems for aspiring electrical engineers.

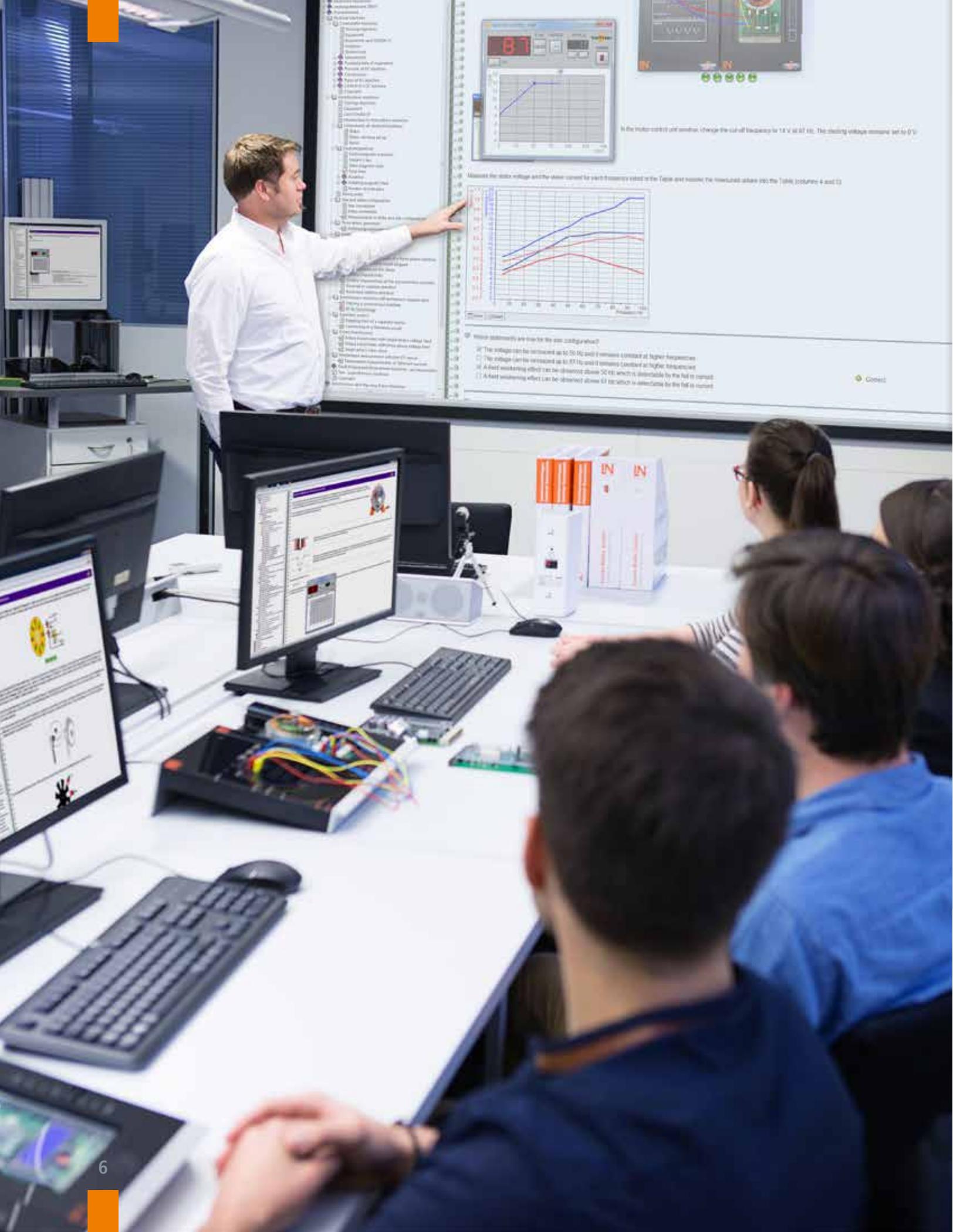## 1 device with more than 120 measuring instruments and sources

The core is the UniTrain interface, a portable, PC-based measurement and control interface which provides the functionality of a complete electrical laboratory in a single device. Available here are more than 120 instruments and sources for measuring, controlling, programming and analysing.

More than 130 learning programs

A combination of more than 130 learning programs with associated experimentation hardware allows all areas of electrical engineering to be explored. Besides imparting the necessary expertise, the learning programs ensure successful and safe experimentation, thereby uniting theory and practice to provide a highly efficient learning environment.

Authoring tools and administration

The LabSoft Classroom Manager included is an extensive software package for electronic management of users and learning programs. Whether it be administering educational content and users, monitoring learning progress or independently creating exercises, courses and exams, no wish goes unfulfilled.

BLENDED LEARNING

Individual learning - the key to success

The ever growing availability of the Internet has revolutionized education in recent years. Digital learning media have established themselves to become an indispensable part of flexible and individualized training concepts.
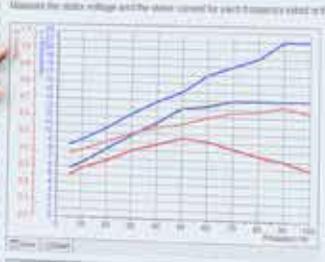
With its open multimedia courses, the UniTrain system has pursued this approach for many years, thus enabling it to be deployed in diverse learning scenarios. The multimedia courses are closely aligned with international standards to allow their integration into numerous learning management systems.

Recreation

Laboratory

Workplace

Your benefits

✓ One system – many applications
✓ For the classroom, laboratory, workplace and recreation
✓ For independent studies, laboratory internships and teaching
✓ Stand-alone, in a network, or as part of a learning management system (LMS)

UNITRAIN – MOTIVATED LEARNING WITH A METHOD

A single system for comprehensive technical training

Gaining knowledge and practical skills in increasingly complex technical systems in ever shorter time cycles is the major challenge for present-day and future technical training. This challenge can be met with the help of the UniTrain system, a computer-aided, multimedia system for experimentation and training in electrical engineering and electronics.

A combination of learning programs with a fully equipped electrical laboratory in just one mobile interface enables efficient transfer of theoretical and practical skills at any place and any time.

NEW: Internal Wifi module
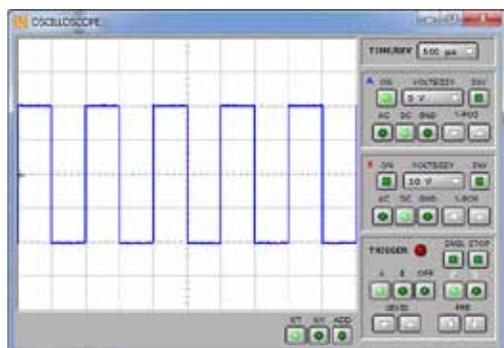
2 **Virtual instruments**
120 virtual instruments for interface control
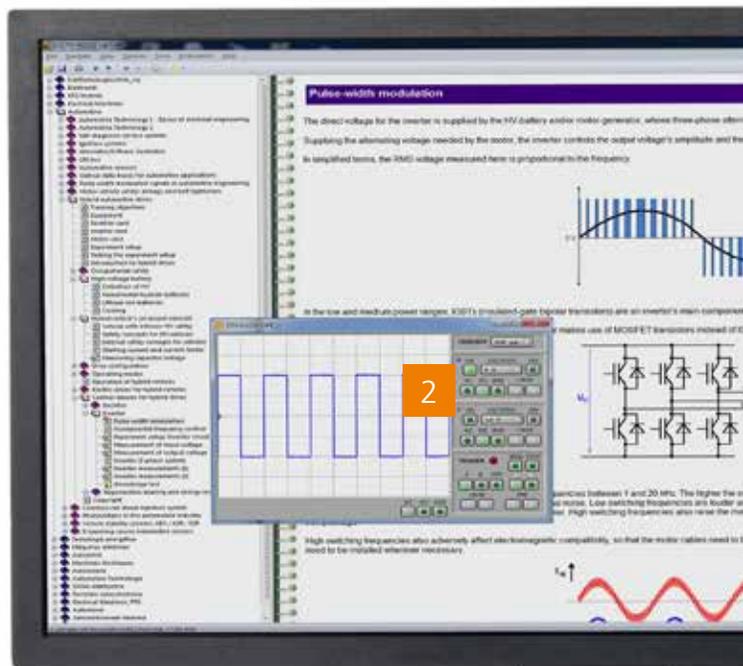
1 **UniTrain interface**
Measurement and control interface:
Analog / digital measurement inputs and voltage
sources for experiments
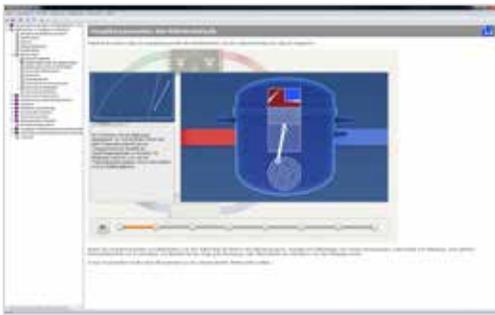
3 **LabSoft course**
Over 130 learning programs with experiment hardware from all areas of electrical engineering

Your benefits

✓ Universal training system
✓ Mobile and useable anywhere
✓ Promotes individual learning
✓ Practical competence through practical experimentation
✓ High motivation through dynamic requirements
✓ For the entire field of electrical engineering
✓ Safe experimentation with safety extra-low voltages
✓ Combination of theory and practice in learning programs

Product video
Convince yourself of the advantages.

4 **Experimenter**
Mounting of experiment cards and additional voltage outputs (three-phase)

MORE THAN A TRAINING SYSTEM

UniTrain lab for vocational training

1 Presentation tools
Survey what has been learned and explore complex topics and experiments, together.

2 Total control with Labsoft Classroom Manager
Central administration of users, groups and LabSoft courses: Check learning progress, edit courses, create own courses and exams.

3 LabSoft courses
Conduct LabSoft courses with the help of text, graphics, animations, experiments and test questions to obtain solid expertise and practical skills.
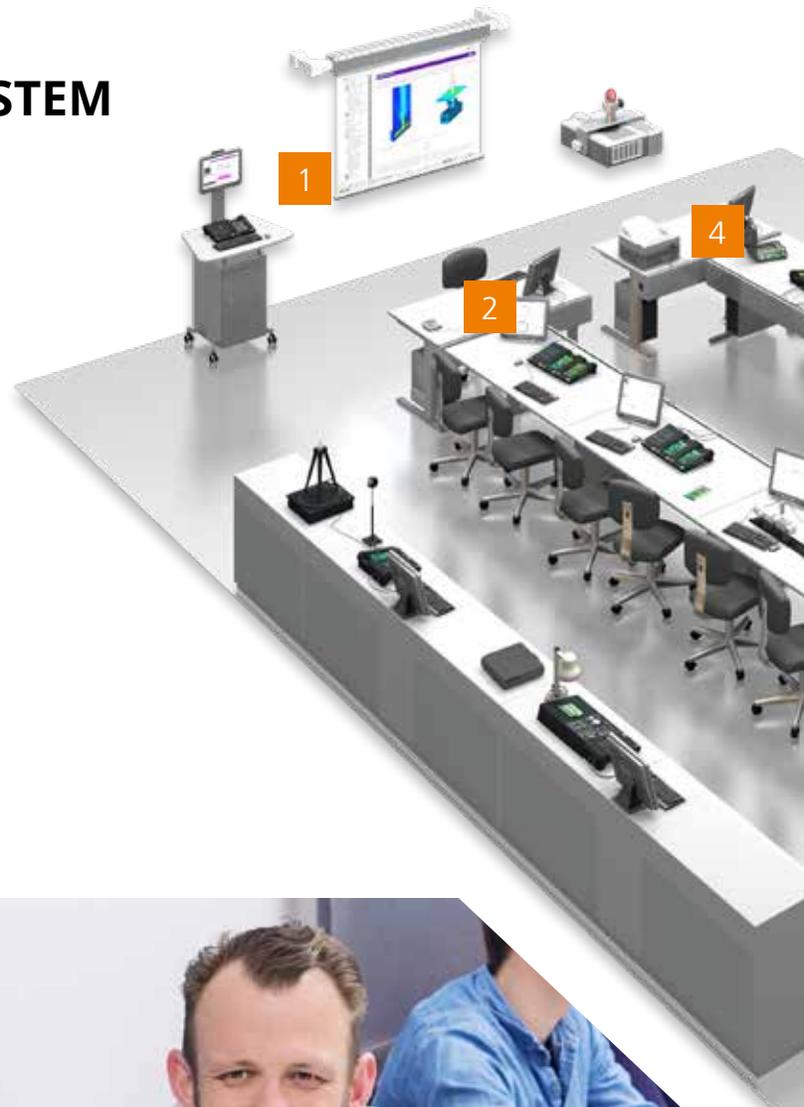
4 Server-PC
Store and manage learning
programs and data centrally in a
network.

**5 Sideboards –
for storing courses**
Clearly arranged storage for quick
retrieval.

6 Multimedia tables
Network connections and power
supplies are concealed in ducts
beneath moveable tabletops.

ANALOG IN

CURRENT

E+ E-
F+ F-

A+
C+ C-
B+
D+ D-
S ⊥

DIGITAL IN

0 1 2 3 4 5 6 7

DIGITAL OUT

0 1 2 3 4 5 7

DISPLAY

1 2 3 4

1 **2** **3** **4** **5**

I 2mA

U
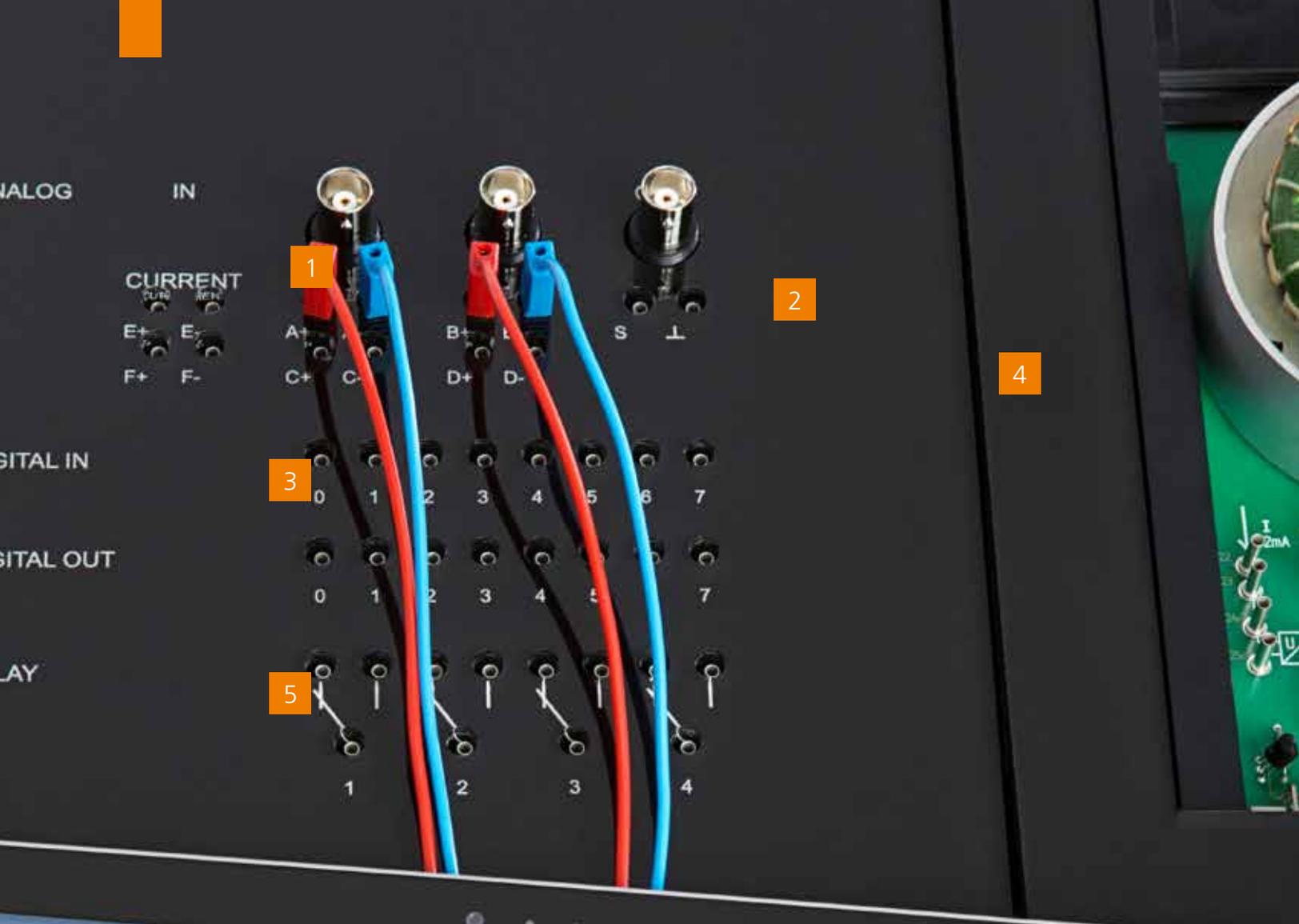
ons Tools Instruments Help

LUCAS-NÜLLE LabSoft

3-PHASE POWER SUPP_

AC VOLTAGE [V]   FREQUENCY [Hz]

1 1 5   5 0

...he menu Instruments/Power supply and set it using its frequency indicator and voltmeter A: f= 50 Hz, U_U = 10V

POWER

A VOLTM_

100.0 V

20 V

DC AC

OVR

...voltage and current in winding U and enter these values into the appropriate boxes.

...ase voltage $U_{phase\ U}$ = 10 V

...r B: Phase current $I_{phase\ U}$ = 0.295 A

...based on the measured values compute the apparent electrical power absorbed by the machine:

S_y = ... VA

☺ Correct

☺ Please select at l...

AN ENTIRE LAB IN A SINGLE DEVICE

UniTrain interface and its instruments

The UniTrain interface is a PC-based measurement and control interface. Its inputs and outputs are controlled via virtual instruments on a PC. More than 120 different measuring instruments and sources are available.

Your benefits

✓ Mobile, handy and ready for quick use everywhere
✓ Universal operating concept for all instruments for faster familiarization
✓ Able to replace an entire range of devices
✓ A lab which is always at hand
✓ Safety ensured thanks to extra-low voltage

More than 120 instruments in a single device!

1 Measurement inputs
- Bandwidth: 10 MHz
- Sampling rate: 100 MSamples
- Measurement ranges: 100 mV to 50 V
- Oscilloscope time ranges: 100 ns – 10 s
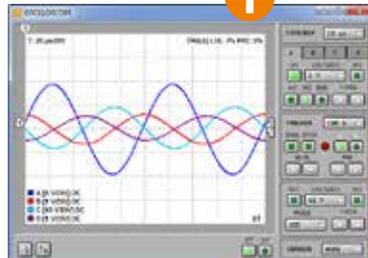
2 Analog output
- -10 V to 10 V, DC to 5 MHz

3 Digital inputs /outputs
- 16 Bit, DC to 100 kHz

4 Bus connection for experiment hardware and voltage supply
- Three-phase output 0 - 14 V_{RMS}, DC to 150 Hz
- Fixed voltages 5 V, +/- 15 V

5 Relay connections
- 8 relays for manual control and automatic fault insertion
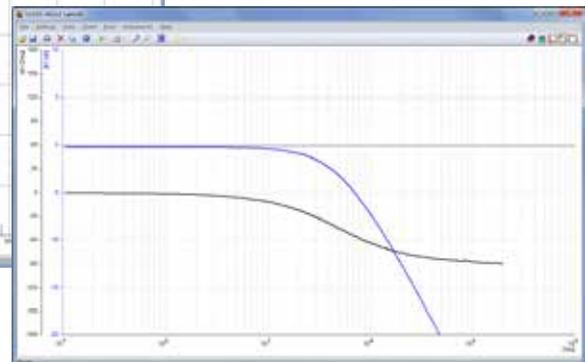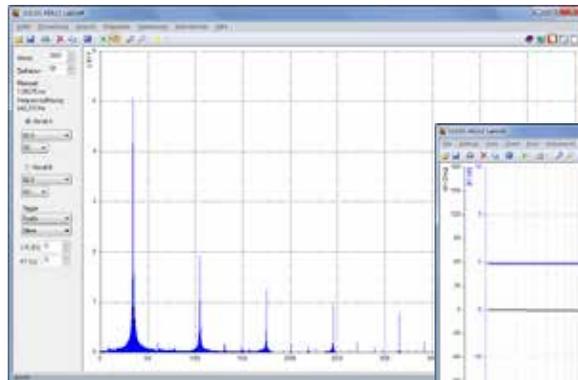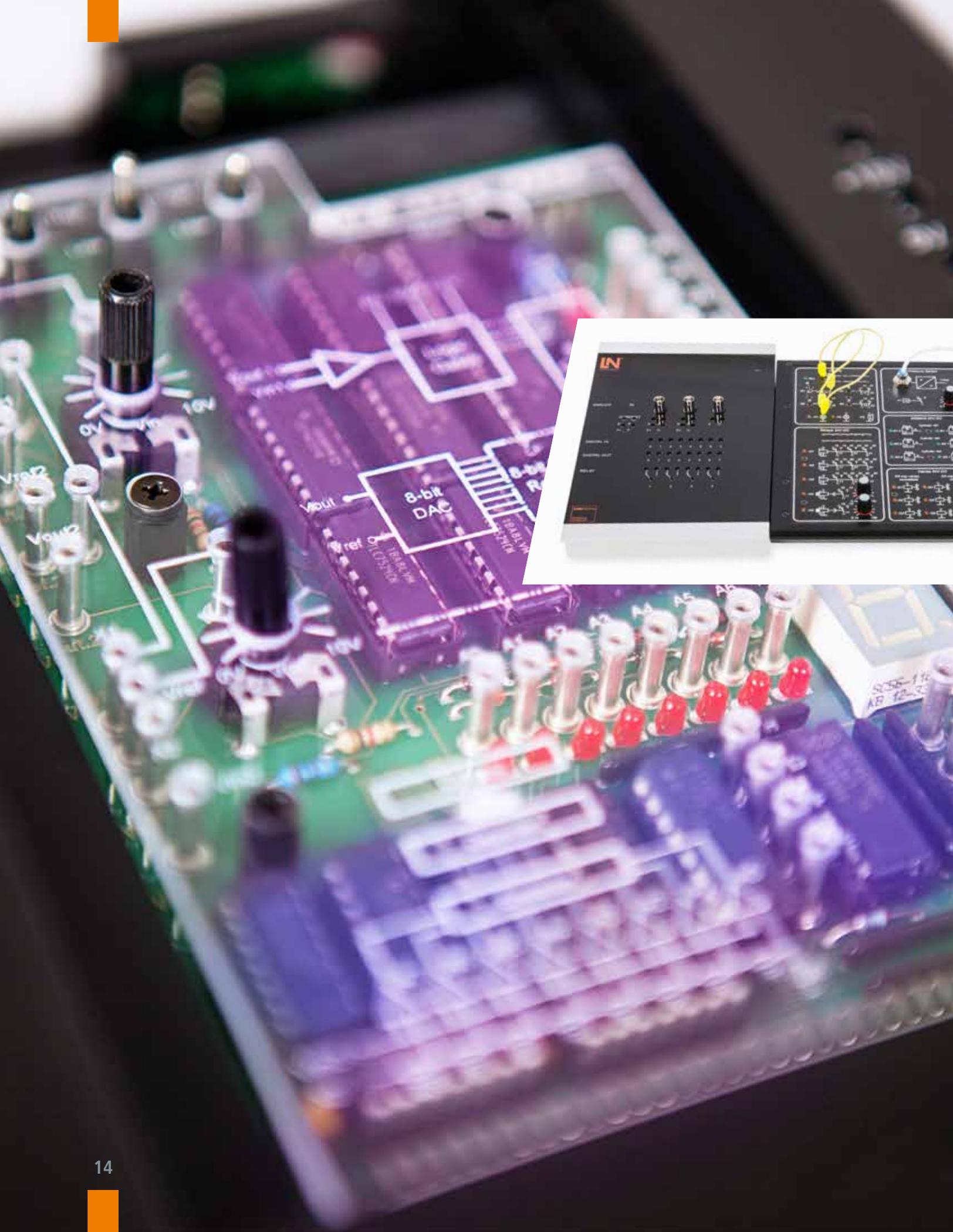
SYSTEM COMPONENTS - IDEAL FOR EXPERIMENTING

Diverse connection options: Experimenter, boards or plug-in systems

For experimentation, the interface permits connection of diverse experiment hardware from the UniTrain courses. Electric and electronic circuits on standard, industrial European-format cards or breadboards are coupled to the interface via experimenters.

Large boards are available for circuits with large mechatronic components; the Elotrain experimenter is connected to the interface for the courses of the EloTrain plug-in system.

Interface with large experiment board

> ### Your benefits
> ✓ High flexibility
> ✓ Experiments with circuits, industrial components or plug-in modules
> ✓ Control and voltage supply via the interface
> ✓ Short setup times

Interface with experimenters hosting experiment cards

Interface with EloTrain experimenter for plug-in modules

COMPLEX MATERIAL PRESENTED LUCIDLY

UniTrain courses – learning programs with matching experiment hardware

UniTrain courses combine interactive learning programs with experiment hardware that fits the content. Experimentation with real parts and industrial components reinforces acquired knowledge and imparts practical, hands-on skills. Questions for self-testing, direct feedback as well as constant alternating between theoretical and practical segments promote learning.

Animations and graphics facilitate comprehension and step-by-step understanding of experiment set-ups.

Openly structured courses in HTML provide all possible options of modifying and fine-tuning courses. In addition, courses can be supplied in all languages supported by HTML.

More than 130 courses for technical training +

Your benefits

✓ More than 130 courses from the entire spectrum of technical education
✓ Theoretical and practical competence combined in a single learning unit
✓ Animations, graphics, experiments, self-test questions and troubleshooting to support learning
✓ Educationally oriented experimentation hardware with industrial components
✓ HTML-based multimedia courses
✓ All courses editable
✓ Language diversity: All HTML-languages realizable

LABSOFT – A MULTIMEDIA LEARNING ENVIRONMENT

Everything from a single source

LabSoft is a convenient user interface for visualizing learning programs and controlling instruments. A navigation window provides free and direct access to all course contents. The UniTrain interface is controlled via integrated virtual instruments

All measurement results and answers obtained in the course are saved automatically for each user. This permits easy tracking of the respective learning progress.

LabSoft, a system with diverse installation options: Local, networked or in combination with a learning management system.

Your benefits

✓ Direct access to all course content via a navigation tree
✓ Interface control via virtual instruments
✓ User-specific login and storage of results
✓ Storage of measurement results and measurement curves
✓ Operation locally, in a network, or in combination with an LMS
✓ Language diversity: All HTML-languages realizable
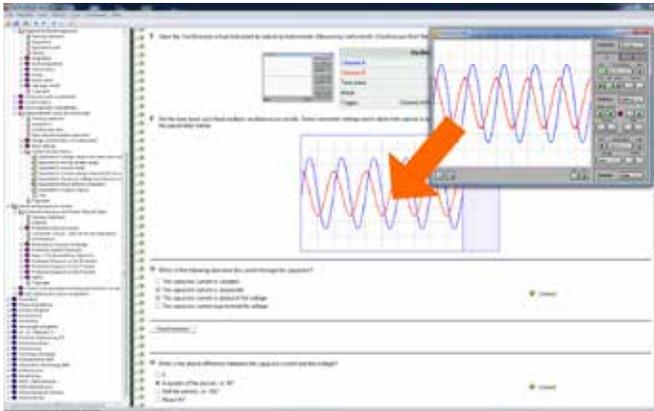
The navigation window provides free and direct access to all course content. Measurement results can be saved within the courses.
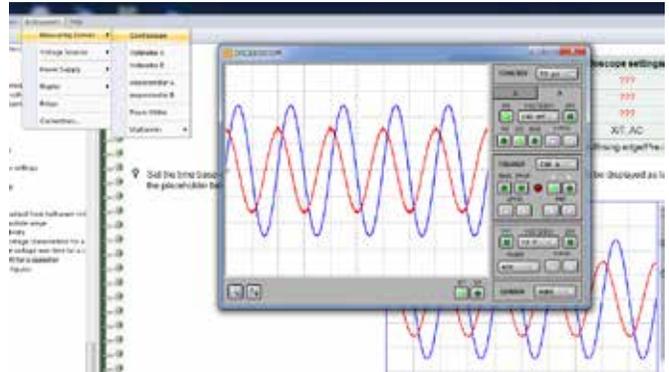
The UniTrain interface or other connected devices are controlled via integrated virtual instruments.

SAVING TIME FOR THE ESSENTIALS

LabSoft Classroom Manager Suite –
Administration, customization, testing and evaluation

LabSoft Classroom Manager Suite is an extensive administration software for the UniTrain-system and all LabSoft courses. The Classroom Manager's apps are optimized for the related applications to facilitate daily routines.

Your benefits

✓ Intuitive operation via graphic user interfaces
✓ Easy installation
✓ No need for any additional database or server systems
✓ Operable in the local network or Intranet

Manager - minimise administrative effort

- Everything under control: Manage students, student groups and content.
- Appropriate content at all times: Provide only the required courses for student groups.

Reporter – everything at a glance

- Tracking learning progress: Retrieve processing statuses and test results.
- Focusing: Assessments of users, group tests and courses.

Editor – customize subject matter

- Customization: Adapt courses to individual requirements.
- Innovation: Create new courses.

Questioner – create questions and measurement exercises

- Knowledge tests: Create measurement exercises and quizzes for courses and exams.
- Diverse types of question: Single answer, multiple choice, filling in blanks, and more.

TestCreator - check knowledge and skills

- Progress checks: Compile exams and tests from sets of questions.
- Optional: Numerous, finished assignment sets with questions and measurement exercises.

EVERYTHING UNDER CONTROL AT ALL TIMES

Manager and Reporter –

Electronic aids for preparation and follow-up

Manager	Reporter

Manager

Make your life easier and utilize the benefits of managing students and courses electronically. This saves time and paper.

Reporter

Retrieve learning progress and test results with the LabSoft Reporter. Clearly arranged selection functions lead to quick evaluation results.
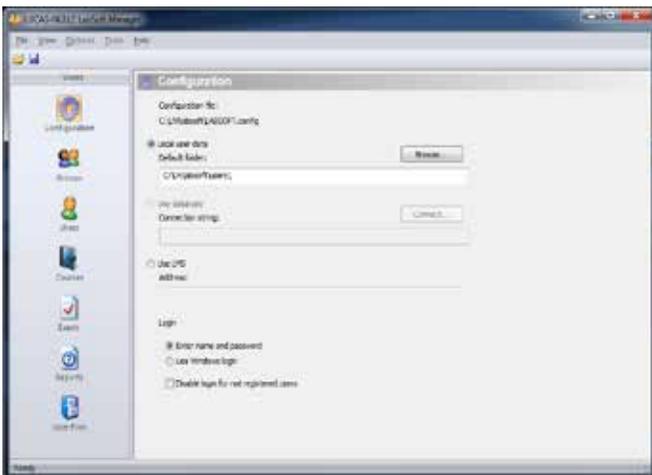
Window configuration: Basic settings for LabSoft installation
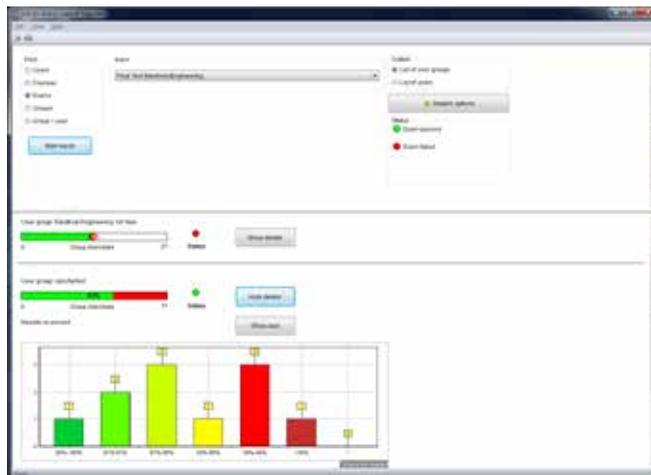
Assessment of group exam results
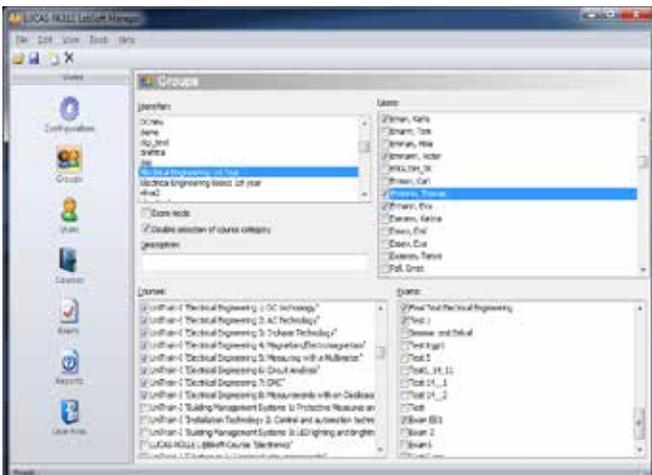
Window groups: Define groups comprising selected users and subject matter

Your benefits

✓ Electronic assessment of learning progress
✓ Graphic presentation of processing status
✓ Representation of individual or group results
✓ Assessments of courses and tests
✓ Extensive search functions quickly leading to the desired assessments

Your benefits

✓ Administration of the entire LabSoft installation
✓ Unlimited number of users and courses (learning programs)
✓ Creation and admin. of users and subject matter
✓ Creation and administration of student groups

THE RIGHT CONTENT AT YOUR FINGER TIPS

Editor and Questioner –

Course customization: Independently create courses and exercises

Editor

Use the LabSoft editor to tailor your LabSoft courses to students' current needs. Create your own questions, experiments, measurement exercises and courses, which then become immediately available to students.

The Editor's numerous wizards and an extensive help function facilitate course creation.
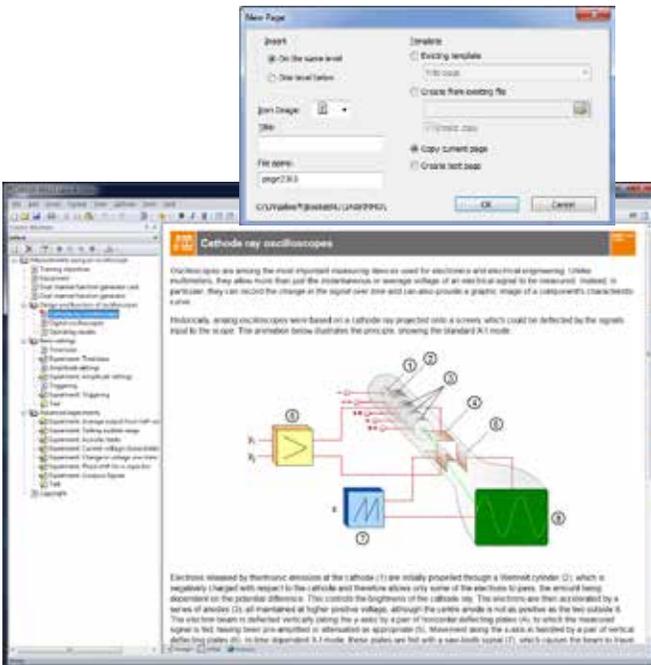
New pages can be added to a course with just a few mouse clicks. Various different options for addition are available.

Your benefits

✓ Editing and adaptation of existent courses
✓ Independent creation and editing of new courses
✓ Import of individual pages or chapters
✓ Preview of created pages in editing mode (wysiwyg)
✓ Automatic provision of newly created courses in LabSoft

Questioner

The LabSoft questioner offers many types of question for configuring quizzes, measurement exercises and exam problems. The exercises and questions can be used for courses as well as tests.
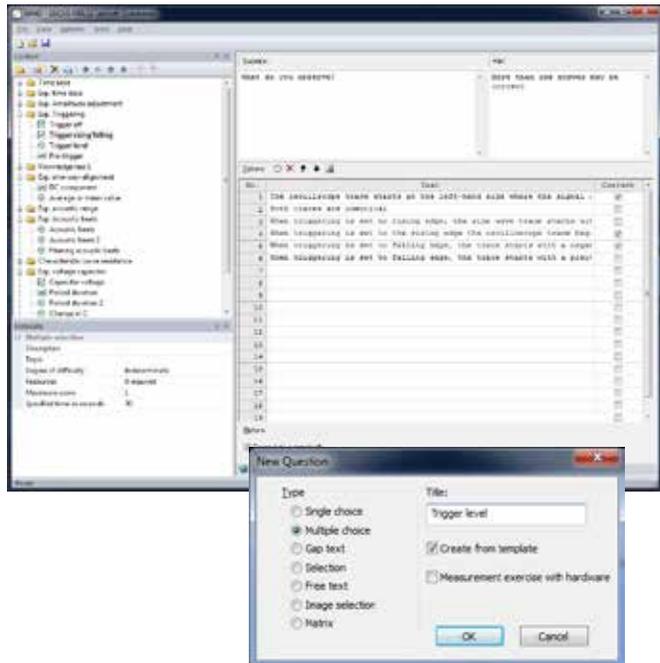
Single-choice question: Question and answer options are formulated, and the correct answers are subsequently determined with a mouse click.

Your benefits

✓ Simple creation of interactive exercises and questions
✓ Availability of diverse question types
✓ Freely selectable tolerance ranges for measurement exercises
✓ Use of questions for exams as well as learning programs

LEARNING CHECKS MADE EASY

TestCreator –

Create exams with theoretical questions and practical exercises

TestCreator

Create tests in the TestCreator quickly and easily with just a few mouse clicks. For this, use questions created independently in the questioner, or finished exercise collections containing questions and measurements to review acquired knowledge and practical skills. The exercise collections regarding various topics are available separately and can be combined as desired in the TestCreator.

Selection of exam problems via drag-and-drop

Test conduction in LabSoft

Your benefits

- ✓ Creation of electronic exams with just a few mouse clicks
- ✓ Review of acquired knowledge and practical skills
- ✓ Manual or automatic exam creation
- ✓ Availability of numerous optional assignment collections
- ✓ Question pool extensible at all times

Exercise collections with prepared assignments

A fresh breeze
for your lab –

with the „Renewable
Energies" training system
from Lucas-Nülle.

nuelle.com
s-unitrain-i.com

OUR COURSE PROGRAM

- Electrical fundamentals
- Electronics
- 2-mm plug-in system
- Digital and microcomputer technology
- Building management systems
- Power engineering
- Power electronics
- Electrical machines
- Communication technology
- Measurement and control technology
- Automation
- Pneumatics, hydraulics
- Process technology
- Mechatronics
- Automotive technology

COURSES ON ELECTRICAL FUNDAMENTALS

DC technology

- Electricity, electric charge, electric fields
- Current, voltage and resistance in DC circuits
- Ohm's and Kirchhoff's laws
- Parallel and series connections of resistors
- Coils and capacitors
- Recording of characteristics and trouble-shooting
- Course duration: approx. 8 h

AC technology

- AC variables; sinusoidal and periodic signals
- Capacitance, inductance, reactance
- Phase shift and frequency response of RL and RC combinations
- Active, reactive and apparent power
- Resonant circuits
- Transformers
- Course duration: approx. 8 h

Three-phase technology

- Star and delta circuits
- Phase-to-phase/line-to-line voltages and currents
- Resistive and capacitive loads
- Symmetric and asymmetric loads
- Phase shift and power
- Compensation currents in neutral conductors
- Course duration: approx. 4 h

Magnetism/ electromagnetism

- Magnetism, electromagnetism, magnetic materials
- Magnetic poles, magnetic felds, field intensity and lines, hysteresis
- Magnetic field of a coil
- Magnetic induction, Lorentz force, induction law
- Coil, transformer, relay, Hall sensor, reed switch
- Course duration: approx. 4 h
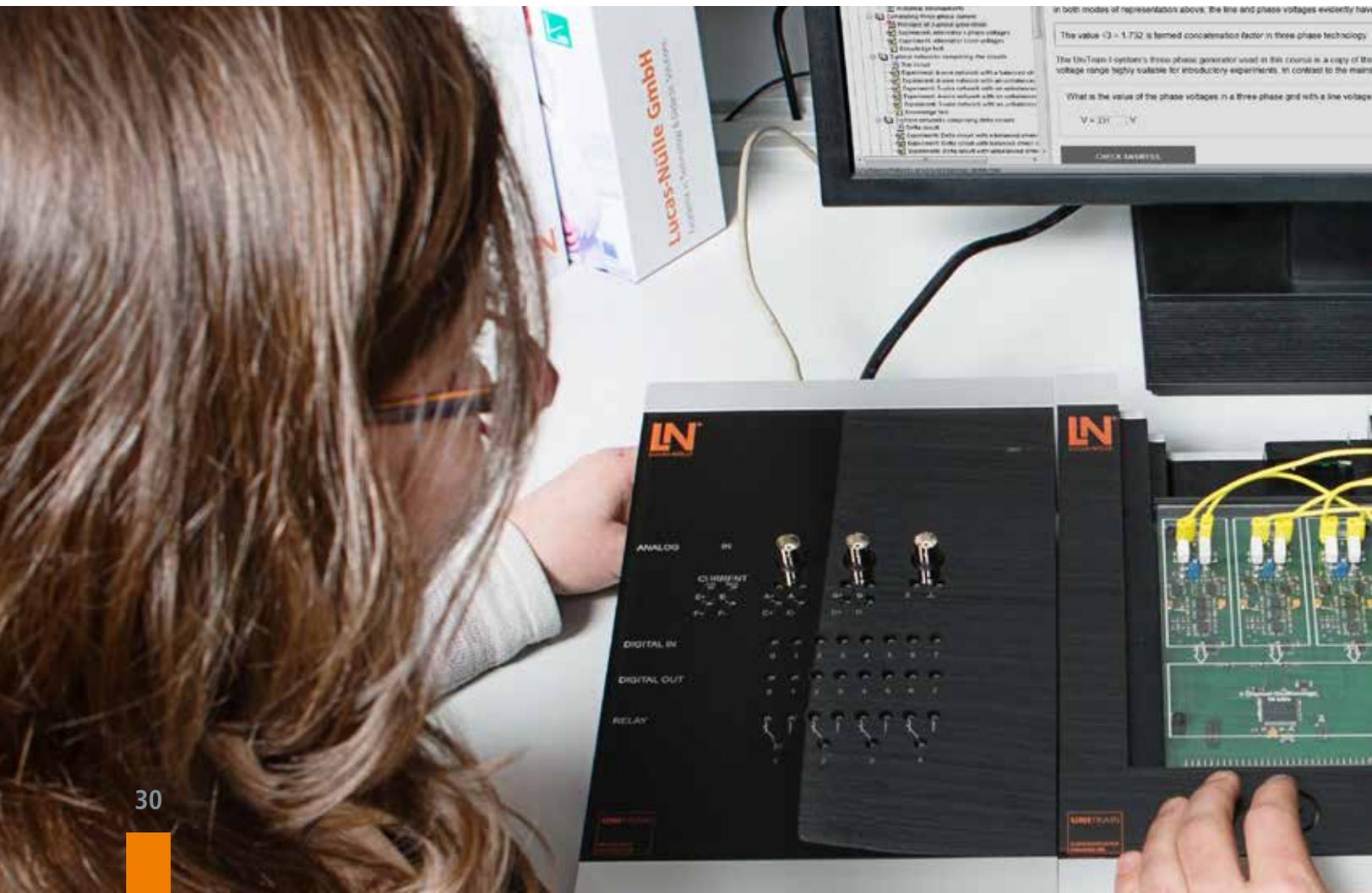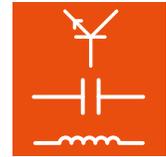
CO4204-4B

Measurements with a multimeter

- Multimeter controls
- Potential dangers during measurements of electric circuits
- Measuring voltage, current, resistance and diodes
- Measurement range adjustment and error sources
- Determining ratings of unknown components
- Course duration: approx. 3 h

CO4204-4C

Electrical network analysis

- Kirchhoff's equations for resistor networks
- Network analysis
- Analysis methods: Star-delta conversion, superposition theorem
- Network simplification: Equivalent current and voltage sources
- Mesh current method and node potential analysis
- Course duration: approx. 5 h

CO4204-4K

Electromagnetic compatibility (EMC)

- EMC concepts and coupling effects
- Standards and guidelines
- Measuring galvanic, capacitive and inductive coupling between tracks
- Improving interference resistance and EMC characteristics
- Course duration: approx. 4 h

CO4204-4L

Measurements with an oscilloscope

- Oscilloscope: Design and functionality
- Settings and operating modes
- Measuring direct and alternating voltages
- Trigger functions and modes (x/t, x/y)
- Measuring Lissajous figures
- Determining component characteristics
- Course duration: approx. 3 h
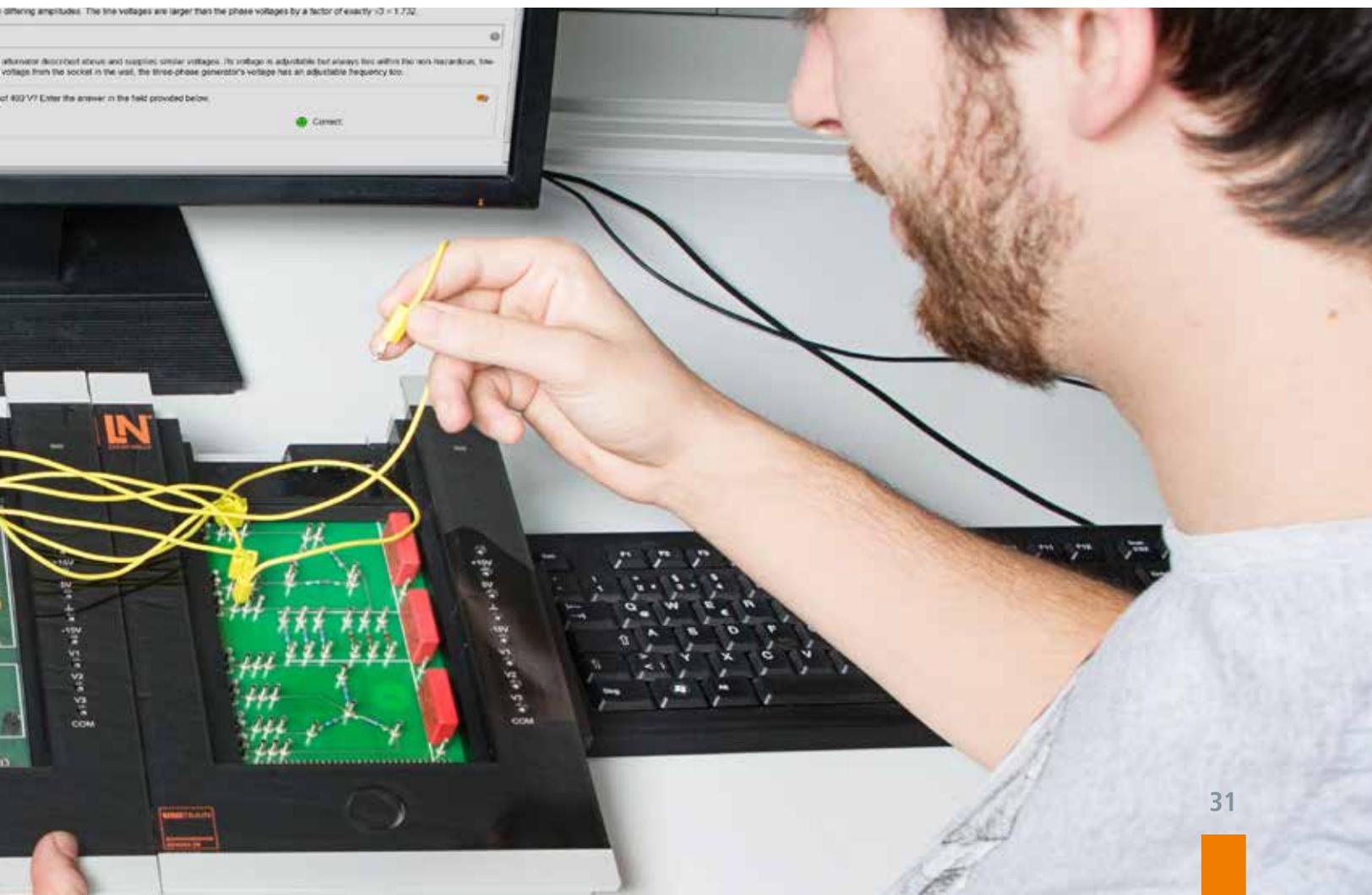
COURSES ON ELECTRONICS

CO4204-5A

Semiconductor components

- Semiconductor materials: Properties and functionality
- Doping, P-N junction
- Diode, Z-diode: Functionality, characteristics, behaviour
- LED, phototransistor, fork-type light barrier, switching characteristics
- Transistor: Basic circuits, characteristics, operating points
- Trouble-shooting
- Course duration: approx. 8 h

CO4204-5D

Transistor multivibrators

- Design and functionality of multivibrators
- Astable, monostable and bistable (flip-flop) multivibrators
- Input/output signals and dynamic response
- Changes in input wiring
- Response to pulsed and square-wave signals
- Trouble-shooting
- Course duration: approx. 4 h

CO4204-5H

Transistor and amplifier technology

- Data sheets: Determining characteristic fields and parameters
- Operating point adjustment
- Amplifier circuits and classes; Darlington amplifier, push-pull amplifier
- Single and multi-staged amplifiers
- Differential amplifiers and constant current sources
- Trouble-shooting
- Course duration: approx. 8 h

CO4204-5K

Field-effect transistors

- FET: Design, functionality, applications
- N- and P-channel types
- Source and drain circuits
- DC and AC negative feedback
- Trouble-shooting
- Course duration: approx. 1.5 h

CO4204-5M

Operational amplifiers

- Basic circuits; characteristic and limiting values
- Inverting and non-inverting op-amps
- Adder, subtractor, integral-action and derivative-action circuits
- Comparator and Schmitt trigger
- Precision-voltage and constant-current sources
- Active filters
- Trouble-shooting
- Course duration: approx. 5.5 h

CO4204-5P

Power semiconductors

- Design and functionality of thyristors, triacs, MOSFETs and IGBTs
- Conducting and non-conducting response
- Load and transmission response
- Threshold voltage and control power
- Course duration: approx. 2 h

CO4204-5R

Power supply circuits

- Half-wave and bridge rectifiers
- Smoothing circuit and load response
- Voltage multiplier circuit, load response, ripple
- Transistor voltage controller
- Load response and control quality of voltage regulators
- Trouble-shooting
- Course duration: approx. 5.5 h

SO4204-5S

Switched-mode power supplies

- Design and functionality of switched-mode power supplies
- Adjustment range and load dependency of step-down regulators
- Adjustment range and load dependency of step-up regulators
- Signal waveform measurements
- Course duration: approx. 2 h

SO4204-5U

Circuit design using NI Multisim

- Designing a PWM-controlled LED light mixer
- Assessing and selecting alternative solution strategies
- Computing component values and selecting components
- Sketching circuits
- Designing and simulating circuits in NI Multisim
- Assembling circuits on the breadboard; testing the circuits and comparing their results with simulations
- Course duration: approx. 8 h

SO4204-5V

PCB layout with NI Ultiboard

- Printed circuit boards: Manufacturing processes and standards
- Imperial and metric units of measurement
- Importing circuit files
- Positioning components, creating footprints
- Routes, through-connections and wire jumpers
- Creating Gerber files
- Course duration: approx. 8 h

COURSES ON THE ELOTRAIN PLUG-IN SYSTEM

SO4206-1A

DC technology

- Assembling electric circuits
- Using ammeters and voltmeters
- Ohm's law, series and parallel connection of resistors
- Voltage divider with and without loads
- Voltage dependent resistors
- Capacitors in DC circuits, relay circuits
- Course duration: approx. 8 h

SO4206-1B

AC and three-phase technology

- Characteristics of alternating current
- Resistor, capacitor and coil in an AC circuit
- Series and parallel connections of RC and RLC
- Transformer with and without loads
- Three-phase network: Star and delta circuit with symmetric/asymmetric loads
- Course duration: approx. 8 h

SO4206-1C

Semiconductor components

- Fundamentals of semiconductors and doping
- Diode, LED, Zener diode
- Half-wave and bridge rectifiers
- Transistor: DC and AC response, characteristics
- Emitter, collector and base circuits
- Power semiconductors: JFET, MOSFET, thyristor, diac, triac
- Course duration: approx. 7 h

SO4206-1D

Basic electronic circuits

- Amplifier circuits with bipolar transistors, FETs and op-amps
- Two-stage, Darlington and coupled emitter amplifiers
- Differential amplifier
- Signal generators, Schmitt trigger, multivibrators
- Rectifier, voltage regulator
- Phase control using thyristors and triacs
- Course duration: approx. 10 h
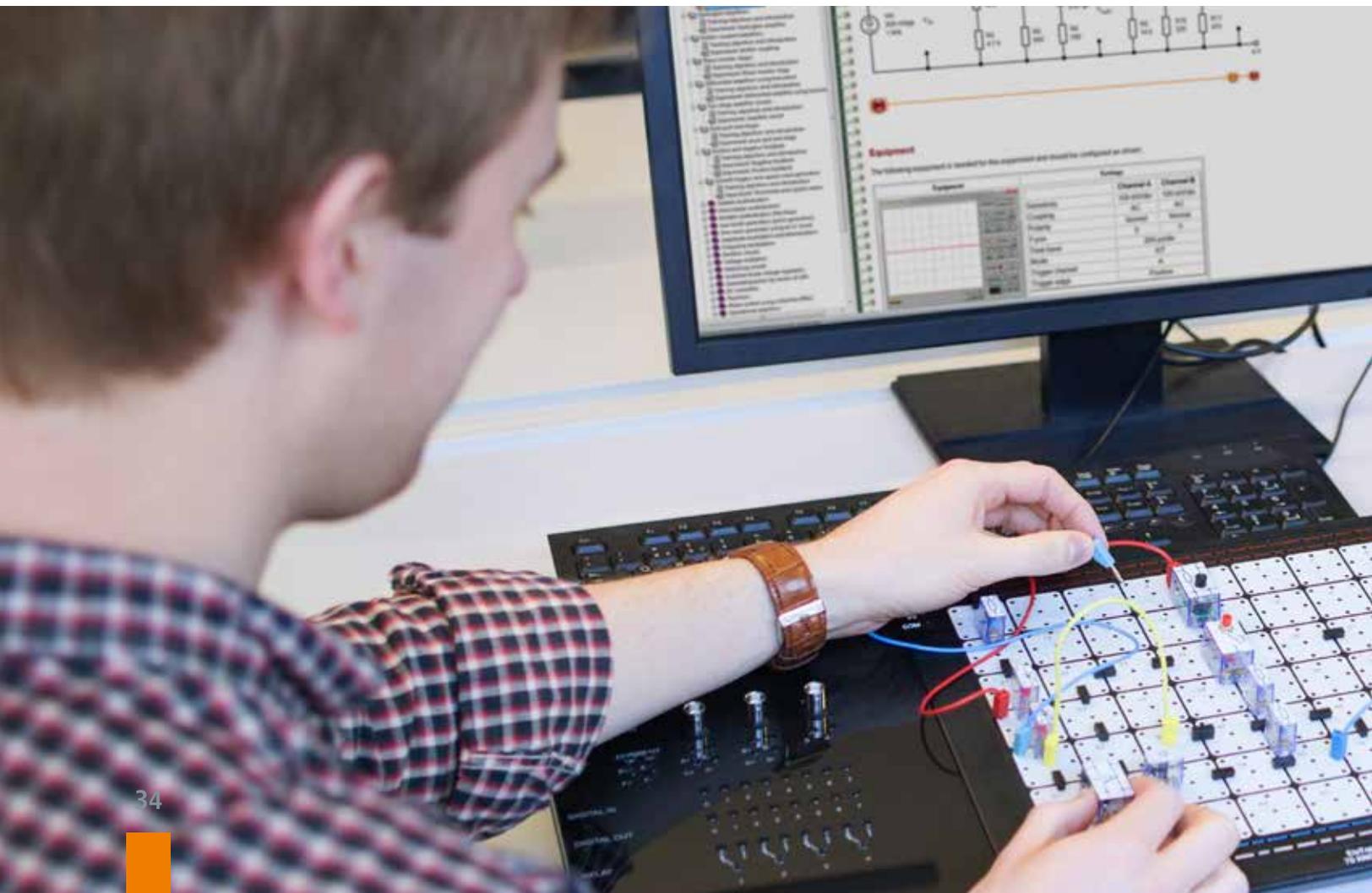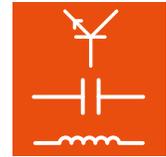
Optoelectronics

- Light-emitting diodes: Parameters, characteristics, control
- Infrared LED, photo-detector, photodiode, phototransistor
- Signal transmission using photodiodes and phototransistors
- Optocoupler, optical fibres
- Course duration: approx. 3 h

Introduction to digital technology

- Number systems
- Basic logic functions
- Antivalence (XOR) and equivalence (XNOR)
- Half adders, full adders, subtracting circuits
- Code conversion
- RS flip-flop, D flip-flop, JK flip-flop, JK master-slave flip-flop
- Flip-flop applications
- Course duration: approx. 6 h

Sequential circuits

- Display of binary numbers on LEDs and LED displays
- Asynchronous 4-bit counter, synchronous counter, decimal counter
- Counters for special codes, divider circuits, registers and shift registers
- Serial and parallel data transmission
- Multiplexers and demultiplexers
- Course duration: approx. 6 h

COURSES ON DIGITAL-/MICROCOMPUTER TECHNOLOGY

CO4204-6A

Gates and flip-flops

- Number systems, calculations with binary numbers
- Basic logic circuits
- Truth tables, symbols, switching equations and timing diagrams
- Boolean functions and laws
- Minimization of logic circuits using Karnaugh maps
- JK flip-flop, counter circuit
- Trouble-shooting
- Course duration: approx. 5 h

CO4204-6C

Sequential circuits

- Design and functionality of flip-flops and registers
- Shift registers with serial and parallel outputs
- Design and functionality of counters and dividers
- Design and assembly of counters and shift-register circuits
- Binary-coded up and down counters
- Trouble-shooting
- Course duration: approx. 5 h

CO4204-6E

Application circuits

- Binary addition and subtraction
- Functionality of binary half and full adders
- 4-bit full adder with parallel / serial output
- Design and functionality of multiplexers and demultiplexers
- Functionality of data and address buses
- Measurements of multiplexer/demultiplexer circuits
- Trouble-shooting
- Course duration: approx. 3 h

CO4204-6B

Converter circuits

- Converter parameters: Resolution, linearity, speed
- D/A converter with an R/2R network and weighted resistors
- Sampling, sampling theorem, signal reconstruction, aliasing
- A/D converter with counting method, single/dual-slope ADC and sigma-delta ADC
- Measurement of internal signals
- V/f and f/V converters
- Trouble-shooting
- Course duration: approx. 5 h
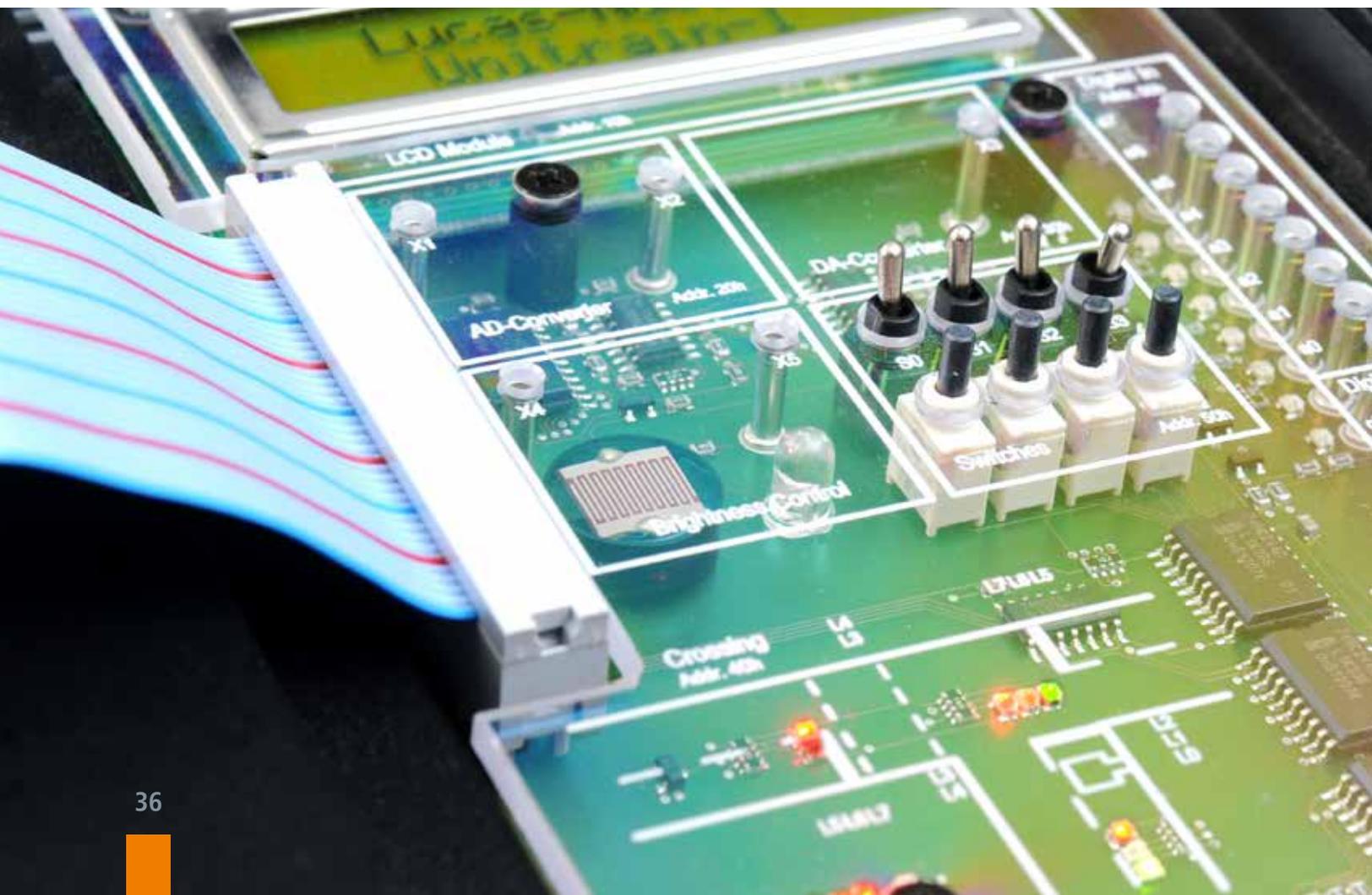
SO4204-6H

Fundamentals of computer technology

- Microcontroller architecture
- Microprocessor components (ALU, registers, stack, command decoder, program counter)
- Design and instruction set of an Intel 8085
- Memory system and buses
- Read-out of signals on address, control and data buses
- Program routines, linear and branched programs
- Course duration: approx. 5 h

SO4204-6J

Applications and programming

- Writing assembler programs
- Designing input programs
- Programming counters, loops and subroutines, interrupts and alphanumeric output
- Error analysis, debugging
- Programming and analyzing traffic light control
- Creating programs for processing of analog variables and serial data transmission
- Course duration: approx. 8 h

SO4206-9A

Microcontroller PIC16F887 (Assembler programming)

- Structure and functionality of a PIC16F887
- Instruction set and program flow
- Registers and addressing
- Programming with the IDE
- Timer and interrupts
- Creating sample programs: External clock source, monoflop, timer-controlled light sequence
- Course duration: approx. 8 h

SO4206-9B

Programming 32-bit ARM Cortex M3 microcontrollers (C programming)

- Introduction to C programming for embedded systems
- Cortex M3 architecture and programming model
- Commissioning a CoIDE
- Programming and debugging
- Projects: Reading in external signals, interrupt with signal output, A/D conversion, I2C LCD display
- Course duration: approx. 8 h

SO4206-9C

Digital signal processing using ARM Cortex M3 (C programming)

- System components for digital signal processing
- Digital transfer functions: Digital voltage divider and amplifier
- Digital signal synthesis: Sine, sawtooth and square-wave generator
- Discrete and fast Fourier transformation
- LTI systems
- Design of FIR and IIR filters
- Digital sound effects
- Course duration: approx. 6 h

SO4206-9E

FPGA: Circuit design using VHDL

- Introduction to programmable logic
- Design and functionality of an FPGA
- Design flow with VHDL
- Familiarization with the Lattice IDE
- Independent circuit design
- FPGA configuration
- Course duration: approx. 16 h

COURSES ON BUILDING MANAGEMENT SYSTEMS

CO4204-4M

Safety measures and power network types

- Design of various mains systems (TN, TT, IT)
- Protection against contact
- Protection by isolation and safety extra-low voltage
- Protection against excess and residual-leakage currents
- Protective earth resistance, insulation resistance measurement, RCD test, earthing electrode, loop resistance measurement
- Course duration: approx. 10 h

CO4204-4N

Control systems/contactor circuitry

- Familiarization with control components
- Planning control projects
- Functionality checks with circuit simulators
- Function testing and troubleshooting in control projects
- 25 control projects
- Course duration: approx. 25 h

CO4204-4P

LED lighting and colour detection

- Familiarization with different types of LED
- Brightness control for various LEDs using pulse width modulation (PWM)
- Recording of characteristics and measurement of brightness
- Additive mixing of colours and setting of colour temperature
- Colour detection and reproduction
- Course duration: approx. 10 h
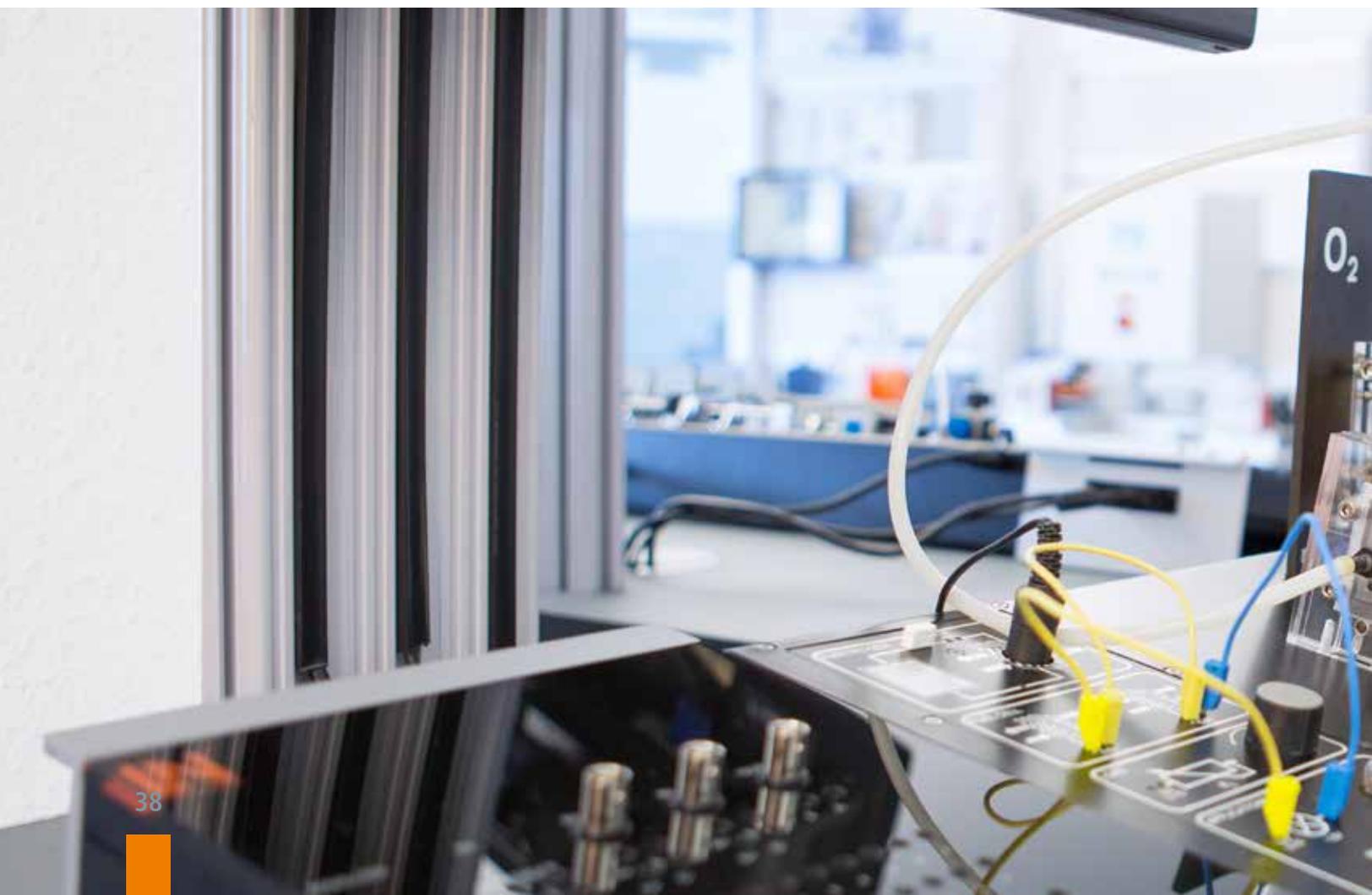
COURSES ON POWER ENGINEERING

CO4204-3A

Photovoltaics

- Operating principle and function of a solar cell
- Meaning of the terms „solar radiation" and „solar constant"
- Solar cell: Series and parallel connections
- Recording a solar module's characteristics, dependence on temperature, irradiance and angle of incidence
- Storage of energy in a solar cell
- Insular network with solar cells
- Course duration: approx. 4.5 h

CO4204-3B

Transient processes in AC and DC networks

- Switching processes in power supply networks
- Hazards of switching processes in power supply networks
- Current and voltage response when powering up a DC / AC circuit
- The effect of loads (R, L, C)
- Switch-on and switch-off times
- Signal characteristic measurements
- Course duration: approx. 3.5 h

CO4204-3C

Fuel cell technology

- Operating principle and function of a fuel cell
- Recording a fuel cell's characteristic
- Faraday's 1st and 2nd laws
- Faraday / energy efficiency and power of a fuel cell
- Series and parallel connections of fuel cells
- Operating principle and function of an electrolyser
- Characteristic of an electrolyser
- Course duration: approx. 4.5 h
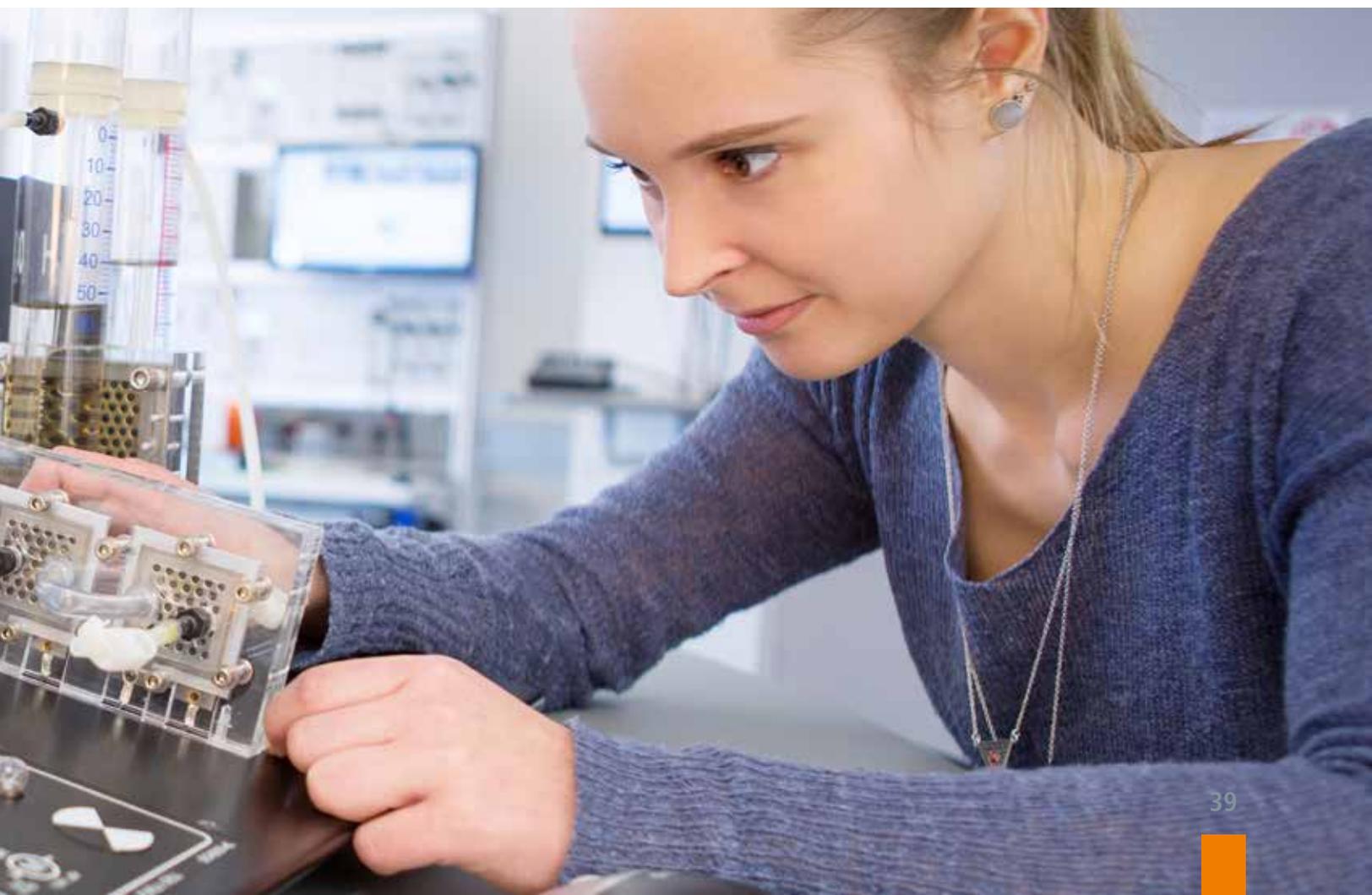
COURSES ON POWER ELECTRONICS & ELECTRICAL MACHINES

CO4204-7N

Line-commutated power converters

- Functionality and control of power semiconductors
- Single-phase and three-phase rectifiers
- Converter circuits: control and operating characteristics
- Single-phase and three-phase AC power controllers
- Analysis of power in converter circuits
- FFT analysis
- Course duration: approx. 5 h

CO4204-7M

Self-commutated power converters

- PWM for generating variable direct and alternating voltages
- Load response, control and operating characteristics
- Measurements: Amplitude and signal modulation by converters
- Three-phase converter
- Block commutation, sine, super-sine and space-vector modulation
- Harmonic analysis with FFT
- Course duration: approx. 5 h

CO4204-7P

Frequency converter drives

- Design and functionality of frequency converters
- DC link voltage
- V/f characteristic and boost
- Operating 3-phase motors with frequency converters, 87-Hz technology
- Design and functionality of brake choppers
- Analysis of current, voltage and power
- Course duration: approx. 5 h

CO4204-7Q

Active power factor correction

- Areas of applications and reasons for using power factor correction
- Design and functionality of an active power factor correction circuit
- Comparison with conventional bridge rectifier circuits
- Analysis of current, voltage and power
- Analysis of variables using FFT
- Course duration: approx. 3 h

CO4204-7S

DC machines

- Electromagnetic induction and the Lorentz force
- Design and functionality of DC machines
- Armature and excitation current / voltage / resistance
- Connection types: Series, shunt and compound
- Speed measurement, control and reversal
- Working with AC voltage, braking
- Temperature monitoring
- Course duration: approx. 5.5h

CO4204-7T

Asynchronous machines

- Design and functionality of rotating field machines
- Electromagnetic induction, magnetic field, torque
- Asynchronous machine, capacitor motor, squirrel cage rotor
- Star and delta circuit line, phase, rotor current and voltage
- Nominal data and characteristics
- Temperature measurement
- Trouble-shooting
- Course duration: approx. 5.5 h

CO4204-7U

Synchronous and slip ring machines

- Design and functionality of synchronous, slip-ring and reluctance machines
- Rotating magnetic field in rotating field machines
- Circuit diagram, terminal chart, type plate and nominal data
- Speed adjustment, operating behaviour, generator mode
- Measurements: Current, voltage start-up, speed, cos φ
- Course duration: approx. 5 h

CO4204-7W

Stepper motors

- Design, function and applications of stepper motors
- Permanent-magnet, reluctance, and hybrid-stepper motors
- Unipolar / bipolar control
- Full-step and half-step mode
- Step angle, maximum operating and start frequencies
- Half- and full-step operation, direction reversal, current control
- Absolute / relative positioning
- Course duration: approx. 3.5 h

CO4204-7X

Linear motors

- Operating principle, functions and applications of a linear motor
- Lorentz force and „induced voltage"
- Designs of linear motors
- Advantages and disadvantages in comparison to rotary machines
- Determining motor constants
- Absolute and relative positioning; position determination using encoders and Hall sensors
- Course duration: approx. 4.5 h

CO4204-7Z

BLDC motors

- Design, functionality and applications of BLDC motors
- Advantages and disadvantages of BLDC motors
- Power supply patterns for BLDC motors: Block and sine-wave current signals
- Rotor position detection: Hall sensors, back-emf, pole detection, resolvers and incremental sensors
- Position measurement using Hall sensors
- Current and speed control
- Course duration: approx. 5 h

CO4204-7Y

Three-phase transformers

- Principle of a transformer
- Load response of a single-phase transformer in case of one-quadrant and four-quadrant operation
- Measurement of current and voltage under load / no-load
- Transformation ratio, equivalent circuit diagram
- Three-phase transformer: Load cases with various switching groups
- Determining short-circuit voltages
- Course duration: approx. 3 h

COURSES ON COMMUNICATION TECHNOLOGY

CO4204-9A

Quadripoles and filters

- Transmission function, phase response, filter cut-off frequency
- High-pass and low-pass filters in a Bode diagram
- Bandwidth and median frequency of band-pass filters
- Series and parallel resonant circuits
- Parallel resonant circuit with capacitance diode tuning
- Course duration: approx. 5 h

CO4204-9B

Active filter with operational amplifiers

- High-pass, low-pass, band-pass and band-stop
- Filter order, slope, phase shift
- Cut-off frequency, ripple, attenuation
- Filter approximations: Bessel, Butterworth and Tschebyscheff filters
- Measurements in the time and frequency domains
- Course duration: approx. 5 h

SO4204-9G

Coaxial lines

- Resistance / capacitance / inductance per unit length, characteristic impedance
- Measurements with a Wheatstone, Wien and Maxwell bridge
- Determining a coaxial cable's characteristic impedance
- Reflections in a coaxial cable depending on termination
- Reflection-free cable termination
- Course duration: approx. 2 h

CO4205-4E

Fibre optic cables 650/820 nm

- Converting electrical signals into optical signals
- Characteristic and frequency response of transmitter diodes
- Modulation methods
- Transmission path with various wavelengths
- Step index and graded index fibres
- Optical waveguide configuration
- Signal recovery, bandwidth, attenuation, splices
- Course duration: approx. 4 h
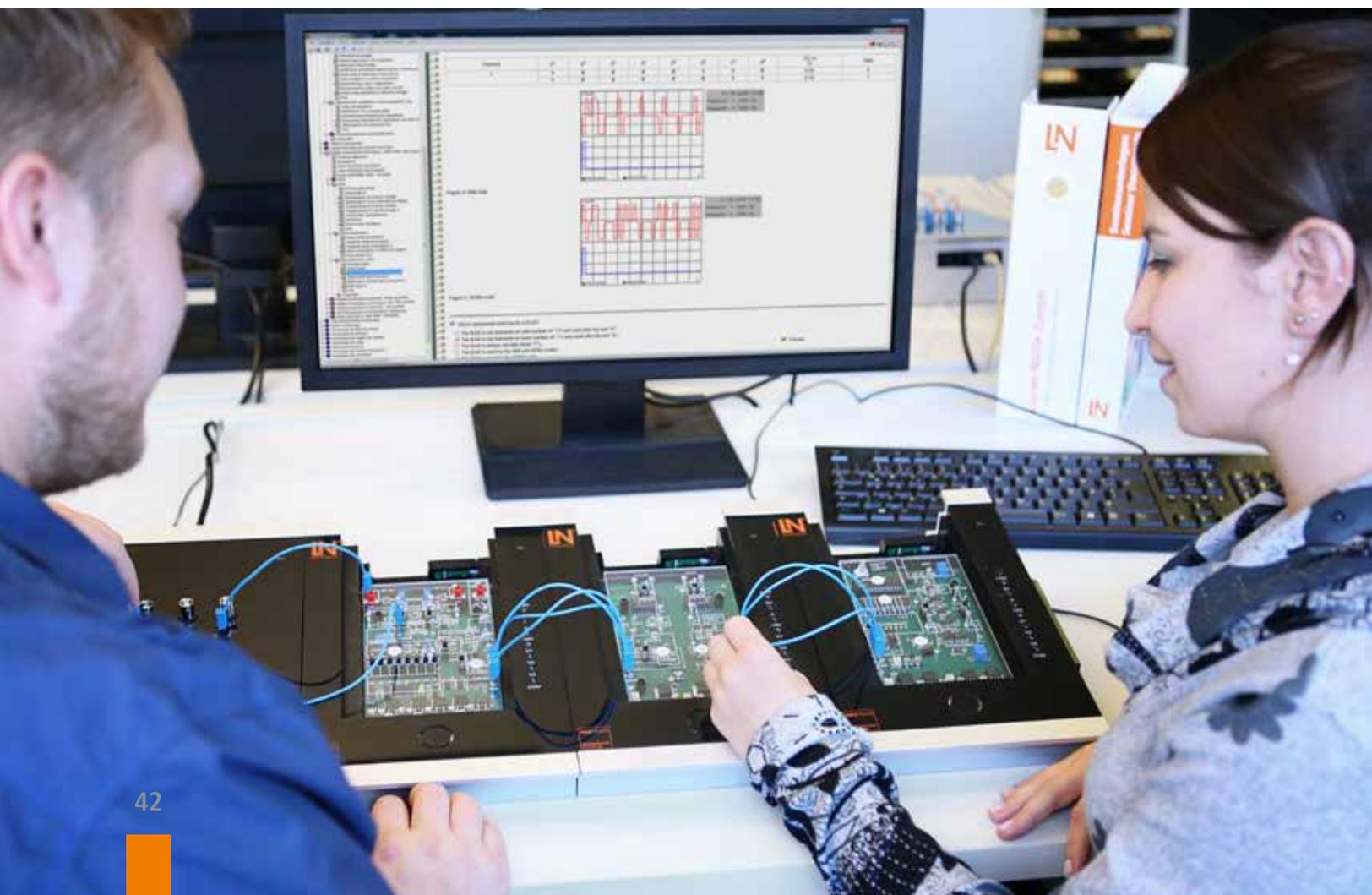
CO4205-4F

Fibre optic cables 1300 nm

- Fibre optic cable FOC (wavelengths, numerical aperture, loss, dispersion)
- Safety measures when working with lasers
- Cable types, (PC, UPC, APC)
- Monomode and Multimode FOC
- Coding procedure for image and audio transmission
- Determination of bandwidth and the volume range of transmission line
- Course duration: approx. 4 h

SO4204-9F

Four-wire lines

- Applications and characteristic line values
- Measuring line parameters at various frequencies
- Characteristic impedance and propagation rate
- Pulse transmission and transit times
- Measurements using FFT
- Cross-talk and coupling
- Course duration: approx. 4 h

SO4204-9J

PAM, PCM and delta modulation

- Principle of PAM/PCM/delta modulation
- Shannon's sampling theorem
- Quantization, companding according to a-Law and µ-law
- Transmission characteristics and signal waveform measurements
- Line codes: AMI, HDB3 and modified AMI
- Clock recovery, phase jitter, optimal filtering, anti-aliasing
- Course duration: approx. 4 h

CO4204-9K

Pulse modulation methods: PTM

- Principle of PWM /PPM modulation and demodulation
- Signal waveform at PWM/PPM outputs
- Signals output by PWM/PPM demodulators
- PWM transmission bandwidth
- Measurement of a PPM demodulator's internal signals
- Advantages / disadvantages of PWM / PPM
- Course duration: approx. 2 h

CO4204-9L

ASK, PSK, (Q)PSK modulation

- Transmission of digital signals via analog lines, ASK, FSK
- Spectrum of an ASK / FSK modulated signal
- Data transmission rate and required bandwidth in the case of ASK/FSK
- Demodulation of FSK signals
- Principle of PSK (DPSK) and QPSK (DQPSK) modulation
- Baud rates, dibits, transmission rate
- Course duration: approx. 2.5 h

SO4204-9M

AM/FM modulation / demodulation

- Principle of AM/FM
- AM: DSB and SSB modulation
- AM: Modulation trapezoid, modulation depth, residual carrier, phase shift
- Demodulation of AM/FM modulated signals
- FM: „Instantaneous frequency", frequency amplitude, modulation index
- Ratio and phase detectors
- Course duration: approx. 3 h

SO4204-9N

Transmission and receiving technology

- Design and functionality of Hartley and Colpitts oscillators
- Modulation depth, frequency response
- AM transmitter / receiver
- Direct and superhet receivers
- AGC and AFC
- Signal-to-image ratio, adjacent channel selectivity
- Filter curves
- Medium-wave AM single-stage superhet receiver with full-range tuning
- Course duration: approx. 4.5 h

CO4205-4S

Data acquisition with RFID/ NFC

- Areas of application and design of RFID systems
- Operating frequencies, properties and range
- Energy link, data transmission and anti-collision procedure
- Transponder designs, read/write operations
- Analysis of RFID messages according to ISO15693
- Course duration: approx. 4 h

COURSES ON COMMUNICATION TECHNOLOGY

CO4205-4Q

Network technology

- Network standards, topologies and structures
- OSI layer model
- Structure and components of an Ethernet network
- Assembling and testing client-server and peer-to-peer computer networks
- The Internet protocol TCP/ IP, differences between IPv4 and IPv6
- Addressing, network masks, sub-networks
- Course duration: approx. 3.5 h

SO4204-9T

Fundamentals of antenna technology

- Characteristic parameters of electromagnetic waves
- Physics of transmitting and receiving
- Dipole, Yagi, helix, patch and microstrip antennae
- Radiation in the near / far fields
- Polarization, antenna gain, impedance, symmetrization
- Measurement of directional diagrams for various antennae
- Course duration: approx. 8 h

SO4204-9Z

Complex antenna systems

- Patch, horn, slot, dielectric, microstrip and parabolic antennae
- Formation and measurement of directional diagrams
- Group antennae and arrays
- Phase relationships in the case of group antennae
- Reflection in radio transmission
- Secondary radiation
- Passive radar transponder
- Course duration: approx. 16 h

SO4204-9U

Fundamentals of micro-wave technology

- Characteristic parameters of electromagnetic waves
- Line variables, wave propagation in waveguides
- Gunn oscillator and LNC receiver
- Current-voltage characteristic
- Standing waves, short circuit, reflection and matching, standing-wave ratio
- Dielectrics in waveguides
- Course duration: approx. 4.5 h
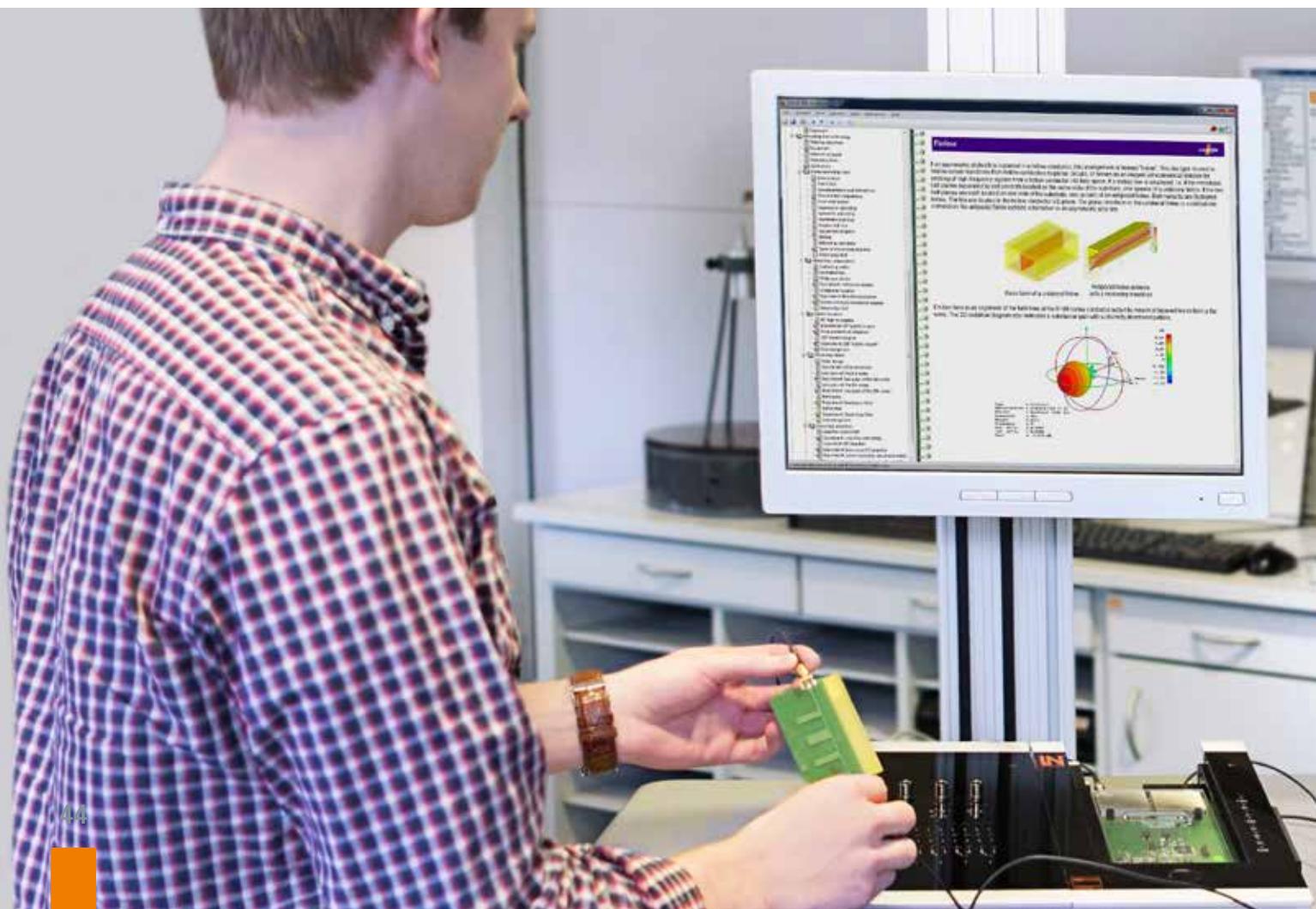
SO4204-9V

Waveguide components

- Wave propagation in a wave-guide
- Waveguide elements for changing directions: Rotary coupling, E-plane and H-plane bends
- Attenuator, phase shifter, ferrite valve
- Attenuation and reflection of coupling elements
- Modulation and demodulation
- Smith chart: Determining impe-dance and reflection factor
- Course duration: approx. 8 h

SO4204-9Y

Microstrip technology

- Characteristic line parameters and transfer function
- Scattering parameters and scattering matrix
- Transfer functions: Wilkinson divider and directional coupler
- Filter design
- 3rd and 5th order low-pass filters, band-pass, band-stop
- Microwave amplifiers: MMIC and FET amplifiers
- Reflection / standing wave ratio
- Course duration: approx. 8 h
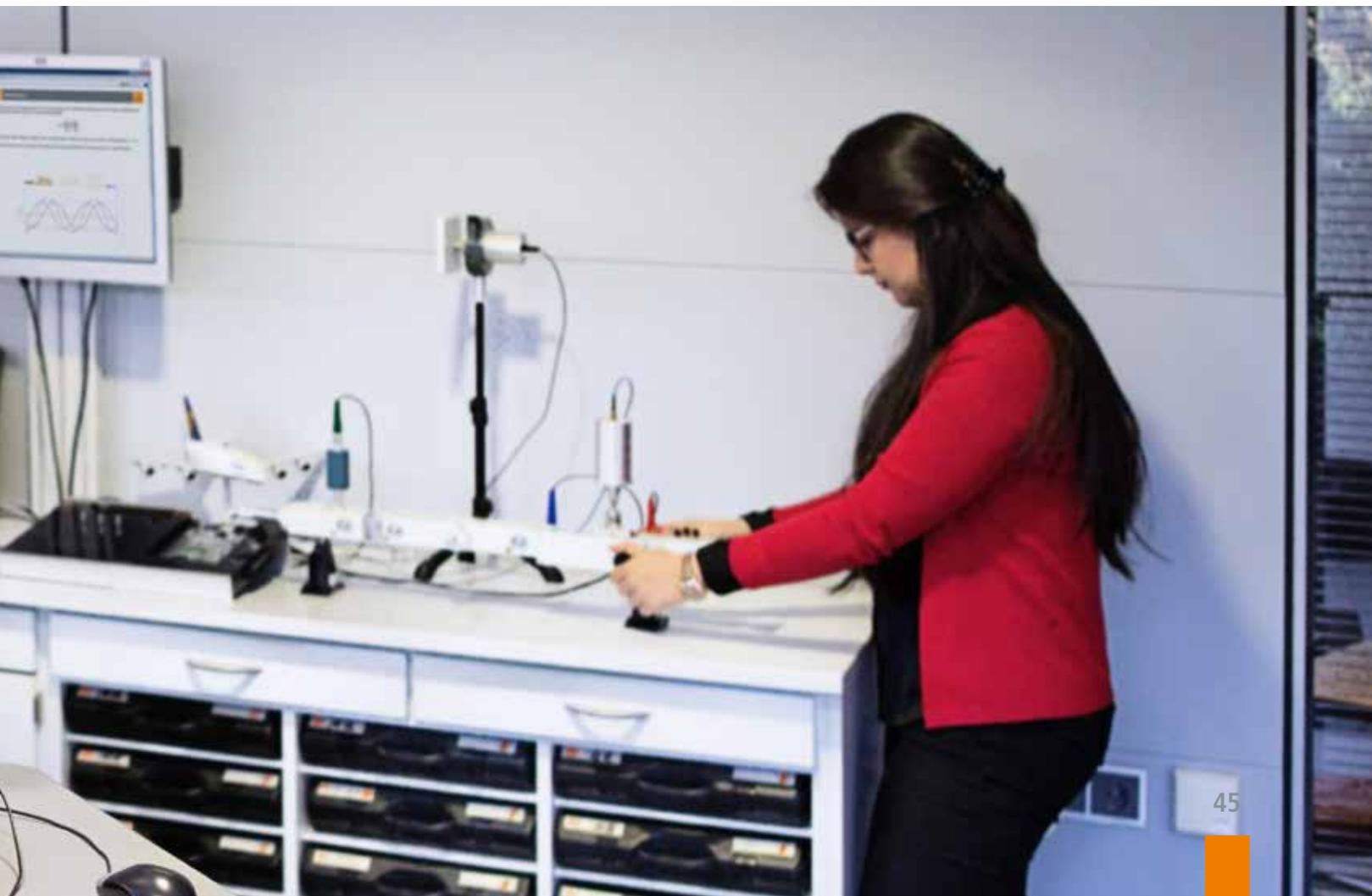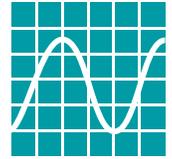
COURSES ON MEASUREMENT TECHNOLOGY

CO4204-8A

Electrical variables

- Functional principles of measuring instruments: Deflection and bridge methods
- Digital and analog methods
- Moving iron, moving coil and electrodynamic instruments
- Extended measuring ranges for current / voltage measurement
- Measuring effective, apparent and reactive power
- Measuring power factors, electrical work and frequency
- Course duration: approx. 5 h

CO4204-8B

Non-electrical variables: Temp./pressure/force

- Influence of measurement circuits
- Linearization of characteristics
- Temperature: NTC, Pt 100, KTY, thermocouple
- Pressure: Piezo-electric, inductive and resistive sensors, absolute and differential sensors
- Force: Strain gauges on a bending bar and torsion rod
- Course duration: approx. 7.5 h

CO4204-8C

Non-electrical variables: Displacement/angle/speed

- Measuring displacement with inductive and capacitive sensors
- Displacement measurement incremental, binary and Grey code encoders
- Position measurement on rotating shafts: Optical encoder, Hall sensors, resolver
- Angular measurement with a resolver
- Determining motor speed using Hall sensors
- Course duration: approx. 6 h

CO4204-8D

RLC measurements

- Measurement principle of bridge circuits
- Measuring resistance and impedance using a Wheatstone bridge
- Measuring inductance using a Maxwell-Wien bridge
- Measuring capacitance using a Wien bridge
- RLC measurements using the impedance measurement technique
- Course duration: approx. 3 h
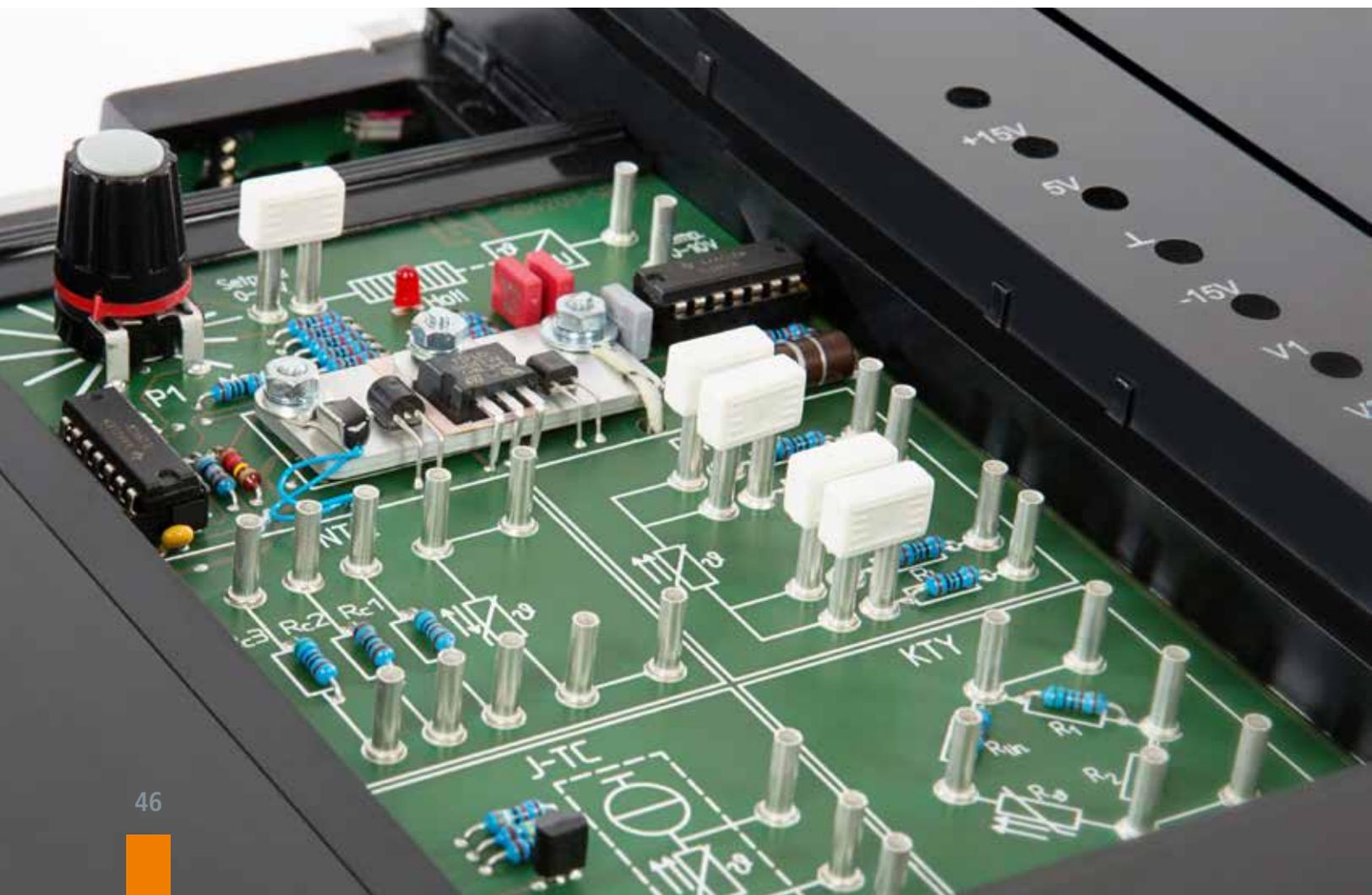
COURSES ON AUTOMATIC CONTROL TECHNOLOGY

PID

CO4204-8J

Practical introduction to control technology

- Open-loop and closed-loop control
- Continuous and discontinuous controllers
- Temperature, speed, light, filling-level and flow rate control
- System characteristics and disturbance response
- Parametrization and optimization
- Recording step responses
- Investigating a closed control loop
- Course duration: approx. 6 h

CO4204-8H

Servo motor technology

- Angular and speed control
- Positions and speed detection by means of an incremental encoder
- Control characteristic, dead time, transient response, system deviation and control oscillation
- Step response and time constant
- Operation using various controller types
- Investigating a servo drive's response to load variations
- Course duration: approx. 4 h
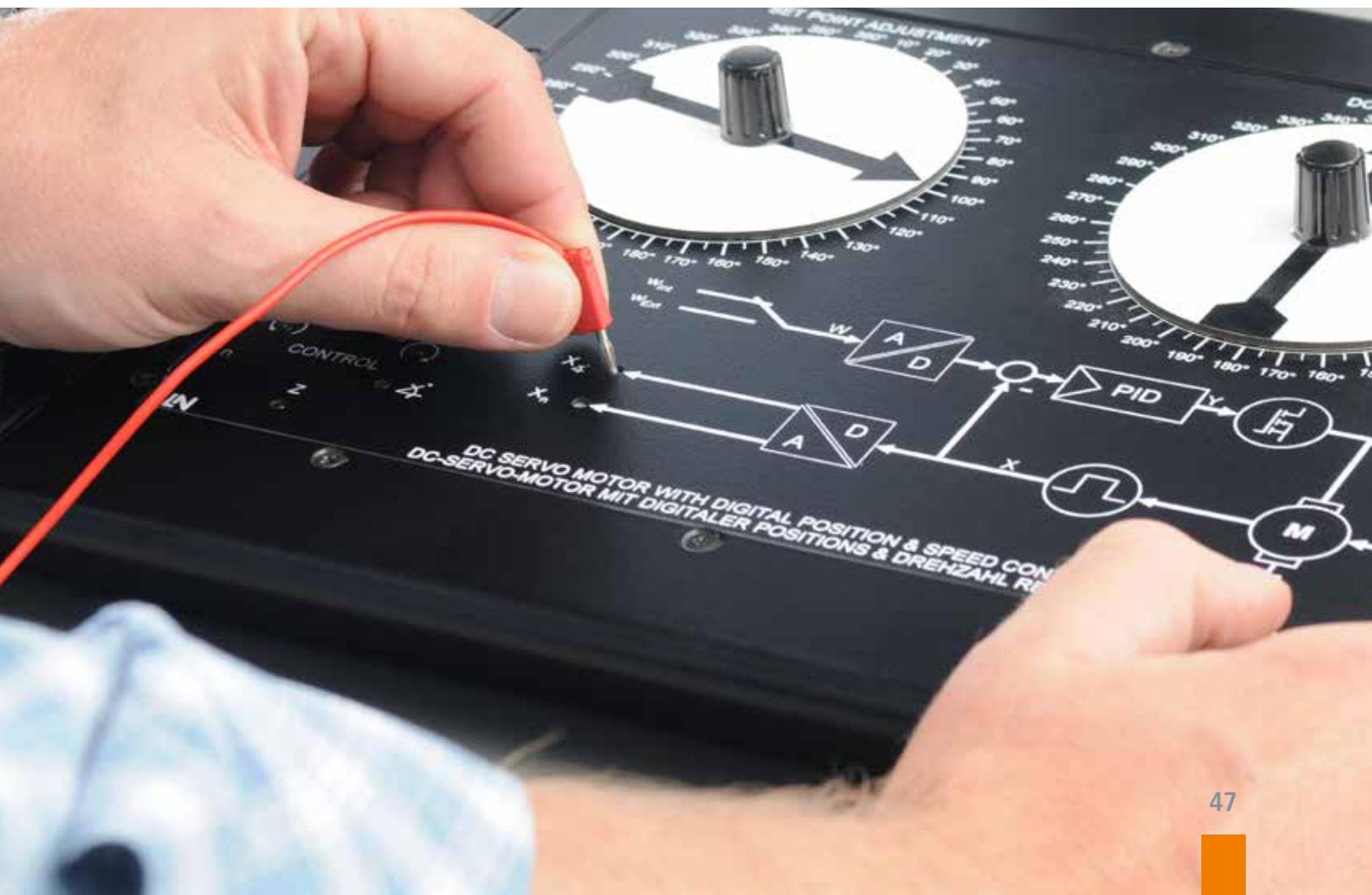
COURSES ON AUTOMATION TECHNOLOGY

CO4204-8N

PLC and bus technology

- PLC design, functionality and commissioning
- Program sequence, addressing and analog value processing
- Planning an automation system
- Programming with IL/ST editors according to IEC 1131
- Setting up PROFIBUS networks
- Transmission and fault analysis
- Connecting devices, GSD
- Course duration: approx. 10 h

SO4204-8T

PLC model: Lift

- Manual motor control
- Sensor signal detection
- Lift control for two storeys
- Lift control for three storeys
- Lift control with door opening/closure
- Programming emergency-stop functions
- Course duration: approx. 4 h

SO4204-3P

Basics of robot technology

- Industrial robots: Types and tasks
- Programming of movements: Movement types, coordinate systems, speed and acceleration
- Movements in joint and cart mode
- Combining a robot, PLC and conveyor belt in a robot cell
- Programming loading and unloading operations
- Course duration: approx. 8 h

CO4204-8U

Sensors used in automation

- Operating principle and functionality of industrial sensors
- Inductive, capacitive, optical and magnetic-field sensors
- Influence of various material samples on sensor response
- Measurement of sensing distances, hysteresis, limiting values and switching frequencies
- Reduction factor
- Course duration: approx. 4 h

COURSES ON PROCESS TECHNOLOGY

CO4204-3E

IPA1 Compact station

- Design and commissioning of a process plant
- Selecting and connecting different sensors
- Measurement: Filling level, flow rate, pressure and temperature
- Automatic control of filling level, flow rate and pressure
- Analyzing, designing and optimizing control loops
- Maintenance and servicing
- Course duration: approx. 8 h

SO4204-3F

IPA2 Mixing station

- Design and commissioning of a process plant
- Piping and instrumentation (P&I) diagram
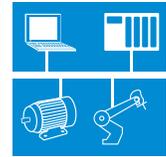- System sensors and actuators
- Formulation control, filling-level calculation
- PLC programming: Mixing, pumping out, cleaning, filling of dye reservoirs
- Maintenance and servicing
- Course duration: approx. 4.5 h

SO4204-3G

IPA3 Filling station

- Design and commissioning of a process plant
- Selecting and connecting different sensors
- Designing open-loop and closed-loop programs
- PLC programming: Filling, cleaning and emptying reservoirs, filling bottles
- Course duration: approx. 4.5 h

SO4204-3H

IPA4 Corking station

- Design, commissioning and monitoring of a process plant
- Sensor connection
- Designing open-loop and closed-loop programs
- PLC programming: Belt control, bottle cap mounting
- Maintenance and servicing
- Course duration: approx. 4.5 h

COURSES ON PNEUMATICS / HYDRAULICS
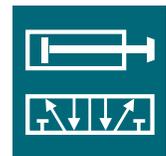
CO4205-5E

Pneumatics

- Fundamentals and safety regulations
- Pneumatic diagrams, single- and double-action cylinders, directional valves
- Holding element control, command variable control
- Displacement- and time-dependent control
- Displacement-time diagrams
- Sequence control, hard-wired control
- Course duration: approx. 8 h

CO4205-5F

Electropneumatics

- Basics
- Pneumatic and electrical circuit diagrams, single- and double-action cylinders, directional valves
- Holding element control, pilot control
- Position and time-dependent controls
- Position/timing diagrams
- Sequential control, hard-wired programmed control, programmable control
- Course duration: approx. 8 h

SO4205-8A

Hydraulics / Electrohydraulics

- Fundamentals
- Hydraulic and electrical circuit diagrams, single- and double-action cylinders
- Forward feed control, start (inhibit) interlock with intermediate stopping
- Pressure-dependent and time-dependent control
- Mechanical / electrical interlock of pushbutton contacts
- Rapid forward-feed/traverse control
- Displacement-time diagrams
- Course duration: approx. 8 h

COURSES ON MECHATRONICS

SO4204-8K

Transfer system with DC drive

- Assembling, adjusting and testing mechanical components
- Speed and direction control
- Sequence control using a PLC
- Movement in inching mode
- Automatic transport of a workpiece carrier with holding time
- Programming movement sequences with end-limit switches
- Slip monitoring
- Course duration: approx. 5 h

SO4204-8L

Transfer system with three-phase drive

- Assembling, adjusting and testing mechanical components
- Speed and direction control
- Sequence control using a PLC
- Movement in inching mode
- Automatic transport of a workpiece carrier with holding time
- Programming movement sequences with end-limit switches
- Slip monitoring
- Course duration: approx. 5 h

SO4204-8M

Sorting sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning a sorting unit for bottom sections
- Defining a process sequence for loading a workpiece carrier
- Programming a production sequence in manual and automatic modes
- Course duration: approx. 4 h

SO4204-8O

Assembly sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning an assembly robot for top sections
- Defining a process sequence for workpiece assembly
- Programming a flasher component and a stop cylinder
- Programming a production sequence in manual and automatic modes
- Course duration: approx. 4 h

SO4204-8P

Processing sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning an automatic processing unit
- Defining a process sequence for workpiece processing
- Programming a flasher component and a pressing cylinder
- Programming a production sequence in manual and automatic modes
- Course duration: approx. 4 h

SO4204-8Q

Testing sub-system

- Assembling, adjusting and testing pneumatic cylinders, and valves
- Optical, inductive, capacitive and magnetic test sensors
- Defining a process sequence for simple workpiece testing
- Programming a flasher component and a stop cylinder
- Programming a testing sequence in manual and automatic modes
- Course duration: approx. 4 h

SO4204-8R

Handling sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Vacuum generator and vacuum suction device with sensors
- Commissioning and controlling a pneumatic handling unit
- Defining a process sequence for workpiece sorting
- Programming a sorting sequence in manual and automatic modes
- Course duration: approx. 4 h

SO4204-8S

Storage sub-system

- Commissioning and controlling a pneumatic linear unit
- Rack level positioning with the aid of incremental sensors
- Defining a process sequence for a high rack storage system
- Programming a pulse counter
- Programming a complete warehousing procedure in manual and automatic modes
- Course duration: approx. 4 h

SO4204-8W

Routing sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning and controlling a linear unit
- Defining a process sequence
- Programming a routing sequence in manual and automatic modes
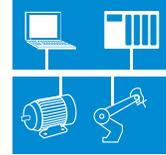- Course duration: approx. 4 h

SO4204-8X

Buffering sub-system

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Commissioning a buffer unit
- Defining a process sequence
- Programming the production sequence in manual and automatic modes
- Course duration: approx. 4 h

SO4204-8Z

Production line

- Assembling, adjusting and testing pneumatic cylinders, valves and sensors
- Defining a process sequence
- Applying the principles of control technology
- Working with various actuators and sensors
- PROFIBUS project planning and commissioning
- Linking of multiple individual systems to create a totally integrated system
- Course duration: approx. 6 h

COURSES ON AUTOMOTIVE TECHNOLOGY

CO4204-7A

DC and AC circuits in motor vehicles

- Current, voltage and resistance
- Electric circuit with a lamp, measurements with a voltmeter and ammeter
- Ohm's and Kirchhoff's laws
- Resistor circuits
- Voltage divider, potentiometer, bridge circuits
- LDR, NTC, PTC, VDR
- Trouble-shooting
- Course duration: approx. 5.5 h

SO4204-7B

Electronics and digital technology in vehicles

- Designs and functions of diodes and Z-diodes
- Basic transistor circuits
- Transistor as a switch and amplifier
- Basic logic circuits
- Truth tables, symbols, logic equations
- Boolean functions and laws
- Trouble-shooting
- Course duration: approx. 9.5 h

SO4206-1J

Automotive electrics / electronics with a plug-in system

- Circuit assembly with a 2-mm plug-in system
- Current, voltage and resistance
- Ohm's law, resistor circuits
- Voltage divider, potentiometer, bridge circuits
- Variable resistors, capacitors and coils
- Typical automotive applications
- Course duration: approx. 5.5 h

SO4205-1G

Fundamentals of automotive electrics

- Direct and alternating voltages, pulse-width modulated signals
- Current, resistance, Ohm's law
- Series, parallel and mixed resistor circuits
- Circuit analysis: Brake light, instrument lighting, heating fan, horn
- Fault diagnosis: Interrupted circuit, short circuit, defective components
- Course duration: approx. 5 h

CO4204-7J

Pulse-width modulated signals

- Principle of pulse-width modulation (PWM)
- Automotive applications of PWM
- Power matching with PWM
- Measuring key PWM signal parameters: Frequency, amplitude, duty cycle, pulse-width, edge and signal shapes
- Control and operating circuits
- Diagnosing PWM-controlled components
- Course duration: approx. 2.5 h

SO4204-7D

Three-phase generator (alternator)

- Electromagnetism
- Single-phase and three-phase generators, rectifiers
- Automotive electric circuits, charge control light, battery charging
- Electromagnetic and electronic voltage regulators
- Dependency of alternator voltage on motor speed and load condition
- Trouble-shooting
- Course duration: approx. 7.5 h

SO4204-7F

Sensors in motor vehicles

- Induction, Hall effect, piezo-effect
- Speed measurement with inductive and Hall sensors
- Throttle valve switch, throttle valve potentiometer
- Air-flow measurement with hot-wire and hot-film sensors, pressure measurement in the intake manifold
- Detecting ignition timing with a knock sensor
- Temperature measurement with NTC and PTC sensors
- Course duration: approx. 10 h

SO4204-7C

Pulse generation and ignition systems

- Ignition systems: contact-controlled, transistor-controlled, electronically controlled
- Setting the ignition-firing and dwell angles, ignition maps
- Centrifugal-force and vacuum pressure adjustment
- Generation and distribution of high voltage
- Hall and inductive sensors
- Measuring ignition voltage signal waveforms
- Course duration: approx. 8 h

CO4204-6X

Common rail diesel injection system

- Design and function of a common rail system
- Injection response: Pilot, main and post injection
- Design and control of solenoid-valve and piezo injectors
- High-pressure generation and control
- Regeneration of soot particle filters, zero-fuel correction
- Course duration: approx. 6 h

CO4204-6W

Traction control systems, ABS / ASR / ESP

- Driving safety and physics
- ABS: System overview, control loops, functionality
- Effects of typical faults on an ABS braking system
- ASR: Function and system structure, investigating typical control situations
- ESP: Purpose and mode of operation, response to various driving manoeuvres, control loops
- Trouble-shooting
- Course duration: approx. 6 h

CO4204-6Z

Airbag, belt tensioners and crash response

- Active and passive safety in motor vehicles
- Purpose and function of airbags and belt tensioners
- Ignition capsule, safety switch, acceleration sensor, seat occupancy detection
- Typical crash situations
- Fault management in airbag systems
- Trouble-shooting
- Course duration: approx. 8 h

SO4204-7E

LIN bus

- Topology and components of a LIN bus system in a motor vehicle
- LIN bus: Voltage levels, addressing, master/ slave principle
- Analysis of LIN messages using LIN monitor and oscilloscope
- Editing and sending LIN messages using a PC
- Trouble-shooting
- Course duration: approx. 8 h

COURSES ON AUTOMOTIVE TECHNOLOGY

CO4204-7K

CAN bus

- Topology and components of a CAN bus in a motor vehicle
- Low-speed and high-speed CAN
- Electrical properties, data rate
- Addressing and arbitration
- Analyzing CAN messages with a CAN monitor and oscilloscope
- Interpreting CAN messages
- Editing and sending CAN messages using a PC
- Trouble-shooting
- Course duration: approx. 7 h

CO4204-7H

Optical data buses for automotive applications

- Optical bus systems in motor vehicles
- Fundamentals of a MOST bus
- MOST ring, protocol, control units, ring interruption diagnosis
- Design of optical fibre systems in motor vehicles
- Optical characteristics of light (refraction, reflection, attenuation)
- Measurement (electrical and optical) of optical fibres
- Course duration: approx. 6 h

SO4204-6Y

FlexRay

- Structure of a FlexRay node
- Signal generation with symmetric data transfer
- Description of the data link layer
- Analysis of the FlexRay at the bit level
- Measuring bus signals and bus resistance to interference
- Trouble-shooting
- Course duration: approx. 10 h

CO4204-6G

Comfort systems and keyless entry

- Central locking: Mechanical, infrared, radio and self-triggering
- Keyless entry and locking
- Teaching-in and setting comfort systems in vehicles
- Communication between a vehicle and its keyless entry device
- Retrofitting a keyless system
- Course duration: approx. 7 h

CO4205-1N

Autoshop communications with RFID

- Communication with customers: Making appointments, providing service advice, filling out repair shop orders
- RFID technology: System components, operating frequencies, data and power transmission
- Reading and writing transponder data
- Data collisions on data buses
- RFID applications in vehicles
- Course duration: approx. 7 h

CO4204-6L

DC-AC conversion in motor vehicles

- Electromagnetic induction and Lorenz force, "right-hand" rule
- Current and voltage; Ohm's law
- Pulse-width modulation (PWM)
- PWM voltage and current
- Generating alternating voltages via PWM
- Course duration: approx. 3 h

CO4204-6V

Hybrid drives in automobiles

- Working safety in the case of hybrid vehicles
- Serial/parallel hybrid system, dual-mode hybrids
- Electric drives for hybrid vehicles
- Control components for hybrid drives
- On-board networks for hybrid vehicles
- Energy recovery
- Energy and force transmission
- Course duration: approx. 8 h

SO4204-6M

Fuel cells

- Fuel cell technology for automobiles
- Tank and filling procedure, hazards of petrol and hydrogen
- Recording a fuel cell's characteristic
- Electrolysis (Faraday's first and second laws)
- Series and parallel connection of fuel cells
- Investigation of fuel cell power
- Course duration: approx. 4.5 h

CO4205-1P

Solar technology in vehicles

- Solar cell's functionality and operating principle
- Meaning of the terms „solar radiation" and „solar constant"
- Recording a solar module's characteristics
- Temperature, radiation intensity and angle of incidence
- Energy storage in a rechargeable solar battery
- Isolated (offgrid) network with solar batteries
- Course duration: approx. 4.5 h

CO4205-1J

Battery disconnection unit in hybrid and electric vehicles

- Basics of battery disconnection unit
- Design and operation
- Selecting appropriate repair measures
- Investigating the battery disconnection unit using measurement techniques
- Trouble-shooting
- Course duration: approx. 7 h

CO4205-1L

DC-DC step-down (buck) converter in hybrid and electric vehicles

- Fundamentals of DC-DC converters
- Design and operation of the step-down converter
- Circuit variations
- Reading out fault memory
- Selecting repair measures according to manufacturer's specification
- Investigation using measurement techniques
- Course duration: approx. 6 h

CO4205-1K

DC-DC step-up (boost) converter in hybrid and electric vehicles

- Fundamentals of DC-DC converters
- Design and operation of the step-up converter
- Circuit variations
- Reading out fault memory
- Selecting repair measures according to manufacturer's specification
- Investigation using measurement techniques
- Course duration: approx. 6 h
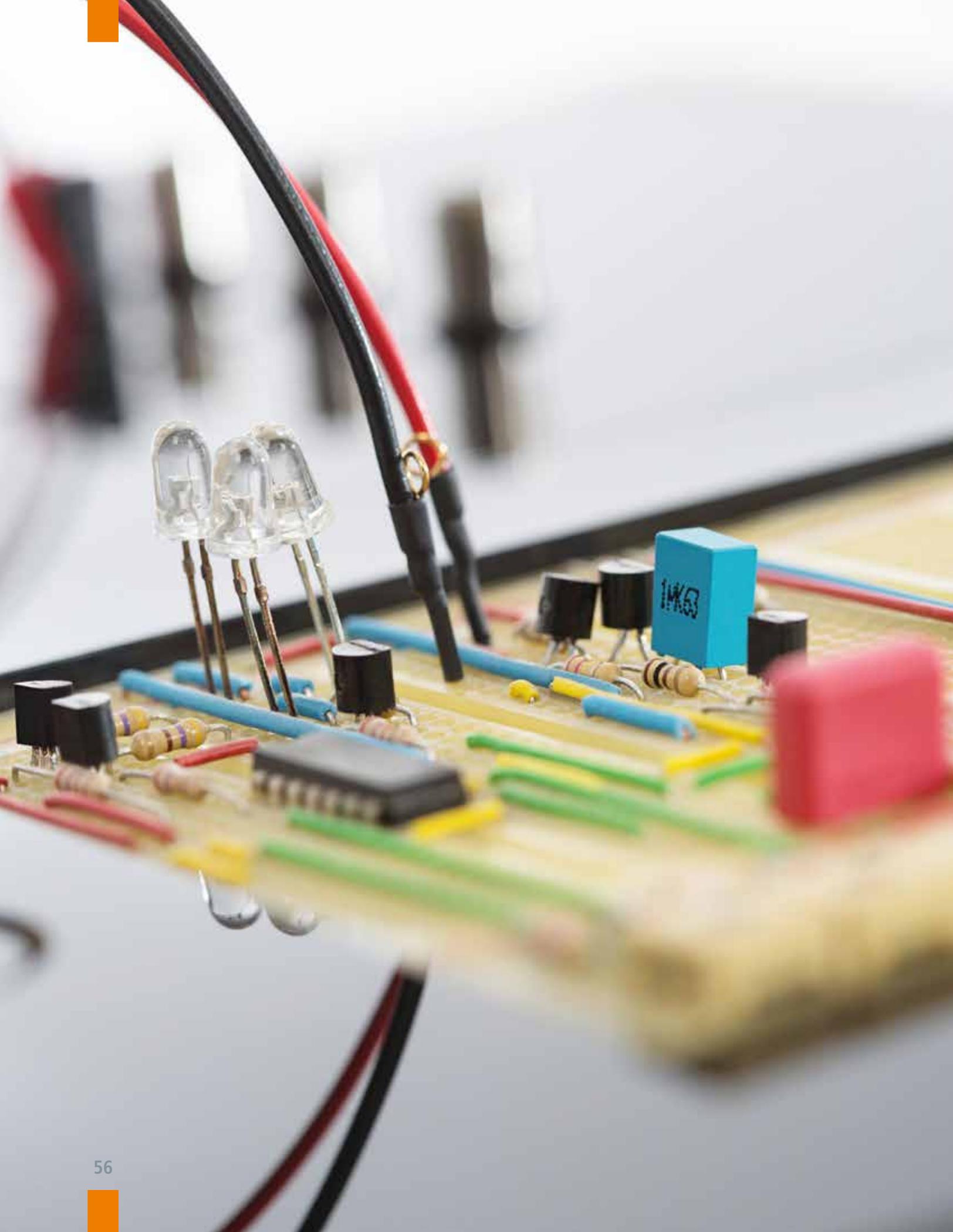
IDEALLY EQUIPPED WITH THE RIGHT ACCESSORIES

Practical solutions for everyday life

Practical accessories expand the UniTrain system's range of applications. A rugged case is available for frequent transport or storage of the system. Integrate a multimeter into the UniTrain system or utilize the breadboard to quickly build and test smaller circuits.

Your benefits

✓ Simple transport
✓ Practical storage
✓ Control via tablet PC
✓ Additional measurement options

Experimenter for mounting experiment cards, multimeters and breadboards, and supplying additional experiment voltages.
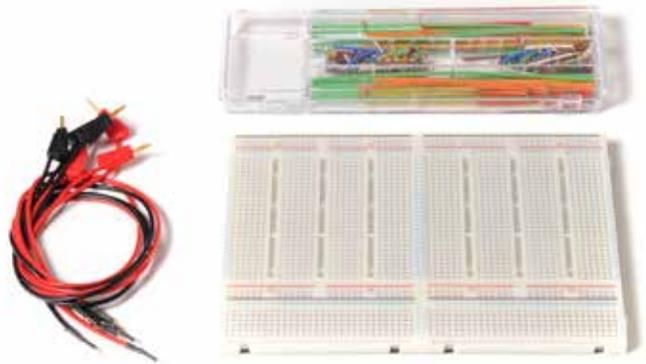
Breadboard for circuit configuration with wired components

Case for storing and transporting an entire system

Multimeter with optical data interface for display via a virtual instrument on a PC

UNITRAIN – COURSE AND EQUIPMENT OVERVIEW

Basic equipment and accessories

UNITRAIN SYSTEM

Basic equipment

UniTrain interface	CO4203-2A
UniTrain measurement accessories (shunts, jumpers and connection cables)	CO4203-2J

Required accessories
Depending on the course one or more UniTrain experimenters are required.

1	UniTrain experimenter (quantity)	CO4203-2B

Basic equipment EloTrain 2-mm plug-in system

UniTrain interface	CO4203-2A
EloTrain experimenter	SO4203-3B
EloTrain measurement accessories (bridge connectors and connection cables)	SO5146-1N
Digital multimeter Max10	LM2332

Recommended accessories

UniTrain storage case	CO4203-2Y
Digital multimeter Multi 13S	LM2330

LabSoft Classroom Manager

LabSoft Classroom Manager	SO2001-5A

Collections of assignments (for use with classroom manager)

Electrical fundamentals	SO2001-6A
Elektronics	SO2001-6B
Digital electronics	SO2001-6C
Electrical power engineering	SO2001-6D
Building management systems	SO2001-6E

Electrical fundamentals

DC technology CO4204-4D	**1**
AC technology CO4204-4F	**1**
Three-phase technology CO4204-4H	
Magnetism / electromagnetism CO4204-4A	**1**
Conducting measurements with the multimeter CO4204-4B	**2**
Electrical network analysis CO4204-4C	**1**
Electromagnetic compatibility (EMC) CO4204-4K	**1**
Measurements using an oscilloscope CO4204-4L	**1**

EloTrain 2-mm plug-in system

DC technology SO4206-1A	
AC and three-phase technology SO4206-1B	

Electronics

Semiconductor components CO4204-5A	**1**
Transistor multivibrators CO4204-5D	**1**
Transistor and amplifier technology CO4204-5H	**1**
Field-effect transistors CO4204-5K	**1**
Operational amplifiers CO4204-5M	**1**
Power semiconductor devices CO4204-5P	**1**
Analog power supplies CO4204-5R	**1**
Switched-mode power supplies SO4204-5S	**1**
Circuit design using NI Multisim SO4204-5U	**1**
PCB layout with NI Ultiboard SO4204-5V	**1**

EloTrain 2-mm plug-in system

Semiconductors SO4206-1C	
Basic electronic circuits SO4206-1D	
Optoelectronics SO4206-1E	

Digital electronics and microcomputer technology

Gates and flip-flops
SO4204-6A
1

Sequential circuits
SO4204-6C
1

Application circuits
CO4204-6E
1

Converter circuits
CO4204-6B
1

Fundamentals of computer technology
SO4204-6H
1

Supplement to SO4204-6H
Applications and programming
SO4204-6J
2

EloTrain
2-mm plug-in system

Introduction to digital technology
SO4206-1F

Sequential circuits
SO4206-1G

Microcontroller PIC16F887 (Assembler programming)
SO4206-9A

8-bit Microcontroller, PIC 16F1937 (UML programming)
CO4205-7A

8-bit Arduino UNO (UML programming)
CO4205-7B

16-Bit Microcontroller dsPIC (UML programming)
CO4205-7C

32-Bit Microcontroller ARM (UML programming)
CO4205-7D

Programming 32-bit ARM Cortex M3 microcontrollers (C programming)
SO4206-9B

DSP using microcontroller 32-Bit ARM Cortex-M3 (C programming)
SO4206-9C

FPGA - Design of circuits using VHDL
SO4206-9E

FPGA Altera Cyclone IV (Verilog)
CO4205-7E

Building management systems

Protective measures and power network types
SO4204-4 M

Control systems / protective circuitry
CO4204-4N

LED lighting and colour detection
CO4204-4P
1

Electrical power engineering

Photovoltaics
CO4204-3A

Transient processes in DC and AC networks
CO4204-3B
1

Fuel cell technology
CO4204-3C

Power electronics

Self-commutated power converters
CO4204-7M
2

Line-commutated power converters, 3-phase
CO4204-7N
2

Frequency converter drives
CO4204-7P
Requires CO4204-7M and CO4204-7T
3

Active power factor correction (PFC)
CO4204-7Q
1

Electrical machines

DC machines
CO4204-7S
1

Asynchronous machines
CO4204-7T
1

Synchronous and slip-ring machines
CO4204-7U
1

Stepper motor
CO4204-7W
1

Linear motor
CO4204-7X

Three-phase transformer
CO4204-7Y
1

BLDC / servo motors
CO4204-7Z
1

Communication technology

Quadripoles and filters
CO4204-9A — **1**

Active filters with operational amplifiers
CO4204-9B — **1**

Coaxial cables
SO4204-9G — **1**

Signal transmission via optical fibres 650 nm / 820 nm
CO4205-4E — **2**

Signal transmission via optical fibres 1300 nm
CO4205-4F — **1**

4-wire lines
SO4204-9F — **1**

Pulse modulation methods PAM / PCM / Delta
SO4204-9J — **3**

Pulse modulation methods, PTM
CO4204-9K — **1**

Modem methods ASK, FSK, PSK
CO4204-9L — **2**

AM / FM Modulation / Demodulation
SO4204-9M — **2**

AM transmission and receiving technology
SO4204-9N — **3**

Data acquisition using RFID
SO4204-9S — **2**

Network technology and cyber-security
CO4205-4Q — **2**

Introduction to microwave technology
SO4204-9U — **1**

Supplement to SO4204-9U
Waveguide components
SO4204-9V

Antenna technology
SO4204-9T — **1**

Supplement to SO4204-9T
Complex antenna systems
SO4204-9Z

Microstrip technology
SO4204-9Y — **1**

Measurement technology

Measurement of electric values V / I / P / cos-phi / f
CO4204-8A — **2**

Measurement of non-electric values Temp. / pressure / force
CO4204-8B — **2**

Measurement of non-electric values Displacement / angle / speed
CO4204-8C — **2**

RLC measurements
CO4204-8D — **2**

Automatic control technology [PID]

Practical introduction to control technology
CO4204-8J

Servo motor technology
CO4204-8H

Automation

Compact automation, PLC and bus technology
CO4204-8N — **3**

PLC model lift application
SO4204-8T — **1**

Sensors for automation
CO4204-8U

Process technology: IPA 1 Compact station
CO4204-3E — **2**

Process technology: IPA 2 Mixing station
SO4204-3F — **3**

Process technology: IPA 3 Filling station
SO4204-3G — **1**

Process technology: IPA 4 Corking station
SO4204-3H — **1**

Pneumatics / hydraulics

Pneumatics
SO4204-8V

Electropneumatics
SO4204-8F

**Hydraulics / electrohydraulics**
SO4205-8A

Mechatronics

Transfer system with DC drive
SO4204-8K — ①

Transfer system with three-phase drive
SO4204-8L — ①

Sorting sub-system
SO4204-8M — ①

Assembly sub-system
SO4204-8O — ①

Process sub-system
SO4204-8P — ①

Testing sub-system
SO4204-8Q — ①

Handling sub-system
SO4204-8R — ①

Storage sub-system
SO4204-8S — ①

Routing sub-system
SO4204-8W — ①

Buffering sub-system
SO4204-8X — ①

Production line
SO4204-8Z — ①

Automotive technology

DC and AC circuits in vehicles
CO4204-7A — ①

Electronics and digital technology in vehicles
CO4204-7B — ①

Automotive electrical fundamentals
CO4205-1D

PWM signals in automotive engineering
CO4204-7J — ①

Alternator / 3-phase generator
SO4204-7D — ②

Sensors in motor vehicles
SO4204-7F

Pulse generation and ignition systems
SO4204-7C

Common rail diesel injection system
CO4204-6X

Traction control systems ABS / ASR / ESP
CO4204-6W

Wheel Speed Sensor Technology
SO4205-1F

Airbag, belt tensioners and crash response
CO4204-6Z — ②

EloTrain
2-mm plug-in system

Fundamentals of electrical engineering in vehicles
SO4206-1J

Automotive technology

LIN bus
SO4204-7E — ②

CAN bus
SO4204-7K — ②

CAN FD in automobiles
SO4204-1S

Optical data buses for automotive applications
CO4204-7H — ①

FlexRay
SO4204-6Y

Comfort systems and keyless entry
CO4204-6G — ① ③ *

Autoshop communications and RFID
CO4205-1N — ②

DC-AC conversion in vehicles
CO4204-6L — ①

Hybrid drives in automobiles
CO4204-6V — ③

Interlock in hybrid and electric vehicles
CO4205-1H — ①

Battery disconnect unit in hybrid and electric vehicles
CO4205-1J — ①

DC-DC step-up converters in hybrid and electric vehicles
CO4205-1K — ①

DC-DC step-down converters in hybrid and electric vehicles
CO4205-1L — ①

Safe handling of HV systems
CO4205-1M — ①

Fuel cell technology in vehicles
CO4204-6M

Solar technology in vehicles
CO4205-1P

* 3 experimenters are required for extension with CAN bus course (SO4204-7K)
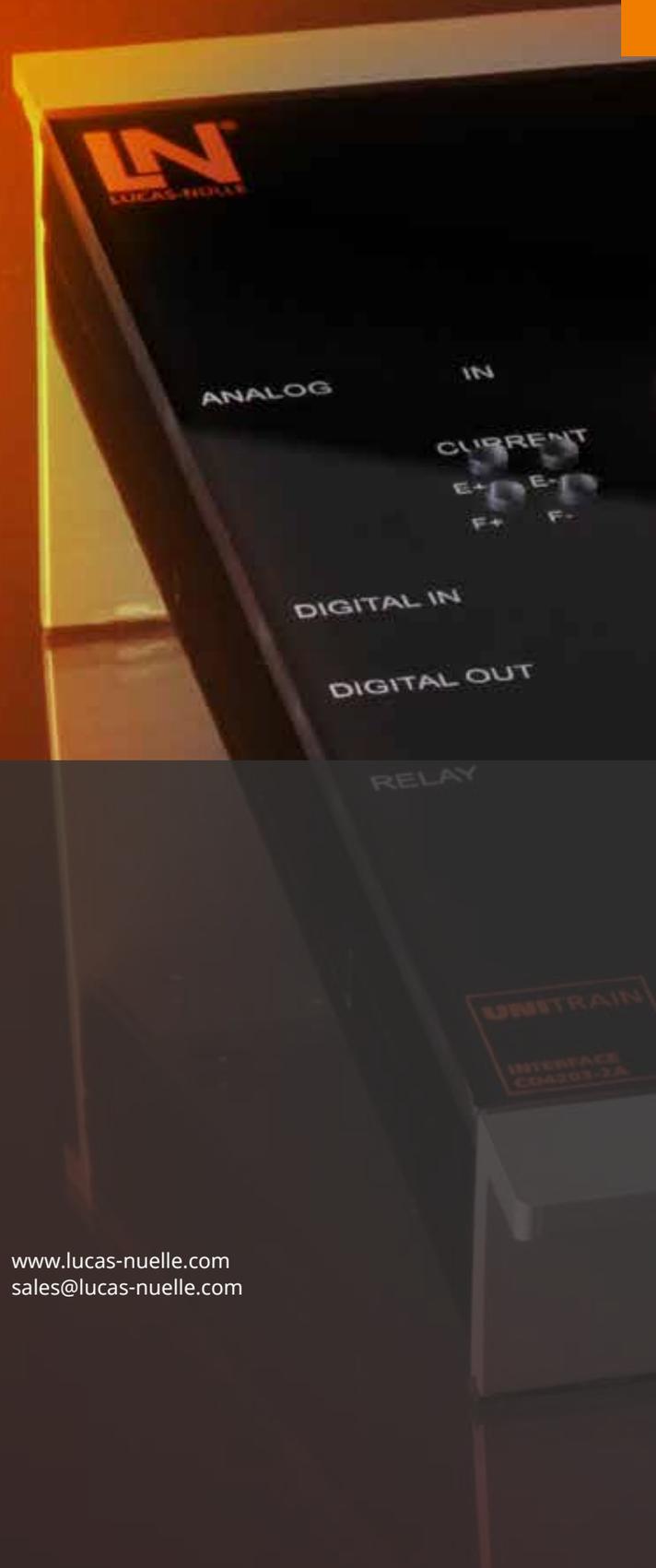
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UniTrain