INDUSTRIAL PNEUMATICS
POWER HYDRAULICS
STATIONARY, MOBILE AND HYDROTRONICS

COURSES CATALOGUE
MECHANICAL ENGINEERING

ENGINEERING TRAINING CENTER
Industry 4.0 Competences
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We specialize in providing training courses in the field of broadly defined engineering techniques. Our main training sections are:

- Visualization and control systems
- **Mechanical engineering**
- Material engineering
- Production quality
- Industrial robots
- Production quality management
- Machinery safety
- SIEMENS PLM

We organize workshops, conduct consultations, implementation advice and support; we sell software and systems automation products, as well as run measurements and tests for specific purposes.

EMT-Systems has been operating on the training market for many years. We offer innovative approach to training engineers and technicians working in different branches of industry. Our courses are based on comprehensive programs focused on the needs of maintenance services and designers working with CAD/CAM/CAE software.

Trainings offered by EMT-Systems are the guarantee of high quality and professionalism resulting from years of experience in developing course programs for firms, public institutions, education units and individual clients. **Success of our clients is our best recommendation.**

Our mission is to **conduct highest quality trainings for industrial personnel to help them adapt to modern jobs using innovative technologies.** We help to identify training needs of each participant and suggest the optimal course path for them. Through the comparison of initial and final tests’ results we monitor the increase in knowledge and skills, which automatically allows us to prove the effectiveness of our work.
QUALITY POLICY. PRIZES AND AWARDS

Quality policy
Prizes and awards

Because we are constantly improving the quality of our training services, we have implemented the Product Certification System according to the following standards:

- PN-EN ISO 9001:2015
- ISO 29990:2010

The awarded certificates encourage us to constantly improve and update our services.

We have been a member of the Polish Chamber of Training Companies since June 2013. We are obliged to obey the regulations of the Code of Good Practice and use them in our everyday work. We have also signed the Training Service Standard document. We are driven by the rules of professional ethics and business integrity.

We have received numerous awards and prizes:

- 2018 Innovation Laurel for the training: Chemoset and thermoset polymeric composites - introduction to polymer chemistry, composite properties and manufacturing methods.
- 2018 European Medal for all trainings in: „Industrial Robots”
- 2017 Training Company of the Year emblem received from Central Office of National Certificate.
- 2017 European Medal for all trainings in: „Plastics”.
- 2016 Caesar of Silesian Business awarded at the solemn Business Centre Club gala.
- 2016 European Medal for the training „CNC1: CNC Operator/Programmer”.
- The prestigious Highest Quality Gold Emblem 2016 a grand prix in the category Services in the most pro quality program in Poland, organized under the patronage of the Polish Agency for Enterprise Development, Polish Committee for Standardization and Polish Forum ISO 9000.
- 2016 Training Company of the Year emblem received from Central Office of National Certificate.
- 2015 Enterprise of the Future.
- 2014 Training Company of the Year emblem received from Central Office of National Certificate.
- The award of the Marshal of the Silesian Voivodeship during the conference „Innowacja. Cię rozwija” Innosilesia.
Training laboratories
Participants can enjoy well-equipped training positions, which enable the practical exercises. We provide cutting-edge workstations built on the basis of actual components for industrial automation.

Experienced trainers
Trainers from the departments of maintenance and design firms with extensive technical knowledge to the design, implementation, and maintenance and repair of equipment and automation systems and high educational qualifications.

Training material and course documentation
Participants receive professional documentation in the form of textbooks, technical documentation, instructions and other publications. There is also the option of using materials and diagrams provided by the client.

Extra classes
Participants are entitled to participate in free extra classes on the chosen days, after the scheduled classes.

Training methodology
We focus on practical exercises and application of our tutors’ knowledge backed up by real-life examples. As a rule, 30% of time is devoted to theoretical training and 70% of time is designated to active forms of participation – workshops and exercises which allow the participants to gain practical skills on operating machines and systems.

Two different course types: open and closed
Such a solution provides the participants with the opportunity of choosing the best option. Open courses are aimed towards individual participants while closed courses are dedicated to firms.

Catering
For courses carried out in our training rooms we provide daily coffee breaks, hot and cold drinks, cookies and two course lunches.

Post-training and implementation support
We also provide support and help within the topics included in the courses in your everyday work.

For the participants of our courses we provide training laboratories allowing to work on industrial components of power hydraulics and pneumatics based on the most popular producers:
## STATIONARY HYDRAULICS

### Specialized courses in power hydraulics

#### Course H1

**Power hydraulic components and systems - construction and operation**

Accurate identification, quick and effective troubleshooting; increase of practical abilities in the field of renovation, current and periodic repairs; deep understanding of the structure and principles of operation of power hydraulics elements; unassisted construction, installation, commissioning and testing of simple hydraulic systems; acquiring knowledge needed to recognize graphic symbols and reading hydraulic systems schemes; learning to interpret hydraulic quantities, characteristics of valves and methods of measuring the flow rate, temperature and pressure; learning about the rules of typical control of displacement, velocity and pressure of the hydraulic systems.

**Course aims**

- Hydrostatic drives
- A workshop in designing and checking operation of hydraulic systems; exercises at the assembly stations
- Displacement pumps
- Hydraulic cylinders
- Rotary positive displacement hydraulic motors
- Hydraulic valves
  - Directional valves
  - Pressure valves
  - Flow control valves
- Hydraulic accumulators
- Hydraulic filters
- Connections of hydraulic devices
- Hydraulic tanks
- Auxiliary elements for hydraulic systems
- Graphical symbols of hydraulic elements and controls
- Reading and interpreting simple hydraulic diagrams
- Constructing and performance testing of power hydraulic systems - practical exercises at the assembly stations
- Application of Fluid-SIM H software in designing and simulating hydraulic control systems

**Course summary**

- Duration:
  - 3 days - 24 hours

- Course type:
  - Open training
### STATIONARY HYDRAULICS

#### Course

<table>
<thead>
<tr>
<th>Course symbol</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2</td>
<td>Hydraulic drives and control systems in machines and devices</td>
</tr>
<tr>
<td>H3</td>
<td>Proportional hydraulics and electrohydraulics</td>
</tr>
</tbody>
</table>

#### Course aims

- **STATIONARY HYDRAULICS**
  - **Course symbol**: H2
  - **Course name**: Hydraulic drives and control systems in machines and devices
  - **Course aims**: Learning the conventional systems of control and regulation of the hydraulic actuators; developing the skills of experimental examination of hydraulic elements and systems; learning the structure and methods of setting adjustable units regulators; learning the design and operating principle of logic elements used in hydrostatic systems; learning the operation, maintenance and repair of hydraulic elements and devices.

- **Course summary**
  - General design of hydraulic systems
  - Motion control in hydraulic systems
  - Methods of controlling speed in hydraulic systems
  - Throttle control
  - Practice in designing and checking the operation of hydraulic systems with throttle and volumetric control
  - Controlling the direction of movement
  - Practice in controlling the receiver movement
  - Systems that guarantee maintaining support capacity of the receivers
  - Practice in securing support capacity
  - Pressure control in hydraulic systems
  - Multi pump systems
  - Systems with hydraulic accumulators
  - Connecting receivers
  - Differences in the operation of systems resulting from the method of connecting receivers
  - Synchronization of movement of hydraulic receivers
  - Practice in connecting and synchronizing hydraulic receivers
  - Load Sensing control
  - Practice in constructing and adjusting Load Sensing systems
  - Addition A – variable displacement pump regulators
  - Addition B – hydrostatic transmissions

- **Duration**: 3 days - 21 hours
- **Course type**: Open training

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#### Course

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<tbody>
<tr>
<td>H3</td>
<td>Proportional hydraulics and electrohydraulics</td>
</tr>
</tbody>
</table>

#### Course aims

- **Course aims**: Familiarizing the design and operation principles in the electrically and proportionally controlled elements; developing the skills of designing, constructing, activating and testing simple electrohydraulically controlled systems; learning the techniques of proportional control and the control based on electrovalves; learning the ways of regulation of the proportional control elements.

- **Course summary**
  - Designing and operations of hydraulic elements with electric control
  - Graphical symbols of electrically controlled hydraulic elements in schematic diagrams
  - Design and operations of the electric control elements
  - Symbols of graphic representation of the electric control
  - Introduction to hydraulic proportional control technique
  - Design and operations of directly and indirectly controlled proportional valves
  - A workshop in designing and checking operation of electrohydraulic systems and proportional hydraulic systems; exercises at the assembly stations
  - Proportional directional control valves
  - The elements of servo valves and their functions (electromechanical converters, hydraulic amplifiers)
  - Adjusting the characteristics of proportional valves
  - Correcting current characteristics of proportional amplifiers
  - Control and regulation systems with proportional valves and servo valves
  - Gain factor of speed-hydraulic servo drives
  - Selection of regulator settings in hydraulic servo drives
  - Experimental tuning of P, PI and PID regulators for hydraulic servo drives

- **Duration**: 3 days - 21 hours
- **Course type**: Open training
## STATIONARY HYDRAULICS

### Course: Servohydraulic drives and control systems

**Course symbol**: H4  
**Course name**: Servohydraulic drives and control systems  
**Course aims**: Knowledge about the proportional control techniques; knowledge about the design and operating principle of servo-hydraulic valves with mechanical and pressure coupling; knowledge about the methods of controlling the flow and flow direction as well as pressure using servo-hydraulic valves; ability to interpret static and dynamic parameters of servo-hydraulic valves; ability to interpret characteristics of servo-valves; knowledge of the design and settings of parameters of regulators in hydraulic systems of automatic regulation; ability to assess technical condition of servo-valves based on the analysis of operation parameters.

**Course summary**
- Application of servo-hydraulic drives
- Differences between control and automatic regulation
- Design of a typical servo-hydraulic system with mechanical coupling and electric coupling
- Differences between electronic switching valves and proportional valves (typical valves and valves with improved dynamics) vs. servo-valves
- Introduction to the technique of servo-valve control
  - Elements of servo-valves and their functions (electromechanical converters, hydraulic amplifiers)
  - Comparison of operation of a control stage of a servo-valve vs. Wheatstone bridge
- Laps of spools of hydraulic servo-valves
- Operation parameters of servo-valves
  - Static characteristics, typical mistakes and their causes
  - Servo-hydraulic drives as systems with automatic regulation
  - Functions of proportional, integral and derivative sections of a PID controller
  - Experimental selection of settings for digital servo-regulators
- Stability in hydraulic systems of automatic regulation
- Regulation of flow rate and pressure using servo-valves
- Using a Compax controller to operate the servo-hydraulic drive
- Practical exercises in building and checking the operation of SERVO-HYDRAULIC systems at student workstations

**Duration**: 3 days - 18 hours  
**Course type**: Open training

### Course: Diagnostics, maintenance and repairs of hydraulic devices and systems

**Course symbol**: H5  
**Course name**: Diagnostics, maintenance and repairs of hydraulic devices and systems  
**Course aims**: Knowledge of the most important rules for safe use and maintenance of hydraulic devices; knowledge of the methods of finding and eliminating typical defects of hydraulic system elements; ability to diagnose and evaluate technical condition of drive’s elements based on the analysis of the selected parameters of hydraulic system’s operation; knowledge of the methods of inspecting technical condition of hydraulically powered machines and devices; ability to identify irregularities and how to eliminate them in a fast and effective way; knowledge of the principles of monitoring and analyzing the physical and chemical parameters of hydraulic fluids; equipment of practical skills and technical awareness regarding renovation and current and periodic repairs.

**Course summary**
- Diagnostics of technical condition of hydraulic system’s elements
- Practical exercises at the workstations – determination and evaluation of operation parameters of pumps and motors used in hydraulic systems
- Diagnosing hydraulic motors
- Diagnosing hydraulic valves
- Diagnostics and safe operation of hydraulic accumulators
- Methodology of detecting irregularities in systems with hydraulic drives
- Analysis of physical and chemical parameters of hydraulic fluids
- Maintenance of hydraulic fluid tanks
- Typical kinds of leakage in hydraulic installations and ways of eliminating them
- Preparing hydraulic systems for the first launch
- Operation and maintenance of the hydraulic elements and devices
- Typical symptoms of defects of hydrostatic system elements

**Duration**: 3 days - 21 hours  
**Course type**: Open training
### STATIONARY HYDRAULICS

#### Course H6: Design of hydraulic drives and control systems

**Course aims:**
- Getting familiar with the algorithm of the design process of hydraulic systems; familiarize with the ways of setting parameters of hydraulics systems; developing the skills of designing drives and controls of hydraulic machinery and devices; learn to select the components of stationary and mobile hydraulics based on defined design specification.

**Course summary:**
- Introduction
- Basic quantities, units and calculation formulas
- Formulas for ideal and real elements (pumps, hydraulic motor, cylinder)
- Formulas for practitioners
  - Basic formulas for pumps, hydraulic motors, cylinders and pipes
  - Formulas for the calculation of pressure, power and temperature losses
- Constructing and performance testing of power hydraulic systems
- Practical exercises at the assembly stations
- Examples
- The algorithm of designing a hydraulic system
- Designing of the hydraulic drives and controls
- Practical exercises using dedicated LabStations

**Duration:**
- 3 days - 21 hours

**Course type:**
- Open training

#### Course H7: Energy efficiency of hydraulic drives

**Course aims:**
- Ability to increase efficiency of hydraulic systems; ability to tell the difference between systems with throttle and volumetric control; knowledge of the design and operating principle of fixed and variable displacement pumps; determination of efficiency of pumps and hydraulic motors and assess their technical condition; regulation of the basic parameters of a hydraulic drive in order to increase energy efficiency; knowledge of the operating principle of Load Sensing systems, as well as other methods of reducing losses in hydraulic systems.

**Course summary:**
- Hydraulic drives
- Losses in power hydraulic systems
- Methods of controlling speed of the receivers
- Capacity of displacement pumps and hydraulic motors in the context of energy efficiency
- Selected methods of assessing the degree of wear of pumps and motors to assess the losses (volumetric and mechanical losses)
- Practical exercises in analyzing the operation of systems with throttle and volumetric control, as well as in diagnosing technical condition of displacement pumps
- Flow control systems with a fixed displacement pump
- Control systems with a variable displacement pump
- Load Sensing control
- Systems with hydraulic accumulators
- Closed drives as an example of high efficiency hydraulic systems
- High efficiency drive systems, according to the concept of Industry 4.0
- Methods of increasing energy efficiency and reliability of hydraulic systems

**Duration:**
- 2 days - 15 hours

**Course type:**
- Open training

### Course H8: Servohydraulic drives: modeling, identification, control

**Course aims:**
- Modeling of the servo-hydraulic system on the basis of the physical properties of the components; knowledge on the basics of the theory of control, which is broadly used in servo-valve hydraulic systems; methods of tuning regulation loops in SvH systems; developing the skills of preparing and running the experiment of the servo-hydraulic system identification (experimental modeling).

**Course summary:**
- Introduction to the servohydraulic drives
- General characteristics of the electrohydraulic servomechanisms
  - Basic elements of the servohydraulic drives
  - Classification of the servohydraulic systems
  - Control and measurement devices in the servo-hydraulic systems
  - Laws of physics in hydraulic systems
  - Physical properties of liquids
  - Flow in the various parts of the servo-hydraulic system
  - Forces operating in pair of spoils
  - Modeling of a servohydraulic system on the basis of the physical properties of the components
  - Basic models
  - Models of the servo-valve control systems
  - Determining the characteristic parameters of the model of the servo-valve system
  - Basics of the control theory
    - Relation between the input and output of the object
    - Differential equations for chosen object models
    - Analysis of zeros and poles of the transfer function
    - Frequency analysis of the transfer function
  - Regulation and adjusting of the system regulating the servo-valve system
    - Main assumptions of control
    - Advanced regulation structure
    - Heuristic approach to adjusting the regulators
    - Regulation by means of the neuron networks
  - Experimental modeling (identification)
    - Preparing the identification experiment, generating stimulations
    - Methods of estimating parameters of the models
    - Identification according to fuzzy logic
    - Identification with the use of neuron networks

**Duration:**
- 3 days - 21 hours

**Course type:**
- Closed training

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**Specialized courses in power hydraulics**

- **Training rooms:**
  - Our training rooms allow working on power hydraulic systems of the most popular manufacturers: PARKER Hannifin, BOSCH, Rexroth, Manuli Fluiconnecto, HYDAC and PONAR WADOWICE.

- **More details on page 14**
SPECIALIZED COURSES IN POWER HYDRAULICS

MOBILE HYDRAULICS

**Course**: Mobile hydraulics in machines and devices
**Course aims**: Design and operation principles of the hydraulic elements applied in mobile systems; design, assembly, implementation and testing simple hydraulic systems; interpreting graphical symbols and reading schematic diagrams of hydraulic systems; interpreting hydraulic quantities, valves characteristics and distinguishing methods of measuring flow temperature and pressure; displacement control principles, velocity and pressure control in hydraulic systems.

- Basics of hydraulic drives in mobile systems
- Hydraulic displacement pumps used in mobile technology
- Hydraulic motors
- Hydraulic cylinders
- Hydraulic valves used in mobile technology – flow control valves
- Design solutions for cut-off valves, check valves and control check valves
- Hydraulic steering valves - Orbitrol
- Hydraulic valves – pressure control valves
- Flow rate control valves
- Integrated control blocks in mobile applications
- Criteria for selection of hydraulic valves
- Hydraulic accumulators
- Working fluids applied in hydrostatic mobile systems
- Conditioning elements for working fluids
- Connections of hydraulic devices
- Seals in hydraulic elements of mobile hydraulic systems
- Graphic symbols of hydraulic elements and control systems in hydraulic mobile systems
- Reading and interpretation of simple schematic diagrams of hydraulic systems
- Exercises at laboratory workstations – testing operational features of hydraulic elements in mobile applications
- Using FluidSIM-H software to present the functions of the elements of hydraulic systems

**Duration**: 3 days - 24 hours
**Course type**: Open training

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**Course**: Hydraulic drives and control systems in mobile hydraulics
**Course aims**: Control and regulation of the velocity of actuators applied in mobile hydrostatic systems; operation principles of control systems type LS and LUDV; presentation of the typical pump controllers and regulators (DR, LR, HD, EP) and adjustable motors (EP, HZ, HA, DA) applied in mobile drive systems; design and operation principles of hydrostatic steering systems – Orbitrol; running experimental tests related to hydraulic elements and systems in mobile applications; operation, maintenance and repairs of the elements and devices in mobile applications.

- General design of mobile hydraulic systems
- Hydrostatic systems
- Controllers and regulators of adjustable pumps and hydraulic motors in mobile applications – design and operation principle
- Drive systems dedicated to mobile hydraulic systems – design and operation principles
- Synchronization of the cylinder motion
- Receiver protection
- Control systems in mobile units
- Testing elements and hydraulic systems
- Basic information on operation, maintenance and repairs of hydraulic elements in mobile applications
- Reading and interpretation of schematic hydraulic diagrams
- Practical exercises on training positions – constructing and testing hydraulic systems
- Using Fluid-SIM-H software to design and simulate hydraulic control systems

**Duration**: 3 days - 21 hours
**Course type**: Open training
SPECIALIZED COURSES IN POWER HYDRAULICS

### MOBILE HYDRAULICS

<table>
<thead>
<tr>
<th>Course symbol</th>
<th>HM3</th>
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<tbody>
<tr>
<td><strong>Course name</strong></td>
<td>Basics of IQAN control system</td>
</tr>
<tr>
<td><strong>Course aims</strong></td>
<td>Fluent knowledge of the hardware layer characteristics of the IQAN Parker Hannifin system; unassisted basic operation of the IQAN.</td>
</tr>
</tbody>
</table>
| **Course summary** | - Basic characteristics of the hardware layer of the IQAN system – modular structure, “stand-alone” applications
- Selected hardware modules of the IQAN system
- Overview of the IQAN environment: IQANdesign, IQANsimulate, IQANanalyze, IQANrun
- Practical exercises at the workstations featuring IQAN system
- Developing the sample application for the IQAN central unit:
  - allocating functions to binary and/or analog inputs of the central or extension unit,
  - allocating functions to binary and/or analog outputs of the central or extension unit,
  - introducing the logic functions facilitating the correlation between the input/output status (e.g. between the joystick lever angle and the control of the valve operating the cylinder),
  - introducing the logic functions enabling taking account of feedback signals (e.g. signals from the pressure or position sensors),
- Preparing the virtual operator panel: control and corrective functions
- Practical exercises at the workbenches fitted with the IQAN system
- Unassisted student work |
| **Duration** | 2 days - 14 hours |
| **Course type** | Closed training |

The station of mobile hydraulic drives and mobile control systems equipped in drive system with a pump with variable capacity, LOAD SENSING OPERATING SYSTEM (LS) and control system IQAN - Parker Hannifin.

More details on page 17

### HYDROTRONICS

<table>
<thead>
<tr>
<th>Course symbol</th>
<th>HT1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course name</strong></td>
<td>Hydrotronics – basic course</td>
</tr>
<tr>
<td><strong>Course aims</strong></td>
<td>Has knowledge on the design and operating principle of electrically controlled elements; has the skills of designing, assembling, starting and testing simple hydrotronic systems; knows proportional control and servo-valve control techniques; knows methods of regulating hydrotronic systems.</td>
</tr>
</tbody>
</table>
| **Course summary** | - Explanation of the terms „mechatronics”, „pneumotronics” and „hydrotronics”
- Fields covered by hydrotronics
- Conditions that need to be fulfilled so that a device or a system featuring hydraulic elements may be referred to as a hydrotronic solution
- Hydraulic elements predestined for hydrotronic applications:
  - pumps,
  - valves,
  - actuators
- Typical sensors of hydraulic quantities and other physical quantities associated with hydraulic systems
- Practical exercises in building and checking the operation of hydraulic power systems at assembly workstations
- Controlling the pressure in hydraulic and hydrotronic systems
- Controlling the direction of movement of actuators in hydraulic and hydrotronic systems
- Controlling the velocity of actuators in hydraulic and hydrotronic systems
- Building the station for simulation and optimization of proportional valve settings
- Building the station for measuring energy recovery
- Building the station for testing the stability of hydrotronic systems
- Hydraulic axis controllers as a hydrotronic solution illustrated with an example of Compax3 F by Parker Hannifin
- Integrated hydrotronic environment illustrated with an example of IQAN by Parker Hannifin |
| **Duration** | 1 day - 7 hours |
| **Course type** | Closed training |

<table>
<thead>
<tr>
<th>Course symbol</th>
<th>HT2</th>
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<tbody>
<tr>
<td><strong>Course name</strong></td>
<td>Hydrotronics – advanced course</td>
</tr>
<tr>
<td><strong>Course aims</strong></td>
<td>Has knowledge on the design and operating principle of hydrotronic systems owned by the client ordering the training; knows proportional control and servo-valve control techniques; knows methods of regulating hydrotronic systems.</td>
</tr>
<tr>
<td><strong>Course summary</strong></td>
<td>Training program is being set individually with the customer.</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1 day - 7 hours</td>
</tr>
<tr>
<td><strong>Course type</strong></td>
<td>Closed training</td>
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</table>
## SPECIALIZED COURSES IN INDUSTRIAL PNEUMATICS

### INDUSTRIAL PNEUMATICS

<table>
<thead>
<tr>
<th>Course symbol</th>
<th>Course name</th>
<th>Course aims</th>
<th>Course summary</th>
</tr>
</thead>
</table>
| P1            | Pneumatics - basic course   | Acquiring knowledge on the properties and preparation of compressed air; familiarizing the elements and functions of the pneumatic actuators and control systems applied in modern industry; developing the ability to read pneumatic schematic diagrams; gaining the skills of constructing pneumatic control systems with the use of training positions designed for configuring and testing pneumatic systems; gaining knowledge how to calculate and select proper pneumatic elements for given parameters; acquiring the ability to design pneumatic systems with the usage of of the intuitive and algorithmic methods. | • Introduction to industrial pneumatic systems  
• Systems for generating, preparation and transmission of compressed air  
• Actuators in pneumatic systems  
• Constructing and performance testing of pneumatic systems - practical exercises at the assembly stations  
• Elements of control  
• Typical pneumatic systems: control by means of a single acting actuator and control by means of a double acting actuator  
• Components and functioning of basic pneumatic control systems  
• Compressed air safety  
• Exercises – an individual and self-reliant construction and examination of pneumatic systems by means of PARKER training assembly positions                                                                                                                                                                                                                     |
|               |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Duration: 3 days - 21 hours  
Course type: Open training                                                                                                                                                                                                                                                                                                                                                                              |

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<th>Course aims</th>
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</table>
| P2            | Industrial Electropneumatics | Learning about the elements and operation of electropneumatic actuators and control systems used in the industry; acquiring the skills of reading schematic diagrams of electropneumatic control systems and skills of constructing pneumatic systems fitted with electropneumatic elements at the workstations enabling configuration and testing of the electropneumatic systems; gaining practical skills of constructing pneumatic systems fitted with electropneumatic elements and replacing pneumatic systems with electropneumatic units. | • A short description of the basic elements of an electropneumatic system  
• Presentation of basic components of the electropneumatic systems  
• Characteristics and design of control valves  
• Fundamentals of electrical engineering with respect to electropneumatics (safety voltage, coupling of electrical wires, lifespan of valve coils, characteristics of valve switching)  
• The technology of connecting the pneumatic and electric parts of control systems  
• Industrial sensor systems used in electropneumatic units  
• Construction and operation of the electro-pneumatic control systems  
• Symbols and their meaning in PN - ISO 1219  
• Safety rules regarding pneumatic and electropneumatic systems  
• The standards of pneumatic and electropneumatic systems  
• Requirements for the installation of additional elements allowing configuration of electropneumatic systems  
• Criteria for the selection of electropneumatic systems and conversion of the conventional pneumatics to electropneumatic components  
• Comparison of the pneumatic and electropneumatic systems with regard to the functionalities and the use of additional components for industrial automation  
• Constructing and performance testing of pneumatic systems - practical exercises at the assembly stations                                                                                                                                                                                                                     |
|               |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Duration: 3 days - 21 hours  
Course type: Open training                                                                                                                                                                                                                                                                                                                                                                              |
INDUSTRIAL PNEUMATICS

SPECIALIZED COURSES
IN INDUSTRIAL PNEUMATICS

Course symbol: P3
Course name: Design and simulation of pneumatic and electropneumatic systems
Course aims: Learning about the design and operation of the pneumatic and electropneumatic control systems; acquainting the participants with the methods of designing (synthesis) of such systems and with the simulation software used in the analysis of the pneumatic and electropneumatic control systems; applying the logic methods in designing control systems based on Boolean's algebra.
Course summary:
- The basics of designing pneumatic systems.
- Selection of the basic elements of the system, taking into consideration the dynamics of pneumatic systems and pressure losses.
- Selection of the components and simulation of the pneumatic system using Computer-Aided Design tools (CAD).
- Intuitive method of synthesizing the pneumatic switch systems with examples of their practical application (advantages, disadvantages and functionality constraints).
- Elementary pneumatic actuator control systems constructed using intuitive methods and the detection of typical errors of such systems.
- Detection of typical errors occurring in control systems built according to intuitive method: logic connection errors, inappropriate selection of control and actuating elements, fungibility of control valves.
- Basic control systems with the application of pneumatic logic: NOT, OR, AND units.
- An algorithmic method of designing pneumatic switch systems, the notion of frequency unit (pneumatic cascade, step unit) and its construction on assembly boards.
- The analytic method of designing pneumatic and electropneumatic control systems on the basis of Boolean algebra and Karnaugh maps.
- Practical exercises - structure and testing the functioning of pneumatic and electropneumatic systems using assembly benches.
Duration: 2 days - 14 hours
Course type: Open training

More details on page 23

The laboratory of pneumatics is equipped in tables contained components of: Parker, ORIGA Parker, Festo, Rexroth, Pneumax/Rectus, PIAB, NORGREN, BIMBA Pneumatics, SMC, IFM, BALLUFF, Relpol, SIEMENS, Pneumax and Fluid SIM P software to learn the principles of design and simulation of pneumatic and electropneumatic control systems.

Course symbol: P4
Course name: Basic principles of vacuum technology
Course aims: Knowledge of the methods of preparing compressed air to use in vacuum systems; knowledge of the basic elements featured in vacuum systems; ability to design and modify vacuum handling systems to meet the requirements of industrial processes; knowledge of schematic diagrams of the vacuum systems; knowledge in the area of current trends in the development of vacuum systems.
Course summary:
- Introduction to vacuum technology
- Presentation of the basic groups of applications for vacuum devices (configuration and requirements)
- Configuration of the vacuum system (essential elements and parameters)
- Basic types of vacuum suction cups (features and application areas)
- Construction materials used to produce vacuum suction cups and guidelines for cleaning and maintenance
- Basic parameters of gripping systems based on vacuum technology
- Basics of designing suction cups
- Special grippers (advantages and application)
- Vacuum generators (characteristics, design, advantages and application)
- Vacuum compatible valve technology
- Control components in vacuum technology
- Vacuum filters (suction cup filters, built-in filters)
- Additional components of the vacuum unit
- Design algorithm for vacuum units
- Graphic symbols for pneumatic elements and basics of reading pneumatic or electro-pneumatic schemes in the context of vacuum units
- Safety rules for working with electro-pneumatic systems
- Current trends in vacuum technology, according to the concept INDUSTRY 4.0
- Practical exercises
Duration: 2 days - 21 hours
Course type: Open training

Training rooms:
P1 Rectus, PIAB, NORGREN, BIMBA Pneumatics, SMC, IFM, BALLUFF,
P2 Relpol, SIEMENS, Pneumax

More details on page 23
Laboratories

Training laboratories and unique equipment to practical workshops available as a part of training of POWER HYDRAULICS AND INDUSTRIAL PNEUMATICS. They have been developed from the ground up by the Engineering Training Center. They are based on elements of the largest suppliers of components.
Power hydraulics
stationary, mobile and hydrotronics

Courses codes: HI - HB, HM1 - HM3 and HT1 - HT2

TRAINING POSITIONS FOR POWER HYDRAULICS COURSES

Positions allow to:

- Assembly and testing of freely constructed hydraulic control systems whether conventional or electric,
- Running experimental (operational) tests of the typical hydraulic units like pumps, overflow valves, throttles or flow regulators,
- Simple, effortless and quick assembly of the designed hydraulic systems,
- Testing operation and functions of the power supply, pressure units, flow direction control, flow intensity control and the actuators,
- Acquisition of knowledge on the design and construction of electrohydraulic systems of electric and proportional relay control.
The workstations have a unique and Poland’s only design enabling exercises on different levels of advancement:

- assembly and testing the operation of freely configured hydraulic systems, proportionally controlled in open or closed circuits,
- acquiring skills in the field of design and installation of the electro-hydraulic systems of electric and proportional relay control,
- parameterization of proportional systems.

TRAINING POSITIONS FOR ELECTROHYDRAULICS AND PROPORTIONAL HYDRAULICS

The workstations have a unique and Poland’s only design enabling exercises on different levels of advancement.
The bench for practical exercises presents the classic operation of the hydraulic system. By using components made of PMMA, clearly visible are the channels, flows and the interior of each component used in the system while it is running.

The bench is controlled by the automation system with visualization on the operator panel. The system is used to present to the participants the operation of the hydraulic systems, their strengths, weaknesses and the most failure-prone spots with methods of quick troubleshooting. Components of the system:

- valve block,
- actuator,
- hydraulic accumulator,
- working medium tank,
- control panel with operator panel.
ADVANCED STATIONS OF MOBILE HYDRAULIC DRIVES

The station of mobile hydraulic drives and mobile control systems in proportional technology – Iqan control system – Parker Hannifin.

The position is implemented by the block P70, adjusted to constant performance power pumps and equipped with a 5 section dividers, overflow valves and anti-cavitation on the individual sections and levers for manual control.
The laboratory station is equipped in mobile applications block L90LS (counterpart of M4-1.2, M4-1.5 Bosch Rexroth), adapted to work with a pump with variable outputs, equipped with a Load Sensing system, 4 distribution sections, overflow valves and anti-cavitation, and also overflow valves on LS lines of individual sections. The block is responsible for controlling the pull-out of hydraulic cylinders (3 pieces) and hydraulic engine, loaded by means of throttle valves. The pump PV (Parker) with variable capacity with built-in pressure regulator, flow and overflow is connected to the distributor L90LS adapter. On the basis of described elements students are able to design, simulate action, build and examine a typical mobile hydraulic systems.
During our courses, we also use unique teaching elements and components:

- tailor-made sections of all hydraulic system components,
- we disassemble the components in order to show the classic failure consequences.
 POWER HYDRAULICS

SPECIALISTIC TOOLS

The participants learn and perform a series of exercises using professional industrial tools and measuring equipment. At your disposal:

- **Parker Service Master Plus analyser** used to measure i.a.: flow, temperature and pressure of the working medium,

- **HYDAC HMG 3010 and HMG 4000 analyzer** used to measure i.a.: flow, temperature and pressure of the working medium including a 5.7-inch touchpad,

- **Parker icount oil Sampler (iOS)** - a portable device for monitoring the condition of hydraulic fluid and oil,

- **Parker Kittiwake** – monitoring system equipment and predictive maintenance systems for machinery in oil industry. During our trainings it is used for testing physicochemical properties of hydraulic fluid (such as kinematic viscosity, water content, acid value and base number), according to norms prescribed in the documentation and put into the console. Through the analysis of the results, operational suitability is identified.
MHC - a portable bearing checker instrument and acoustic monitoring device,

**Heated Viscometer** - testing viscosity of fuel oil is important for verifying the correct grade of fuel is delivered, for calculating combustion performance, plus adjusting of fuel handling and injection systems. It is used for monitoring changes in lubricating oil viscosity reporting in cSt @ 40°C and 50°C, preventing costly engine and machinery failures and also to verify correct fuel grade,

**FLIR Thermal Camera** - detects hazards using infrared technology,

many others.

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**A STATION FOR FILTRATING OIL AND REFILLING HYDRAULIC SYSTEMS**

A workstation enables presenting the following elements to the students:

- how to keep lubricants clean,
- how to refill the system with new oil without contamination,
- how to safely dispose of oil from the system,
- how to modify the device to meet the requirements of a precise lubricant and oil management system,
- how to refill the system in order to maintain continuity,
- how to properly take oil samples in order to test it.

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**ELECTRONIC CATALOG OF ELEMENTS**

Our training laboratories are also equipped with an electronic catalog of hydraulic components that participants may have access to. Each component is labeled with bar code. If you put the bar code close to the electronic reader you will immediately obtain a specification sheet of a given element. It enables quick identification of a component and obtaining detailed information – characteristics, technical parameters and many others.
The teaching process is being supported by Fluid-SIM H. The software helps to learn the principles of the design and simulation of hydraulic and electrohydraulic control systems. The software enables analyzing the increase of the level and rate of the flow, pressure drops in the valves as well as designating the velocity and accelerations of the cylinder’s pistons.
Industrial pneumatics

Courses codes: P1-P4

Our training rooms and laboratories allow working on actual industrial pneumatic components by leading manufacturers:

- Parker, ORIGA Parker, Festo, Rexroth, Pneumax/Rectus, PIAB, NORGREN, BIMBA Pneumatics, SMC (pneumatic and electropneumatic control systems and actuators).
- IFM, BALLUFF, Relpol, SIEMENS, Pneumax (industrial sensors, relay and control systems, valve terminals).
WORKSTATIONS OF INDUSTRIAL PNEUMATICS

- actuating systems: single and double acting actuators, rodless linear actuators, grippers, multi-position shuttle tables with cushioning device, standardized multi-position actuators
- directional 3/2, 5/2, 5/3 valves (actuated manually, mechanically, pneumatically and electrically)
- check and throttle check valves, quick exhaust valves, throttle valves, reduction valves, safety valves
- logic valves (AND/OR) in classic versions or to be mounted on DIN rails
- proportional pressure regulators
- vacuum technology elements (suction cups, pressure generators)
- sensors (optical, induction, capacitive)
- ultrasonic leak detector Leakshooter
  - during our training courses, we also demonstrate operation of the leak detector for pneumatic installations. The device that we use is Leakshooter – ultrasonic leak detector with the embedded camera.
  - It enables leak detection of any pressurised gas. Perfect also for vacuum installations. The camera enables finding precise location of leak thanks to the color coded indicator. It is possible to take a photo of the leak location and then download it to your PC for further use.
THE WORKSTATIONS DESIGNED TO STUDY THE SYNTHESIS OF PNEUMATIC SYSTEMS ARE ALSO FITTED WITH THE FOLLOWING MODULES

- monostable and bistable buttons (fitted with NO and NC contact sets),
- relays (enabling the synthesis of the intermediate valve control systems) fitted with NO and NC contact sets,
- multifunction timers with the following functions: on-delay, off-delay controlled by the contact, ON at a set time, one-time ON at a set time triggered by closing the control contact, symmetrical cyclic operation starting with a break or switch on, generation of a 0.5 second pulse after a set time, on at a set time triggered by opening the control contact, on and off-delay controlled by the contact, cyclic operation controlled by closing the control contact,
- visual and acoustic indicators of operation status,
- pneumatic counter,
- valves to be mounted on panels,
- passive hubs for sensor inputs and pneumatic actuator reed relays.

- actuator systems: single- and double-acting cylinders, rodless linear cylinders, grippers, multi-position shuttle tables with cushion device, standardized multi-position actuators,
- directional 3/2, 5/2, 5/3 valves (actuated manually, mechanically, pneumatically or electrically),
- check and throttle check valves, quick exhaust valves, throttle valves, reduction valves, safety valves,
- logic valves,
- pneumatic time valves and pneumo-electrical transmitters,
- proportional pressure regulators,
- vacuum technology elements,
- sensors (optic, induction, capacity sensors),
- monostable and bistable buttons,
- relays (enabling the synthesis of the intermediate valve control systems),
- multifunction timers,
- visual and acoustic indicators of the operation status,
- valves for panel mounting,
- passive hubs for sensor inputs and pneumatic actuator reed relays.
Apart from the open courses organized in our offices, we also offer a selection of courses in pneumatics and electropneumatics organized at our clients’ premises. These trainings are characterized by:

- a training scheme based on the individually chosen topics and tailored course materials,
- in-depth analysis of the hydraulic diagrams provided by the client,
- practical exercises on the industrial components,
- exercises with the machines and systems from client’s production hall.

We have our own car fleet and mobile units for basic exercises and individual assembly of the systems. Their sophisticated design and specially arranged functionality enable the realization of top quality training outside the EMT-Systems laboratory of industrial pneumatics.
Software
Teaching aids

During the training the participants are presented with the functions of Fluid-SIM P software regarding the design and simulation of pneumatic and electropneumatic systems. The software enables the analysis of the medium increase and flow, determining pressure loss in the valves, defining velocity and acceleration of the pistons.
The trainings are conducted by well qualified didactic Staff of the local units of higher education (usually the Silesian University of Technology), who have a vast technical knowledge, and many years of training experience. In addition, they provide consulting services and work as experts for renowned trade periodicals. During trainings, their main focus is on passing knowledge of the real examples they have encountered in their professional work.

Our trainers are open to all suggestions made by the participants. It is very common that during trainings the group discusses the issues beyond the scope of the standard program that cover specific aspects of the students work.

Completed courses also lead to cooperation between EMT Systems and representatives of industrial facilities in the following areas: projects, modernization and commissioning lines.
Training Areas

**Mechanical Engineering**
- Industrial Pneumatics
- Power Hydraulics
- Training courses in Operating and Programming CNC lathe and milling machines
- Conventional Machine Tools
- Mechanical Engineering
- Machine Diagnostics

**Production Quality**
- Quality Management
- Metrology
- Analysis of Measurements
- Quality Management Systems

**Visualization and Control Systems**
- Electrical Engineering and Automation
- SIEMENS S7-300/400
- SIEMENS S7 Migration STEP 7 - TIA Portal
- SIEMENS S7-300/400 TIA Portal
- SIEMENS S7-1200 TIA Portal
- SIEMENS S7-1500 TIA Portal
- SIEMENS S7-SCL/GRAPH in TIA Portal
- SIEMENS Safety Integrated
- SIEMENS S7-SCL/GRAPH w TIA Portal
- SIEMENS Safety Integrated
- HMI/SCADA
- Industrial Networks
- SIMATIC PCS7
- CODESYS
- Drive Systems
- Industrial Sensors
- C/C++ Programming

**Industrial Robots**
- FANUC
- ABB
- KUKA
- WITTMANN
- COMAU
- Industrial Robots Integration

**Material Engineering**
- Plastics
- Polymer Composites
- 3D Printing
- Heat Treatment
- Casting
- Plastic Forming
- Resistance Welding

**Machinery Safety**
- Standards and Directives for Machinery
- Safety Systems

**Production Quality Management**
- Total Productive Maintenance
- SMED Methodology
- FMEA Methodology
- Lean Manufacturing

**SIEMENS PLM**
- SIEMENS NX
- SIEMENS Solid Edge

**SIEMENS PLM Software**
- Siemens NX
- Siemens SOLID EDGE
- Siemens FEMAP
- Siemens FIBERSIM
- Siemens TECNOMATIX
- Siemens TEAMCENTER