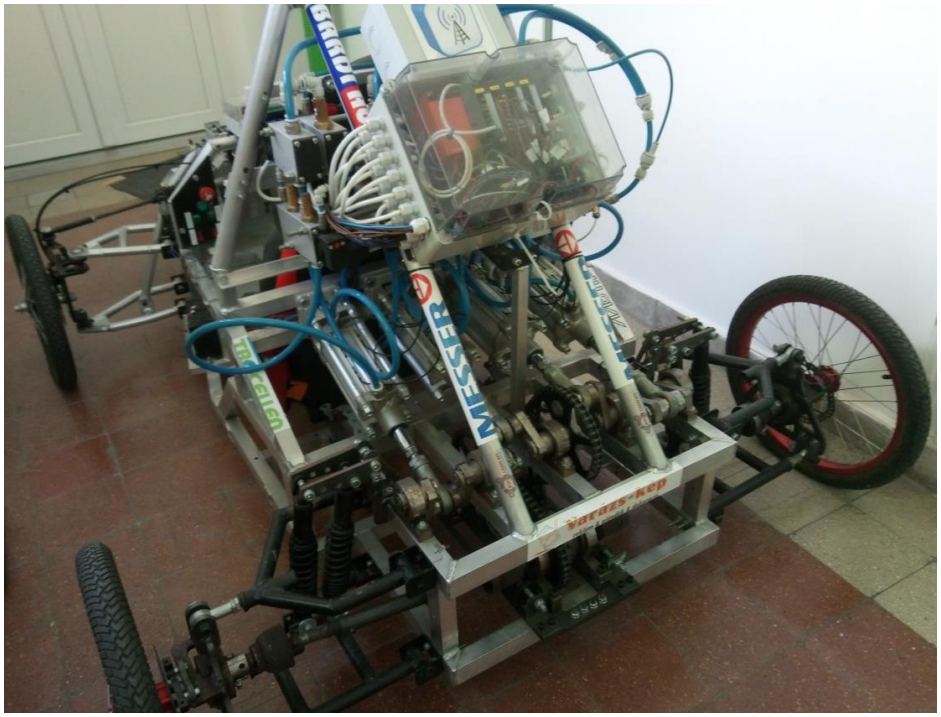
EDUTUS University

ENGINEERING INSTITUTE



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ABOUT THE ENGINEERING INSTITUTE IN BRIEF

Currently, the universities worldwide have to face unprecedented challenges to ensure their stable operations for example beside the R&D (knowledge generation), education (knowledge transfer) to build up their third pillar - the entrepreneurial university – (business exploitation of the marketable knowledge with business potential via getting industrial assignments and contracted research work) to generate additional income due to the shrinkage state-financing. These additional financial sources should be reinvest into the traditional activities to maintain and further develop high standards of education and R&D). In addition, there is a strong competition among the universities for attracting more potential students with introducing tailor made curriculums and new teaching methods, widening their international cooperation networks. Taking into practice these consideration, the Edutus University with Tatabánya HQ – which is a private, innovative and dynamic university and one HEI in Komárom-Esztergom County – can be regarded as a regional university entrepreneurial hub impacted the local economic and social development, strengthening the trust-building and networking among the interested stakeholders.

In order to operate stably and develop, it has to behave as a market-oriented, innovative university that responds flexibly to the needs of economic and local actors (continuously expands its educational offer based on feedback from economic actors), covering its expenses from its own multi-source business revenues and tuition fees paid by foreign students; domestic and international R&D funds, industry assignments). It provides the capital, tools necessary for the development of educational and research infrastructure either by involving external sources or in the framework of corporate collaborations, and it also places great emphasis on exploiting the opportunities arising from international collaborations.

The Engineering Institute of the Edutus University was established in September 2007 to create and coordinate the previously missing technical higher education in Komárom-Esztergom County. According to labour market research feedbacks, the region's restructured industry suffers from a serious labour shortage: it lacks a team of foreign-speaking professionals with up-to-date, well-used theoretical knowledge and sufficient practical skills (high value-added products and production developments). The Engineering Institute coordinates the technical educations in Komárom-Esztergom County in the following fields:

- Mechatronics engineer (BSc level) with laser technology and maintenance (from 2020-2021-1 semester) specialization directions.
- Technical manager with Process and project management as well as quality management (from 2020-2021-1 semester) specialization directions (BSc level); facility management (BSc and MSc. level as well)

The Engineering Institute has established and maintains a wide-ranging strategic partnerships with the Hungarian manufacturing units of large international companies located in the industrial parks of KEM, and the local domestic owned SME's as well. In the course of their business activities, the companies are directly or indirectly related to various segments of the automotive industry, and besides that they are satisfying orders from other sectors as well (e.g. machinery industry, health industry, chemical industry). Inter-institutional collaborations include dual courses, the provision of internships for students, the holding of outsourced training courses tailored to the needs of companies, the channelling of corporate / economic needs into practice-oriented technical undergraduate and graduate courses, and development/sharing the university research infrastructure through corporate sponsorship, attracting high value-added, individual industrial assignments.

The purpose of this summary leaflet is to briefly present the main educational and research infrastructures in the 5 different laboratories of the Engineering Institute (Building B) and the Passive House, which also belong to it, and the their possibilities (collaborations, common infrastructure use). Another different summary was prepared for the laser laboratory in Building C, which is suitable for education and research tasks, high-value-added industrial development assignments as well. The laser laboratory has implemented a quality management system for laser material processing that has been in compliance with ISO 9001: 2015 standard since January 2019. Certified to ISO 9001: 2015 guarantees fast, efficient, high quality work and total customer satisfaction via trust-building and commitment.

1.Laboratory – Maintenance and Automation

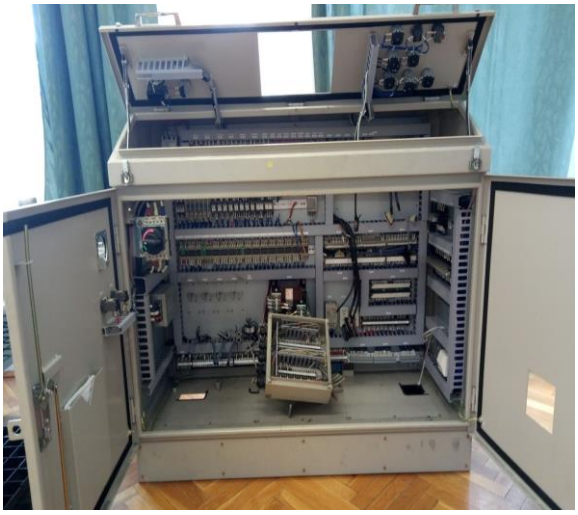
Maintenance section

In the framework of a long-term strategic cooperation agreement between the Edutus University and Bridgestone Tatabánya Manufacturing Ltd., the company provided numerous demonstrations equipment for the University to raise the quality level of the engineering education and widening the education portfolio of the Engineering Institute.

1.1. „Mini factory"

The conveyor belt track for practical education purposes consists of 3 different types of conveyors (individual roller drive, belt drive, roller drive), combined with Karakuri solution (intelligent automation - sloping design to help the material into the third conveyor). The middle part rises to the same level of the first unit when the conveyor belt starts to operate, then tilts the workpiece is loaded and provides its transport to the third unit, where the workpiece stops at the end. The unit is suitable not only for presenting various maintenance tasks but also for teaching logistics and industrial automation problems.
Main dimensions Length = 295 cm; Width= 110 cm; Heights = 95 cm

1.2. Power cabinet



Main dimension of the cabinet:

Length= 150 cm; Width= 60 cm; Height= 125 cm (in basic stage), by opening the two doors of the cabinet in 90 degrees and lifting and fixing the top at an angle of 60 degrees: Height= 145 cm; Width= 60 + 75 cm (door) all together 135 cm.

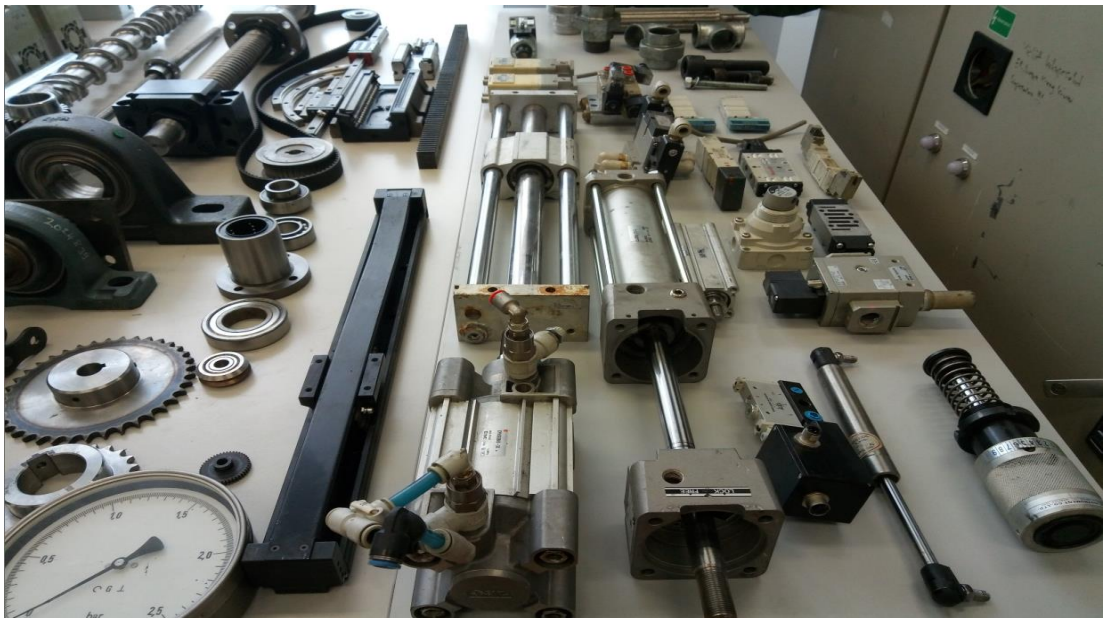
The units in the electrical cabinet (power supply, relays, circuit breakers, terminals, etc.) can be used to teach the electronic and power knowledge for industrial maintenance more effectively.

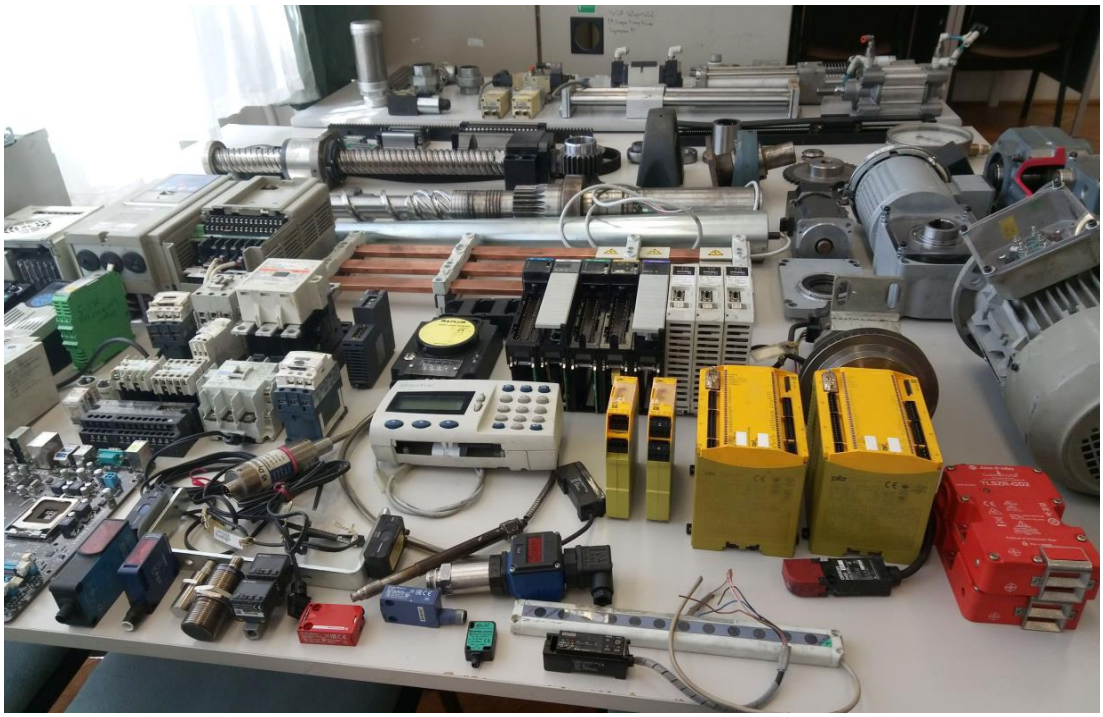
The laboratory has a number of mechanical, electrical and control technology demonstration devices, such as

geared motor with cut-out Length = 43 cm; Width = 14 cm; Geared motor (non-sectioned - with plexi glass insight) Length = 38 cm; Width = 19 cm; 3-phase motor section with terminal box Length = 26 cm; Ball bearing and bearing spindle Length = 35 cm; Ball spindle Length = 80 cm; Width = 16 cm; Y bearing; Extruder screw Length = 130 cm; other mechanical and electrical units:

- small engine
- servo engine
- large screws
- pinion gear
- sprocket
- energy chain
- PLC, security PLC,
- air spring valves,
- end position stop
- electro pneumatic cylinder, stepper motors
- industrial buses, universal valve islands,
- electric guide rail
- manometer

1.3. Various mechanical, electrical and control technology devices for maintenance education and demonstration purposes





Automation section

The laboratory has also basic devices and equipment for teaching hydraulics, compressed air technology (pneumatics), electro pneumatics and programmable controllers (PLC). You can implement effective and relevant knowledge transfer with these tools in the field of the applied industrial automation and control technologies.

The laboratory assembling roller walls consisting of didactically designed pneumatic / electro pneumatic workstations that allow mechatronics engineering students to quickly assemble and disassemble the control engineering solutions discussed in the course of the classroom lectures.

The electrical connections are banana plug solutions instead of the terminal block, and the position of the individual elements can be changed quickly on the profile boards.

1.4. Pneumatics/electro pneumatics assembling ribbed roller walls

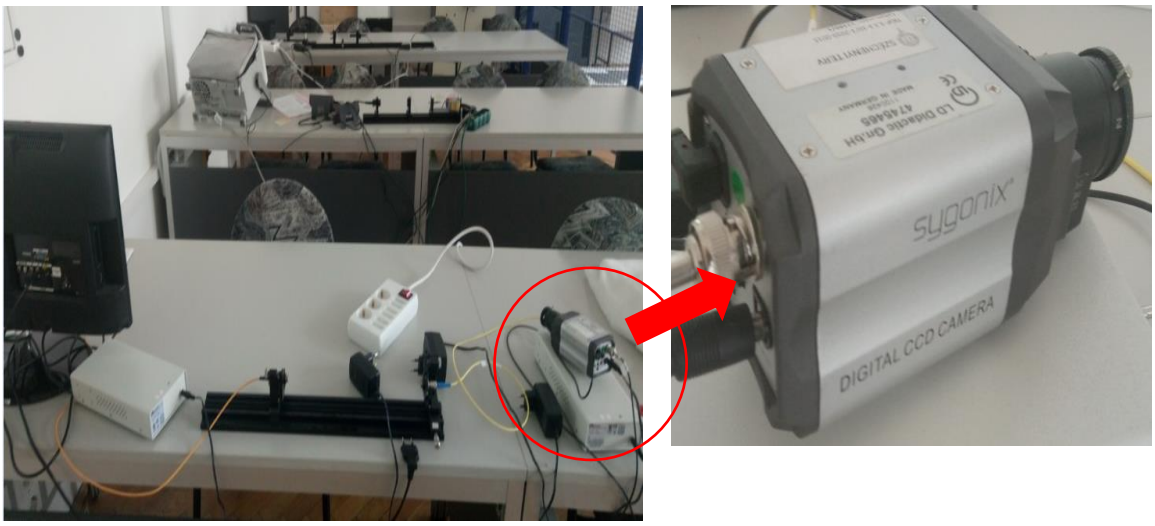
2. Laboratory – Laser Physics and Robotics

Laser physics section

Undergraduate mechatronics engineering students have to get familiar about the main laser physical concepts (atomic structure, atomic transitions, excitation models, pulse generation methods, materials and components used in laser systems) and optical principles (concept, properties, propagation, properties of the light, and its interactions with materials, light sources, lasers, cameras, microscopes, photometry / luminance, luminous flux, luminance /, machine and computer vision, optical resonators, coherent optical amplification, beam conduction), and the different types of lasers (solid state lasers, semiconductor, gas, dye lasers) and their applications.

Deepening the theoretical knowledge of laser physics is done by means of various laser physics and optical laboratory exercises (for example, measuring laser power and beam distribution)

2.1. Laser physics and optical laboratory measuring sites (in the foreground some devices LabMax_TOP type Laserpower / Energy Meter, LD Didactic GmbH.532 nm; 5 mW type laser diode, lenses, Sygonix digital CCD camera)



Robotics section

FANUC M710- ib-45 industrial robot

In the frame of the sponsorship with AGC Glass Hungary Ltd., a FANUC type multifunctional industrial robot with control unit and control panel with 6 degrees of freedom (3 translational and three rotational movement options) has become the property of the Engineering Institute.

The M-710 series robots are characterized by few mechanical parts, a thin wrist, a rigid arm and little space requirements. They can be used in many applications and have a working range of up to 3.1 m. Due to the high axes speed, the members of this series are extremely fast. In addition, they have excellent load capacity and torque, all types can be used in many applications. With maximum 45 kg load capacity and a long working distance, this type is perfect for moving boxes, pallets or panels.

It has built-in pneumatic and electrical connection points to help integrate and mount the tools at the end of the robot arm.

The protection of the entire robot joint and body against the ingress of water and dust in difficult conditions has been solved.

The FANUC M710-ib45 robot used for educational purposes completely meet the requirements of the MSZ EN ISO 10218-1: 2011 standard on the safety requirements of industrial robots and the MSZ EN 12100: 2011 standard on the general principles of machine safety and design.

With the help of Fanuc Roboguide software, mechatronics engineering students can practice the basics elements of programming and moving the robot.

2.2. Control units of the robot

2.3. FANUC robot with ejector vacuum gripper

YAMAHA YK600-X type robot with vertical axes articulated arm

With the SCARA robot donated by Coloplast Hungary Ltd. became possible to “widening” the robotics education with a small scale manipulator-type tasks.

The motor is connecting to the driven shaft via a clutch, increasing rigidity, movement speed and accuracy, as well as reducing the need for service. Widely used, such as electronics manufacturing, fast moving, palletizing, assembling small precision parts, moving larger parts

- Max. load: 5 kg
- Movement range: 120-1200 mm
- Repeat accuracy: +/- 0,01 mm (X, Y, Z axes)
- Max. speed: 4,9 m/s (X, Y axes); 1,1, m/s (Z axe)

2.4. YAMAHA SCARA robot with standard robot cell and control unit

3. Laboratory – TERMOSZ (Design-Modelling-Simulation)

70-80% of a product's development and manufacturing costs depend on decisions made in the early stages of design. In response to this challenge, computer product development, analysis, and manufacturing design emerged.

Rapid Prototyping (RP) is the rapid, fully automated, and highly flexible production of an arbitrary (complex) three-dimensional physical body (piece) from a numerical description (usually using CAD model). The introduction time of new products is reduced, the geometry can be visualized more clearly in the physical model, design flaws can be detected earlier and the structure can be improved.

Undergraduate mechatronics engineering students use to design 3D parameterized body models for various components using Solid Edge ST (direct creation of parts from 2D views or a 3D model from a wireframe model, a surface model, and a volumetric model is used to create the body model using various body primitives and set up operations). Solid Edge design of the parts to be printed and its communication in the documentation is mandatory. The principle of additive manufacturing is that the modelled CAD data, which is in a specific format (STL), is processed and oriented to the optimal construction position. The data is then sent to the RP device where it is sliced into thin layers. The RP tool then creates each 2D cross-section of the model and glues it to the previous layer, so the entire prototype is built "layer by layer" by stacking the layers on top of each other.

There are 3 pieces of Makerbot type 3D printers in the laboratory as RP devices. Makerbot allows you to import native CAD data, making file preparation more efficient and faster without losing important design details. These 3D printers are playing crucial role in the following practice oriented courses: Complex project task; Computer aided manufacturing and measuring systems; and the basics of CAD system as well as solving dissertations tasks.

The special-surfaced, flexible tray provides better adhesion, which minimizes the risk of warping. Meanwhile, flexibility makes it easier to remove models from the tray.

3D printers

- Makerbot Replicator Z18 3D printer

(1 piece)
3D Printing technology: FDM (Fused Deposition Modelling)
Printing size: 30,5 x 30,5 x 45,7 cm
Resolution: 0,1 mm
Filament: Makerbot PLA Filament
Without support materials

- Makerbot Replicator+ (2 pieces)

3D Printing technology: FDM
Printing size: 29,5 x 19,5 x 16,0 cm
Layer heigth: 100-400 micron
Filament: Makerbot PLA Filament (diameter 1,75 mm)
Replaceable print head diameter: 0,4 mm
Nosie level: 58,7 dBA
Optimal temperature: 60-78°F [15-26°C]
Weigth and size: 18,3 kg; 52.8 L X 44.1 W X 41.0 H cm,

3.1. 3D printers in the TERMOSZ laboratory

Ultrasonic welding

Another example on the strong industrial linkages the corporate sponsorship of the B&O Engineering Ltd. This is the domestic owned local SME is interested in design, manufacturing and distributing of the robotics, industrial automation and ultrasonic technology solutions and devices. In the frame of this strategic cooperation, the Engineering Institute received an RINCO MP351 ultrasonic welding machines from the the B&O Engineering Ltd. raising the mechatronic engineering education program level, widening the training and laboratory practices opportunities.

3.2. Rinco MP 351 ultrasonic welding machine in the TERMOS laboratory

The basic principle of ultrasonic welding is:

- Ability of the thermoplastic amorphous and semi-crystal polymers to dampen mechanical vibrations.
- Damping reduces vibration energy while heat is generated in the material.
- The mechanical damping of all thermoplastic polymers is so high that ultrasonic weldability exists.

Elastomers can not be weld with ultrasonic technology.

Main parts of the ultrasonic welding machine:

Generator: Converts mains current (50/60 Hz) to high frequency (20/40 kHz) alternating current. Its power can vary from 100 to 6000 W depending on the equipment. Newer devices incorporate microprocessor control for precise setup and a variety of control modes

Converter: It converts high-frequency current into mechanical vibration, it periodically expands and contracts under the action of the alternating voltage. Its operation can be based on a piezoelectric or megnetostrictive phenomenon. The amplitude of the vibration is usually too small to be usable, so an additional element needs to be inserted.

Booster: Its function is to change (most often increase) the amplitude of the mechanical vibration (vibration) produced by the converter. Because the amplitude of work required for each material can vary, manufacturers produce boosters with different gain (reduction) factors. Accordingly, the ratio of the amplitudes measured between the start and end points can vary from 1: 0.5 to 3.

Sonotrode: its function is to transmit the mechanical vibration to the part to be welded while further increasing the amplitude. The sonotrode is a half-wavelength acoustic body tuned to the resonant frequency, so its shape must not be changed. Materials for sonotrodes:

- High-strength aluminium: excellent machinability, excellent acoustic properties, but only used in small series due to low hardness.
- Titanium: In addition to extremely good acoustic properties, it is characterized by good fatigue properties and high hardness. It is complicated and expensive to machine, so it is used for large series. Its surface is often coated with a carbide

Pneumatic system: Provides the force required during welding and moves the sonotrode. In newer equipment, the force can vary within relatively wide limits and can be programmed separately at each stage of welding.

4. Laboratory – Metrology

In the framework of measurement technology (metrology), engineering students practice the mechanical application of basic length measurements (2D, 3D); the possibilities of using measurement data in determining size, regulating production processes; the use of micro- and macro-geometric measuring instruments, modelling of measurements; analysis of error sources and possibilities of their elimination, digital measurement technology; the main elements of 3D coordinate measurement as well as "reverse engineering" (back modelling based on measurement data).

Mitutoyo TM-510 measuring microscope

With the microscope, the length dimensions and angles of small workpieces can be measured by moving the stage XY or with the help of the rotatable eyepiece. The rotatable eyepiece has angle reading function. You can position the workpiece image to the crosshairs quickly and easily by adjusting the protractor.
The TM-510 microscope allows easy measurement of a wide range of products (e.g. gears, screws, cutting tools, electronic components, metal products).

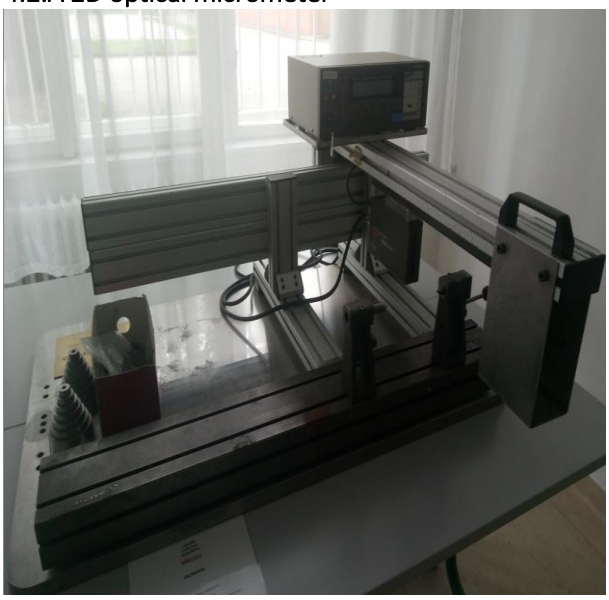
Enlargement: **30X (2X objective and 15X eye lens)**
XY table**: 100X50 mm**
2X digital built-in micrometer
Upper and lower light

4.1. 2D measuring microscope with the QM Data200 analysing unit

Mitutoyo LSM -3100 laser scan micrometer

Through the sponsorship of Grundfos Ltd., the Engineering Institute has obtained this high-precision, non-contact, high-speed laser measuring system.
A low power laser beam with the digital display forms the measuring unit.
The workpiece to be measured can be moved in the XY direction, which is scanned by the laser beam.
The device makes it possible to measure fragile or flexible workpieces, high-temperature parts or products where a high-purity surface is required, or where the measuring force applied by other measuring methods could cause dimensional changes and deformations.

4.2.A 2D optical micrometer



The laboratory has several serious tools that, in addition to education and research tasks, are also suitable for fulfilling individual, high value-added industrial assignments (material testing, 3D coordinate measurements) as well.

Keyence VHX-6000 digital material testing microscope

The device is suitable for 2D and 3D optical examination of objects of different sizes, different materials, inhomogeneous, uneven surfaces, sometimes transparent objects, with high resolution and a wide magnification range. The microscope not only operates on a stand, but also has movable optics, so it is possible to examine the inside of objects as well as large and / or strongly curved surfaces. It has a special image evaluation system with a magnification of a thousand times, which works in the X, Y and Z directions as well.

Due to the spatial arrangement, the materials to be enlarged can be evaluated and viewed on a screen. The lighting can also be changed.

4.3 The microscope with the computer unit

It has also educational role as well, the mechatronics engineering students can practice with it.

Mitutoyo Crysta Apex S-7106 type 3D coordinate measuring devices

Compact, economical CNC measuring machine with 5 µm accuracy with the following advantages:

- Good movement stability and accuracy due to light materials and innovative machine structure
- Temperature compensation in the range of 16 ° C to 26 ° C ensures accuracy in measurements in the production environment
- Compatibility with optical and scanning head for flexible and efficient measurement capability
- Multisensory capability
- Can be programmed offline

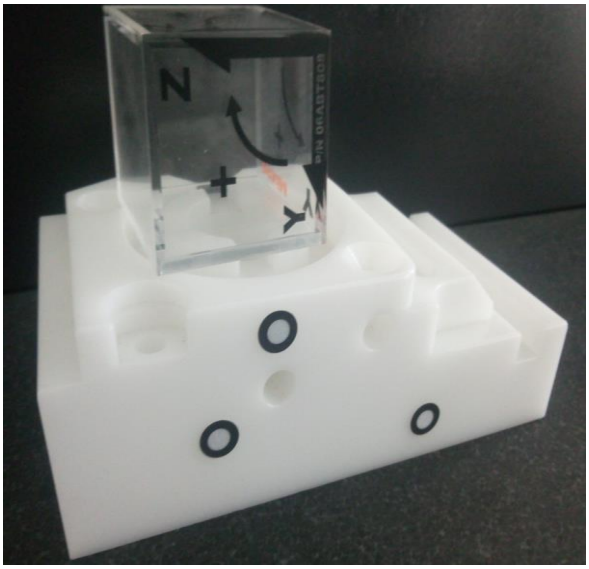
The workpiece CAD file can be uploaded to the virtual space.

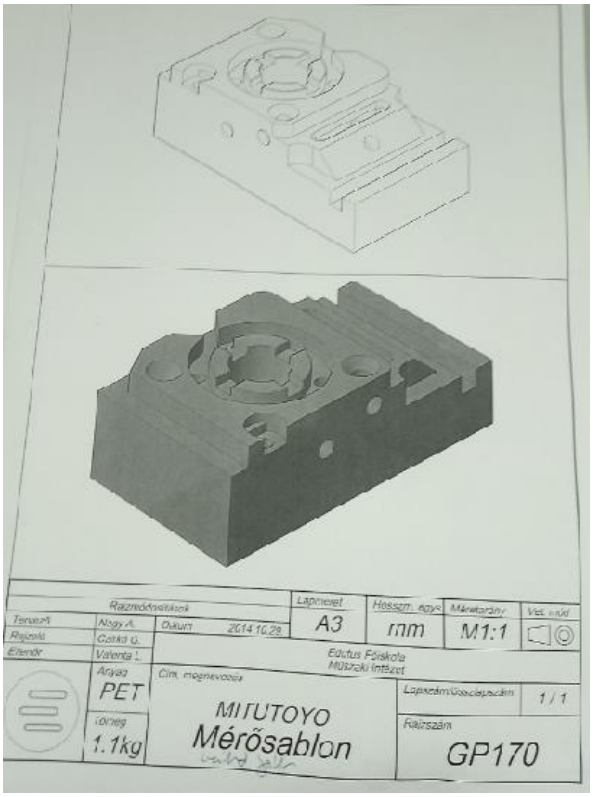
Measuring range:	**700 x 1000 x 600 mm**
Pressurised air:	**Pressure = 0,4 MPa**
Loading:	**1200 kg**
Weigth:	**2231 kg**
Movement speed:	**519 mm/s (3 axes)**
Software:	**MCOSMOS V4.0**

4.4. Laboratory 3D coordinate measuring equipment in the foreground with PET Mitutoyo measuring template (white)

4.5. Tools to assist in the construction of "devices" for holding the workpieces to be measured

4.6. Mitutoyo PET measuring template and its 3D technical drawing. With the help of the measurement template, students can practice the basics of 3D coordinate measurement (dimensions, radius of curvature, hole diameter and depth, grooves, positioning of holes, etc.).





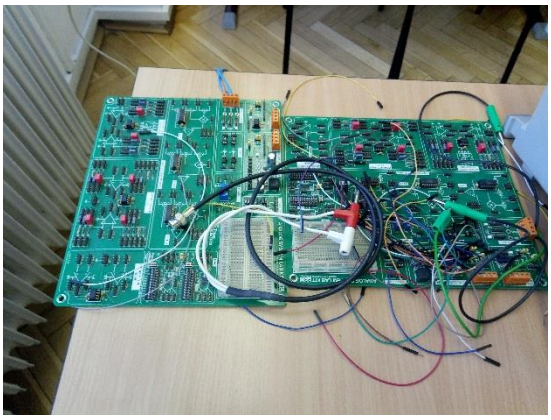
5. Laboratory – Electronics

The task of the electronics laboratory is to deepening and widening the technical students basic electrical engineering knowledge tasks which can be necessary for solving non-electrical engineering problems. They have to use the National Instruments (NI) equipments, which can be found in the laboratory. Examples about the electrical engineering issues:

- Basic electrical and magnetic phenomena
- The operation of specific circuit elements in direct current and alternating current networks (calculation and examination of networks produced from resistance, capacitance, inductance and their mixed connections)
- Structure, operation and application possibilities of electrical machines.
- Electricity system structure. Production, transport, transformation, consumers. International electricity network connections. To determine, calculate and measure the electrical parameters, voltage, current, power factor, frequency characteristics of single- and three-phase electrical networks. Symmetrical and asymmetrical consumers. Three-phase power. Phase correction.

With the help of modern measuring devices (for example, digital oscilloscopes, power supplies, multi meters, function generators) the measuring points are suitable for the examination of both analogue and digital circuits and systems.

5.1. Circuit boards



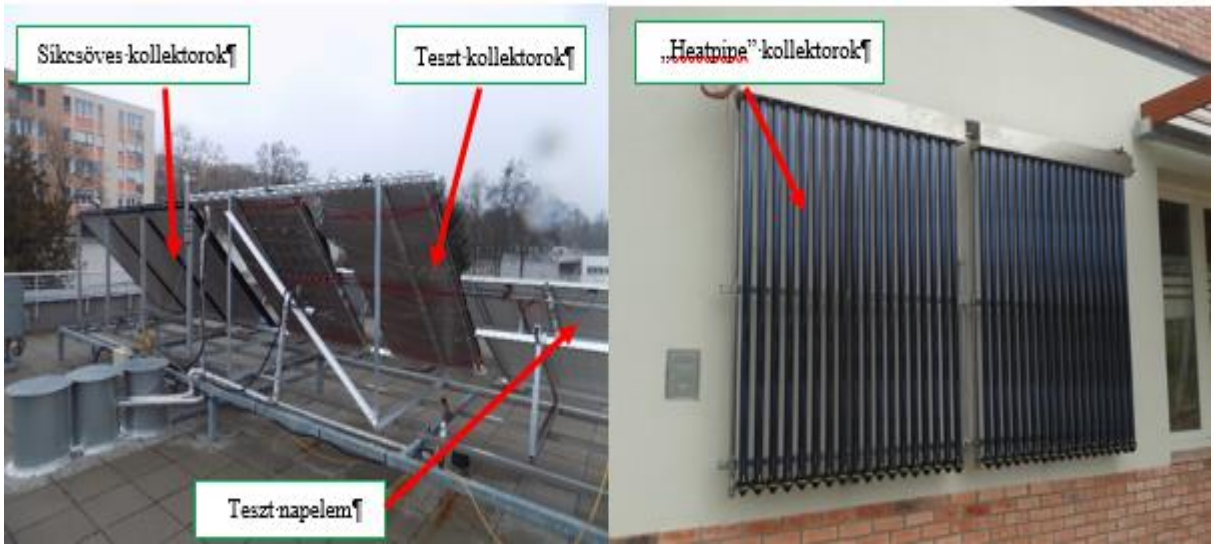
5.2. The laboratory inside

Passive House:

According to the basic function of the building, it is a building that presents renewable and alternative energy use options (thermal insulation, geothermic or air heat pumps, solar panels, flat sheet, flat and vacuum tube solar collectors, pellet boiler, LED lighting, etc.). The built-in technologies can be perfectly integrated into a passive house design with very low energy consumption, which thus provides an opportunity to present and teach the energy and sustainability elements within the Facility Manager training in the Technical Manager program. In addition, it plays an important role in shaping social attitudes (organizing visits, holding presentations for those interested - schools, public institutions, companies)

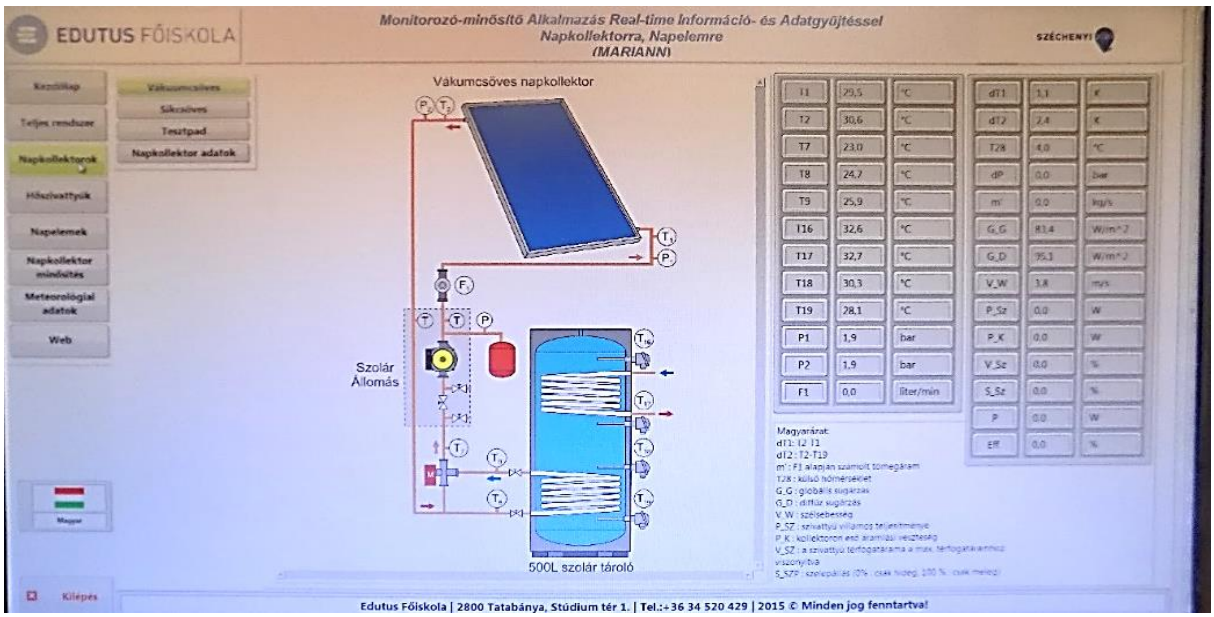
PH1: Edutus University, the building of the Passive House left side and front view (with fixed built-in shading structure

PH2: Flat tube and test collectors and test solar cells (left) and heat pipe solar collectors (Tatabánya, Edutus University on the top and side wall of the Passive House)



The MARIANN software package includes several software programs that can be used for full monitoring of the passive house, display of the measured data on a web interface and qualification of various solar collectors. The classification of solar collectors can be made primarily on the basis of their instantaneous or given energy yield for a given period of time. The system currently measures ~ 63 physical features (under development) directly in addition to reading another 29 features from the meteorological station with a sampling time of 1 second.

PH3: Monitoring Qualifier Application Real-Time Information and Data Acquisition for Solar Collector, Solar Panel (MARIANN) complex measurement and data acquisition software user interface



PH4: Left side: Flat and vacuum tube solar collector hot water storage tank (500 liters) and measuring circuits; right side: pellet boiler

PH5: The head of the Passive House in front of the NIBE indoor unit of the geothermic heat pump

In addition, the unique device: SunSnail -100% solar-powered commercial vehicle

In the frame of the Passive House educational and research programs, in 2017 an unique island operated solar-energetic vehicle prototype was developed and tested by the lecturers and their engineering students for demonstrating the feasibility of sustainability, efficient usage of the renewable resources and changing the social attitudes. The vehicle named as „SunSnail". It uses only that electricity which the mounted solar panels producing, it couldn't uses network electricity, because we disassembled the network charger on purpose.

There were several aspects to consider during designing this solar-powered vehicle:
The amount of available solar energy. Considering the efficiency of solar panels, a few hundred watts can be expected from three solar panels. If the solar panels are installed on the surface of the vehicle, this power is also utilized while driving. However in a standing position it charges the batteries.
The surface of the vehicle. This van-tricycle was chosen because 5 square meters of solar panels can be placed on it without any trouble. At the same time, it has a closed cab, which is essential due to Hungary's weather. The rear cargo area can be used as normal despite the solar panels, each door can be opened. The electric power consumption of the 2 HP vehicle is only a few hundred watts, which is in accordance with the capacity of the battery (3-4 kWh) and with the average daily charge of the solar panel (0.5-1.2 kWh).
The orientation of the solar panels. They would only deliver maximum performance, if they were just perpendicular to incoming rays of sun and the sky is clear. These conditions cannot be met on a vehicle. The solar irradiation will be reduced by cloud, shadow, rain, or dawn. However the solar panels are installed on different surfaces of the vehicle, assuming the fact that at least one of them may have a favourable orientation towards the Sun. We can help this situation by ensuring that during parking, which is 90% of the time, the solar panels face the Sun, possibly without shadow. In addition, the right-

hand solar panel can be opened up in order to optimize solar energy collection. This increases the charging power by up to 70%, we could even say, this is the fast charger.
The performance of the vehicle isn't too much, but it shouldn't be underestimated, because the same number of solar panels in our house – in a better orientation – supplies the whole household, our whole life.

PH6: The SunSnail on demostration roadshow