Lab-Volt®

INDUSTRIAL WORKFORCE DEVELOPMENT

- ELECTRICAL & MECHANICAL SYSTEMS
- HYDRAULIC AND PNEUMATIC SYSTEMS
- PLCS AND DRIVES
- INSTRUMENTATION & PROCESS CONTROL
- WEB-BASED INDUSTRIAL TRAINING
- AUTOMATION & ROBOTICS
- EXPLORING TECHNOLOGY

INDUSTRIAL WORKFORCE DEVELOPMENT

Technical Training Systems

- Electric Power and Control
  - Electromechanical
  - Power Electronics and Drives
  - Power Transmission, Distribution, and Protection
  - Industrial Controls
- Telecommunications
  - Digital and Analog
  - Radar Technology
  - Microwave Technology
  - Antenna
  - Telephony
  - Fiber Optic Communications
- Manufacturing / Mechatronics
  - Mechanical Systems
  - Fluid Power
  - Instrumentation and Process Control
  - Web-Based Industrial Training
  - Automation and Robotics
  - Exploratory Technology
- Tech-Design®
  - Communications
  - Transportation
  - Construction
  - Manufacturing
  - Bio-Related
- Tech-World®
  - Applications in Manufacturing
  - Applications in Information Technology
- Computer-Based Learning for Electronics Training (FACET®)
  - Basic Principles of Electricity and Electronics
  - Circuit Simulations
  - Digital and Microprocessor Electronics
  - Telecommunications
  - Industrial Electronics

MANUFACTURING TECHNOLOGY

MANUFACTURING AND CENTRAL SALES OFFICES

LAB-VOLT SYSTEMS, INC.
P.O. Box 686
Farmingdale, New Jersey, USA 07727
Telephone (732) 938-2000 Fax (732) 774-8573
Toll Free U.S. Telephone (800) LAB-VOLT
E-MAIL: us@labvolt.com

LAB-VOLT LIMITED
675, rue du Carbone
Charlesbourg, Québec, CANADA G2N 2K7
Telephone (418) 849-1000 Fax (418) 849-1666
Toll Free Canada Telephone (800) LAB-VOLT
E-MAIL: ca@labvolt.com

LAB-VOLT'S WEB SITE
www.labvolt.com

Introducing Lab-Volt's

Training Systems for Manufacturing & Mechatronics Technology

Lab-Volt Systems, Inc. is recognized as the leading designer and manufacturer of world-class technical training systems that deliver the highest standards of quality, service, and educational integrity. Lab-Volt is recognized for its commitment to hands-on training curriculum that empowers students to progress directly from the classroom to the workplace.

Mechatronics, a relatively new engineering discipline, integrates mechanical energy with electronic and intelligent computer control in the design and manufacture of industrial products and processes.

Lab-Volt's training systems in Manufacturing and Mechatronics Technology include modular courseware, hardware, and carefully structured learning systems that span a variety of manufacturing applications. These include:

- **Electrical & Mechanical Systems** the transition from classroom to workplace is seamless with Lab-Volt's modular training units featuring industrial quality equipment and task-based training in mechanical, pumps, rigging, and wiring systems.
- **Fluid Power** a series of modern, state-of-art modular training units and computer-based curriculum covering a broad range of applications in hydraulics and pneumatics.
- **Instrumentation and Process Control** an extensive series of hands-on systems that provide basic to advanced troubleshooting and repair skills in most major areas of industrial-level processing systems.
- **Web-Based Industrial Training** delivers a broad range of online and CD-ROM-based fundamental and specialty industrial training courses designed to build a more competent, qualified, and efficient workforce.
- **Automation & Robotics** (Lab-Volt Automation™), comprising a line of high-precision, industry-standard equipment, courseware, and software that provide integrated training in mechatronics through the study of robotics, CNC milling, CNC turning, and PLC-operated flexible manufacturing systems.
- **Exploring Technology** a series of modular training units that introduce students to the concepts and operations underlying important manufacturing processes, including Mechanisms, Sensors, and Electricity.

Lab-Volt Technical Training Systems are used world-over in secondary and post-secondary vocational programs, trade and technical schools, military installations, government training centers, and industrial job training programs.

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ELECTRICAL & MECHANICAL SYSTEMS

The Transition From Classroom to Workplace is Seamless with Lab-Volt's Industry-Relevant Training

Lab-Volt understands the need for highly skilled employees in many sectors of the economy, including manufacturing, health care, service and leisure industries, government, education, and the military. Lab-Volt's mechanical training systems provide trainees with all the knowledge, skills, and practical experiences needed for a rewarding career in industrial maintenance, whether they are college-bound or aim for employment after graduation.

Each model consists of comprehensive courseware, including a training manual and instructor guide. These materials provide everything needed to ensure safe, effective training and verification of trainees' skill development.

Heavy-duty motor mounting base from the Mechanical Training System

Students follow job sheets to complete tasks safely and efficiently

FEATURES

- Industrial grade equipment
- Task-based learning through job sheets, work orders, and reference material
- Workplace topics such as health, electrical safety, and tool safety are enforced
- Interdisciplinary learning allows for flexible career options
- Trainees gain solid employability skills, such as communication, troubleshooting, teamwork, work measurement, problem solving, and critical thinking
- Optional workbenches and simulation software save training dollars and space
- Modular design and various lab configurations allow for customization of curriculum

Models include:

MECHANICAL TRAINING SYSTEM
Model 46101

INDUSTRIAL WIRING TRAINING SYSTEM
Model 46102

PUMPS TRAINING SYSTEM
Model 46106

RIGGING SYSTEM
Model 46109

INDUSTRIAL CONTROLS TRAINING SYSTEM
Model 3100

VARIABLE SPEED DRIVES
- DC Variable Speed Drive, Model 3250
- AC Variable Speed Drive, Model 3260

Mechanical Training System
Model 46101

The Lab-Volt Mechanical Training System, Model 46101, familiarizes students with the selection, installation, use, maintenance, and troubleshooting of mechanical drive components.

Engineered for extreme ease of use, the system comes with a universal steel base unit on which the students prepare the setups using T-slotted extrusion bars. This innovative design allows the base to be configured as required by the task. The universal base includes a disconnecting switch, current meter, and the controls required to operate the motors and clutch-brake. It also includes a Start/Stop push-button station for local and remote operation.

The curriculum is based on practical, hands-on tasks using industrial grade components. This ensures that students are well prepared for today's competitve workforce.

TOPIC COVERAGE

- Belt Drives
- Chain Drives
- Gear Drives
- Lubrication
- Couplings
- Shaft Alignment
- Bearings
- Ball Screws
- Gaskets and Seals
- Clutches and Brakes
- Laser Alignment
- Vibration Analysis

FEATURES

- Universal base unit can be mounted on a regular table as well as optional Lab-Volt benches
- Fully illustrated job sheets direct students to complete tasks safely and efficiently
- Lockout/tagout on the disconnecting switch and safety panels ensure student safety
- Working space can be increased by adding a slave base unit
- Quality industrial components are mounted on panels for storage and inventory control

Industrial Wiring Training System
Model 46102

The Lab-Volt Industrial Wiring Training System, Model 46102 faithfully reproduces an industrial environment where students can develop their skills in the installation and wiring of industrial electrical equipment, in compliance with the National Electrical Code® (NEC®). The system can also be used to teach trainees how to adjust and maintain industrial electrical equipment as well as enforce the safety rules to be followed when working at industrial sites.

Due to its modular design, the Industrial Wiring System can be configured to fit various training needs. A versatile, mobile workstation is the basis of the system. A variety of equipment packages, tool packages, and industrial application packages are available to adjust the curriculum to customized training levels. Packages of consumable goods such as conduits, conduit fittings, dummy electrical enclosures and boxes, and reels of electrical wire are also available.

TOPIC COVERAGE

- Cabinet Installation
- Conduit Installation
- Industrial Equipment Wiring
- Electrical Safety
- Electrical Diagrams
- Power Distribution
- Motor Starters
- AC/DC Drives
- Industrial Applications

FEATURES

- Supports up to four equipment setups at the same time, allowing multiple student groups to work at a single workstation
- Two or more equipment setups can be grouped together to form complex industrial applications
- Selection of equipment packages allow the system to meet a wide range of training objectives
- Fully illustrated courseware guides students through various tasks
- Mobile workstation features swivelling casters with a lock mechanism for easy motion and stable operation
- Sized to fit through standard door openings

Pumps Training System
Model 46106

The Lab-Volt Pumps Training System, Model 46106, familiarizes students with maintenance tasks such as pump installation, lubrication, shaft alignment, inspection, and component replacement. Students also learn how to start up, operate, and troubleshoot industrial pumps in different configurations. Furthermore, during these hands-on activities they will discover the impact of valve restriction, air injection, and NPSH on pumps efficiency by using a cavitation valve, a load valve, and two different water reservoirs.

The modularity of the system permits the selection of models required to meet customized training objectives.

TOPIC COVERAGE

- Pump Installation
- Lubrication
- Shaft Alignment
- Inspection
- Component Replacement
- Valve Restriction
- Air Injection
- Pump Wiring
- Fluid Mechanics
- Pump Maintenance
- Laser Alignment
- Vibration Analysis

FEATURES

- Thirteen different types of pumps
- Latest 3-phase AC drive included to vary the speed of motor-driven pumps
- Easy electrical connections between the drive and motor can be made using banana jacks or terminal blocks
- Configure variable speed drives using local panels, or remotely using optional computer software
- Transparent pump cover allows cavitation observation

Industrial quality pumps are used for the most realistic training

Rigging System
Model 46109

Moving machines is a basic requirement for any industrial plant. Machines to be moved are all different since they are usually built for a special application. They have different shapes and are often asymmetrical. Their weight, which is not evenly balanced on the machine supports, creates difficulties to the rigger. Therefore, installation requires skilled and highly qualified riggers.

To help acquire these basic skills, the Lab-Volt Rigging System was created to cover the fundamentals of rigging practices. Students practice the techniques that must be developed and used to install and move a machine safely.

Work orders help students develop the skills required for rigging practice and are an excellent test bench for the students.

TOPIC COVERAGE

- Moving machines using rollers
- Lifting and handling odd-shaped loads
- Moving loads according to center of gravity and weight
- Handling machines with wire rope pullers
- Identify different types of rope, cut rope properly, and make knots
- Assemble a wedge socket on a wire rope
- Install hoist trolleys, chain links, chain hoist, and electric hoist on the gantry crane
- Move a machine from ground position to a pedestal
- Lift an unbalanced load

FEATURES

- Storage for all material
- Work orders for task-based learning
- Industrial-grade equipment

Industrial Controls Training System
Model 3100

The Industrial Controls Training System, Model 3100, has unique controls training capabilities, enhanced by its modularity and instructor-inserted faults. The system allows trainees to select and mount control devices to form typical control circuits, and to troubleshoot them once a fault is inserted.

Each module is equipped with up to four faults that can be inserted using switches mounted behind the faceplate. Typical faults include open coils and contacts, dirty contacts, and shorted connections.

The modules of the Industrial Controls Training System can be interconnected with those of other Lab-Volt training systems for interdisciplinary training applications. Connections are made using flexible PVC-insulated connecting leads terminated with 4-mm safety banana plugs. These leads allow safe connection of components, since the live parts of their plugs are concealed and insulated so they cannot be contacted accidentally.

TOPIC COVERAGE

- Introduction to Motor Control
- Pilot Devices
- Circuit Layout Connections and Symbols
- Basic Control Circuit
- AC Reduced-Voltage Starters
- Three-Phase, Multispeed Controllers
- Wound-Rotor Motor Controllers
- Synchronous Machine Controls
- Direct Current Controllers

FEATURES

- Comprehensive, competency-based courseware is adjustable to both self-paced and lock-step instructional methods
- Up to four fault insertion switches can be front activated on each module by an instructor
- Standard industrial quality controls devices, capable of handling 1 horsepower machine
- Can be interconnected with any of Lab-Volt's electronics and digital control trainers for interdisciplinary training applications
- Schematic diagrams silk-screened on front panels
- Open motor ends allow observation of motor windings

Variable Speed Drives

Models 3250 and 3260

The DC and AC Variable Speed Drives enable trainees to develop competence in operating and troubleshooting control systems that include industrial-type drives. They can be used with the Industrial Controls Training System, Model 3100, as well as most commercial motors.

Courseware includes an Operation Manual and Project Job Sheets addressing setup and operation of the drives and their controls.

The DC Variable Speed Drive, Model 3250, is an industrial-type drive whose power circuitry is composed of a half-bridge with two thyristors and two diodes. A full-wave field voltage is provided for shunt wound motors. The drive includes controls for Minimum Speed, Maximum Speed, Acceleration, IR Compensation (Regulation), and Current Limit by means of five potentiometers located on the main circuit board. The speed of the motor is set by the means of a potentiometer located on the faceplate of the drive, or an insulated voltage course of 0 to 12 V dc.

The AC Variable Speed Drive, Model 3260, uses the latest solid-state PWM technology to control a three-phase squirrel-cage induction motor. A keypad and an LCD screen allow modification and visualization of many different parameters, such as min/max speed, acceleration/deceleration time, and torque. The V/Hz output characteristic is user-selectable for constant torque, pump, and fan applications. Up to eight preset speeds may be programmed. Speed can be controlled using either the digital keypad or the analog input on the front of the module.

The AC Variable Speed Drive is available in two versions: Models 3260-1 and 3260-2. Model 3260-1 requires 120-V, 60 Hz power available from any standard wall outlet. This single-phase option is not available for 220 V and 240 V, 50 Hz, line supplies. Model 3260-2 requires three-phase supply. The three-phase supply is applied at the 4-mm banana jacks on the module front panel.

Model 3250
DC Variable Speed Drive

Model 3260
AC Variable Speed Drive

TOPIC COVERAGE

DC Variable Speed Drive

- Trainer Familiarization
- Maximum Speed Trimpot Adjustment Characteristics
- Minimum Speed Trimpot Adjustment Characteristics
- Speed Regulation Trimpot Adjustment Characteristics
- Current Limit Trimpot Adjustment Characteristics
- Acceleration Trimpot Adjustment Characteristics
- Remote Control Characteristics
- System Configuration

AC Variable Speed Drive

- Trainer Familiarization
- Maximum Speed Control Characteristics
- Minimum Speed Control Characteristics
- Acceleration Control Characteristics
- Deceleration Control Characteristics
- Boost Control Characteristics
- System Configuration

FEATURES

DC Variable Speed Drive

- Adjustable horsepower settings up to 1 HP
- Designed for DC permanent magnet, shunt wound, and some universal (AC/DC) motors
- Converts incoming AC voltage to adjustable full-wave rectified DC for armature circuit A full wave field voltage is provided for shunt wound motors
- Incorporates transient voltage protection with adjustable current limit and an AC fuse for protection
- Adjustable minimum and maximum speeds along with adjustable acceleration and IR compensation

AC Variable Speed Drive

- Designed for three phase induction motors up to 1 HP (220/240V)
- Combines power bi-polar, MOS devices, and hybrid drivers
- Inverter produces an output frequency range of 2-100 Hz with a constant V/F ratio between 2-48 Hz, suitable for constant torque applications, and a reducing V/F ratio between 48-100 Hz giving an approximate constant HP characteristic
- Adjustable controls for low frequency boost, minimum speed, ramp up, ramp down

FLUID POWER TRAINING FOR INDUSTRIAL APPLICATIONS

Innovative Design Offers Exceptional Options

Lab-Volt offers the most comprehensive and flexible course in fluid power available. Lab-Volt's premier training system for fluid power technology consists of two programs. The Hydraulics Training System, Model 6080, and the Pneumatics Training System, Model 6081. Both are innovative, modular systems that use state-of-the-art hardware and courseware to deliver job training in fluid power.

The entire fluid power series has been designed for educational growth. Using either the Hydraulics or the Pneumatics Training Systems, students gain a solid foundation in, and hands-on experience with, fluid power components and circuits; the principles and concepts underlying fluid power systems and applications; and methods of troubleshooting and testing fluid systems. Each lesson builds upon previous lessons, making this an ideal job-training program.

Engineered for extreme ease of use, the core system begins with a work surface assembly consisting of a solid metal, universal drip-tray hinged to a perforated, tiltable work surface that serves as a panel onto which hydraulic or pneumatic components are mounted. By adding optional expansion panels, the work surface can be configured to accommodate a wide variety of space and teaching needs. Mounting and dismounting components is easy with push-lock fasteners that snap easily into the perforation on the work surface. The tilting work surface facilitates instructor demonstration to an entire class.

The scope of the entire Lab-Volt Fluid Power product line addresses the diverse needs of secondary and post-secondary technology programs. The interfacing of electronics, sensors, robots, and controls makes the Lab-Volt program an ideal cornerstone of any job-training program in Mechatronics, Electromechanical Systems, or Automation.

The courseware includes reference textbooks, optional video tapes and courseware illustrations. The illustrations are available in the form of transparencies and on CD-ROM.

The courseware for Hydraulics Fundamentals and Pneumatics Fundamentals is also available in a Computer-Based Learning format. The CBL version enables electronic grading of review questions and unit tests. For those who purchase this version, an Instructor Answer Key is provided. All other hardware and supporting materials remain the same as the book course.

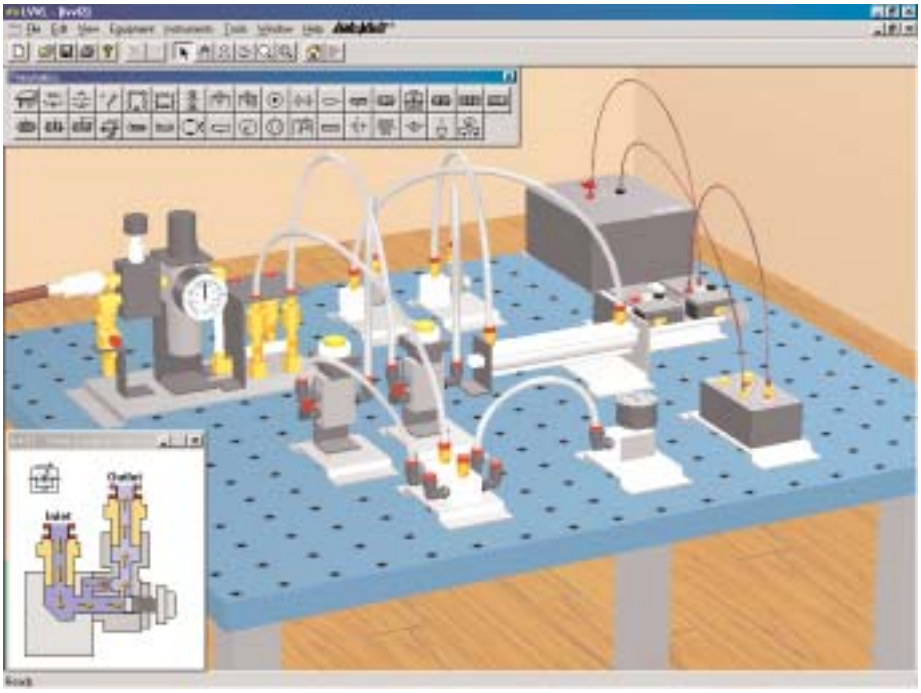
VERSATILE AND FLEXIBLE SYSTEMS FIT ANY CLASSROOM CONFIGURATION

The basic Lab-Volt Hydraulics Training System consists of a power unit, work surface assembly, industrial grade components, hoses, hose rack, metering instruments, and related courseware. The basic Pneumatics Training System consists of a work surface assembly, pneumatic components, measuring instruments, accessories, and related courseware. All components in both systems exceed industrial safety standards, and are identified with ANSI symbols. Optional equipment includes a mobile support bench with expandable storage shelves, dress panels, and additional expansion panels.

Operating on a standard electrical supply, the Hydraulics system requires no special wiring. The power unit was designed to match components with training needs. The pump delivers flow to components at a rate that allows observation and is powerful enough to provide pressures in excess of 6200 kPa (900 psi).

SIMULATION SOFTWARE FOR HYDRAULICS AND PNEUMATICS

Ideal for Training Centers Tight on Budget and Space



To provide training centers and students with a fast and effective instructional tool, Lab-Volt has created a series of Windows®-based simulation software programs (LVSIM®) that cover the same material and produce the same results as actual laboratory equipment. The Lab-Volt Hydraulics and Pneumatics training systems, Models 6080-1/2 and 6081-1/2, are also available as simulation software programs through the LVSIM® trademark.

LVSIM®-HYD (Model 6385) and LVSIM®-PNEU (Model 6485) cover the same courseware as the standard programs, but standard laboratory equipment is replaced by computer-screen images that fully simulate the mechanical characteristics of the actual hydraulic and pneumatic modules. Using the mouse, students can select and set up virtual equipment for a given exercise, make the necessary connections between the simulated modules, and obtain the same results as with the real equipment.

Used either as a complement to the actual laboratory equipment or as a stand-alone product, LVSIM® is a cost-effective tool that enables students to safely and accurately perform experiments and become familiar with the equipment configuration and laboratory setup before they enter the lab. As a result, their time spent in duplicating hands-on tasks in the actual laboratory may be reduced significantly, resulting in the need for less physical hardware per student. With these cost-saving features, institutions with tight budgets can deliver a quality program in hydraulics and pneumatics with limited investment.

An additional advantage to LVSIM® is its protected portability. Students can install the software onto their own personal computers in order to practice and prepare in advance for their lab exercises, but measurement capability is restricted by means of a security hardlock device.

PRODUCT PROFILES

HYDRAULICS FUNDAMENTALS TRAINING SYSTEM
Model 6080-1

The Hydraulics Fundamentals Training System, Model 6080-1, gives students a solid foundation in, and hands-on experience with, hydraulic components and circuits; the transmission of force through liquids; conversion of force to pressure; the control of power; and methods of troubleshooting hydraulic systems.

The standard modular system consists of a perforated work surface, components for the Hydraulics Fundamentals course, a drip tray attached at the bottom of the work surface, a hose rack with hydraulic hoses, and a mobile power unit with a dead-weight stand.

The work surface of the 6080-1 can be placed on a table or an optional bench, containing sliding channels for storing additional work surfaces, or on a lockable, paneled bench.

Components for Hydraulics Fundamentals

TOPIC COVERAGE

- Introduction to Hydraulics
  - Familiarization with the Lab-Volt Hydraulics Trainer
  - Demonstration of Hydraulic Power
- Fundamentals
  - Pressure Limitation
  - Pressure and Force
  - Flow Rate and Velocity
  - Work and Power
- Basic Circuits
  - Cylinder Control
  - Cylinders in Series
  - Cylinders in Parallel
  - Regenerative Circuits
- Functional Circuits
  - Accumulators
  - Hydraulic Motor Circuits
  - Pressure Reducing Valves
  - Remotely-Controlled Pressure Relief Valves
- Troubleshooting
  - Hydraulics Pump
  - Directional Valve Testing
  - Flowmeter Accuracy
  - Effects of Temperature on System Operation

Work surface on optional bench without dressing panels

FEATURES

- Engineered for extreme ease of use
- Workstation can be configured to accommodate a wide variety of space and teaching needs.
- Components mount/dismount with push-lock fasteners
- Optional support benchs and dressing panels are available
- Components exceed industrial safety standards

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
40 hours

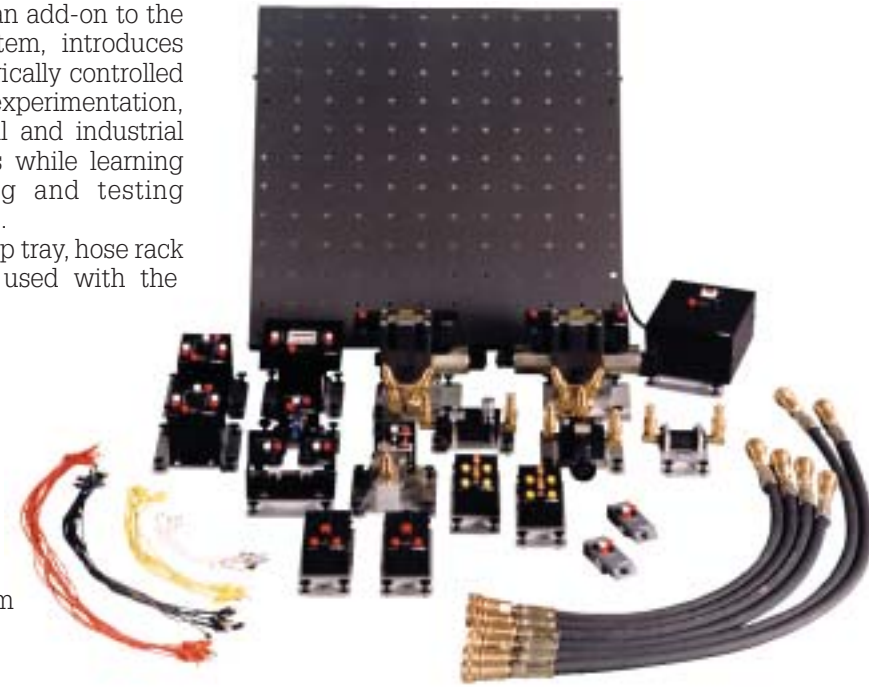
LANGUAGE VARIATIONS
English, French, Spanish

ELECTRICAL CONTROL OF HYDRAULIC SYSTEMS

Models 6080-2

Electrical Control of Hydraulic Systems, an add-on to the Hydraulics Fundamentals Training System, introduces students to electrical concepts and electrically controlled hydraulic systems. Through hands-on experimentation, students gain familiarity with functional and industrial electrically controlled hydraulic systems while learning systematic methods of troubleshooting and testing electrically controlled hydraulic systems.

The same perforated work surface, drip tray, hose rack and hose, and power supply unit are used with the Electrical Control of Hydraulic systems.



Components for Electrical Control of Hydraulic Systems

TOPIC COVERAGE

- Introduction to Electrical Controls of Hydraulic Systems
  - Familiarization with the Equipment
- Electrical Control Principals
  - Basic Electricity
  - Ladder Diagrams
  - Basic Electrically-Controlled System
- Fundamental Systems
  - Hydraulic Sequencing of Cylinders
  - Electrical Sequencing of Cylinders
  - Speed Regulation and Braking of Hydraulic Motors
  - Continuous Reciprocation with Dwell Period
- Industrial Applications
  - Drilling System
  - Safety Circuits
  - Counting of Actuator Cycles
  - Multi-Pressure Systems
  - Rapid-Traverse Slow-Feed Systems
- Troubleshooting
  - Troubleshooting Electrical Control Circuits
  - Troubleshooting Electrically Controlled Hydraulic Systems

FEATURES

- Seamless integration with Hydraulics Fundamentals System
- Prepares students for jobs and advanced education in state-of-the-art fluid power applications
- Provides add-on capabilities for PLC operations, Servo/Proportional Control, and Sensors
- Integrates with Electrical Control of Pneumatic Systems

SYSTEM VOLTAGES

120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS

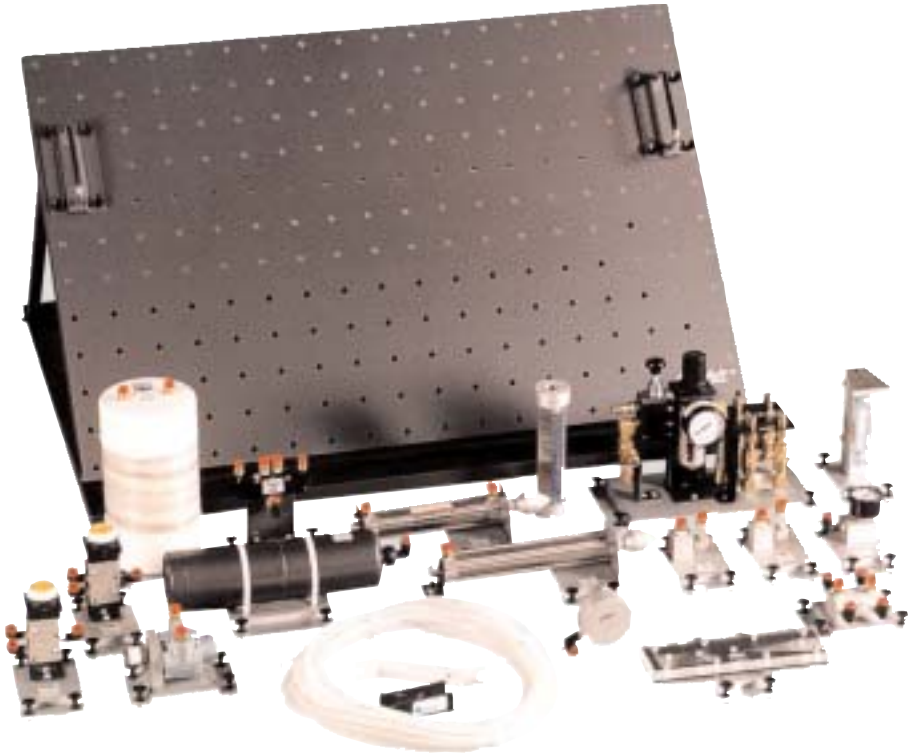
60 hours

LANGUAGE VARIATIONS

English, French, Spanish

Work surface with "A" frame on optional bench with dressing panels and lockable doors.

PNEUMATICS TRAINING SYSTEMS
Models 6081-1 AND 6081-2



Model 6081-1
Components of Pneumatics Fundamentals

The Lab-Volt Pneumatics Training System is an innovative, modular system that uses state-of-the-art hardware and courseware to deliver comprehensive training in the principles of pneumatic energy and its control applications. The Pneumatics Training System uses the same workbench and many electrical components of the Electrical Control of Hydraulic Systems, Model 6080-2, providing a convenient interconnection between both systems.

The system comes with a work surface assembly consisting of a solid metal, universal drip-tray, hinged to a perforated tiltable work surface. This work surface provides a large area for mounting the pneumatic components, using easy push-lock fasteners. All components meet industrial safety standards and are identified with ANSI symbols.

The Pneumatics Fundamentals Training System, Model 6081-1, gives students a solid foundation in, and hands-on experience with, pneumatic components and circuits; the transmission of force through liquids; conversion of force to pressure; the control of power; and methods of troubleshooting pneumatic systems.

In the second level, Electrical Control of Pneumatic Systems, Model 6081-2, students are introduced to electrical concepts and electrically controlled pneumatic systems. Through hands-on experimentation, students gain familiarity with functional and industrial electrically controlled pneumatic systems while learning systematic methods of troubleshooting and testing electrically controlled pneumatic systems.

The student laboratory manuals provided with the trainer are objective-based and self-paced with procedures that direct the student with step-by-step instructions. A general reference text is also provided for theory and background studies.

Additional options, including a mobile bench with lockable and expandable storage shelves, dress panel, and work surfaces are also available.

TOPIC COVERAGE
Pneumatics Fundamentals

- Introduction to Pneumatics
  - Familiarization with the Lab-Volt Pneumatics Trainer
  - Introduction to Pneumatics
  - Air Conditioning and Distributing Equipment
- Basic Physical Concepts
  - Pressure vs Force Relationship
  - Pressure vs Volume Relationship
  - Pressure Drop vs Flow Relationship
  - Vacuum Generation
- Basic Controls of Cylinders
  - Directional Control Valves
  - Directional and Speed Control of Cylinders
  - Cylinders in Series
  - Cylinders in Parallel

Pneumatics Training Systems, Models 6081-1 & 6081-2 (Continued)

Model 6081-2
Components of Electrical Control of Pneumatic Systems

- Basic Controls of Pneumatics Motors
  - Indirect Control Using Pilot-Operated Valves
  - Pneumatic Motor Circuits
  - Pneumatic Motor Performance

Electrical Control of Pneumatic Systems

- Introduction to Electrical Control of Pneumatic Systems
  - Familiarization with the Equipment
- Electrical Concepts
  - Basic Electricity
  - Ladder Diagrams
  - Basic Electricity Controlled Pneumatic Circuits
  - Basic AND and OR Logic Function Circuits
- Functional Systems
  - Basic Memory and Priority Electropneumatic Circuits
  - Multi-Pressure Systems
  - Sequencing Pneumatic Circuits
  - Time-Delay Electropneumatic Applications
- Industrial Applications
  - Pneumatic Actuator Deceleration Circuits
  - Counting of Actuator Cycles
  - Industrial Drilling System and Safety Circuits
  - Garbage Compactor Simulation Circuit
- Troubleshooting
  - Troubleshooting Electrical Control Circuits
  - Troubleshooting Electrically Controlled Pneumatics Systems

FEATURES

- Engineered for extreme ease of use
- Workstation can be configured to accommodate a wide variety of space and teaching needs
- Components mount/dismount with push-lock fasteners
- Optional support bench and dressing panels are available
- Components exceed industrial safety standards

SYSTEM VOLTAGES

120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS

Pneumatics Fundamentals:	40 hours
Electrical Control of Pneumatic Systems:	60 hours

LANGUAGE VARIATIONS

English, French, Spanish

ADVANCED FLUID CONTROLS APPLICATIONS
Models 6082, 6080-4, 6081-4 and 6085

HYDRAULICS & PNEUMATICS APPLICATIONS - PLC
Model 6082

Using a PLC with either the Hydraulics or Pneumatics Training System, students learn how to send instructions to the PLC and download ladder programs in order to operate fluid power circuits by means of switches, sensors, and solenoid-operated directional valves. The PLC also allows students to make comparison with relay-operated control circuits and design time-delay circuits, up and down counting circuits, latch and unlatch circuits, and more.

Three PLC models are available: Allen Bradley, Omron, and Siemens. Each of them may be programmed using an advanced programming software.

Model 6082

TOPIC COVERAGE

- Programmable Logic Controller Review
- Timer Instructions
- Counter Instructions
- Latching and Comparison Instructions
- Time-Delay Control of Hydraulic Actuators
- Counting Actuator Cycles
- Safety Control of Actuators
- PLC-Controlled Clamp and Work System
- Troubleshooting
- Designing a PLC-Controlled Punching Press (Hydraulics)
- Designing a PLC-Controlled Conveyor System (Hydraulics)
- Designing a PLC-Controlled Die Casting Machine (Hydraulics)
- Designing a PLC-Controlled Stamping Machine (Pneumatics)
- Designing a PLC-Controlled Conveyor System (Pneumatics)
- Designing a PLC-Controlled Injection Molding Machine (Pneumatics)

SYSTEM VOLTAGES

120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS

45 hours for each program

LANGUAGE VARIATIONS

English, French, Spanish

SERVO/PROPORTIONAL CONTROL
Model 6080-4 Servo/Proportional Control of Hydraulic System and Model 6081-4 Pneumatic Servo/Proportional Control of Pneumatic Systems

The Servo/Proportional Control module is an add-on to the Electrical Control system for both Hydraulics and Pneumatics. Through hands-on operation of signal conditioners, pressure and position transducers, P.I.D. controller, proportional directional control valve, feedback devices, and corresponding interface hardware and courseware, students are trained in the precise controls used in industrial applications such as robotics, aviation, CNC machines, marine, mobile equipment, and material handling.

All exercises require Basic and Electrical Control of Hydraulic and/or Pneumatic Systems.

Model 6080-4

TOPIC COVERAGE
Servo/Proportional Control of Hydraulic Systems, Model 6080-4

- Proportional Directional Control Valves
- Acceleration and Deceleration Control
- Open-Loop Control of Motor Speed
- Proportional (P) Control of Motor Speed
- Proportional-Plus-Integral (PI) Control of Motor Speed
- Proportional-Plus-Integral-Plus-Derivative (PID) Control of Motor Speed
- Open-Loop Control of Cylinder Rod Position
- Closed-Loop Control of Cylinder Rod Position
- Closed-Loop Control of Cylinder Pressure

Servo/Proportional Control of Pneumatic Systems, Model 6081-4

- Introduction to Servo Control Valves
- Acceleration and Deceleration Control
- Open-Loop Position Control
- Closed-Loop Position Control, Proportional (P) Mode
- Closed-Loop Position Control, Proportional-Plus-Integral (PI) Mode
- Open-Loop Speed Control
- Closed-Loop Speed Control, Proportional-Plus-Integral-Plus-Derivative (PID) Mode
- Closed-Loop Pressure Control, Proportional-Plus-Integral (PI) Mode

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
45 hours for each program

LANGUAGE VARIATIONS
English, French, Spanish

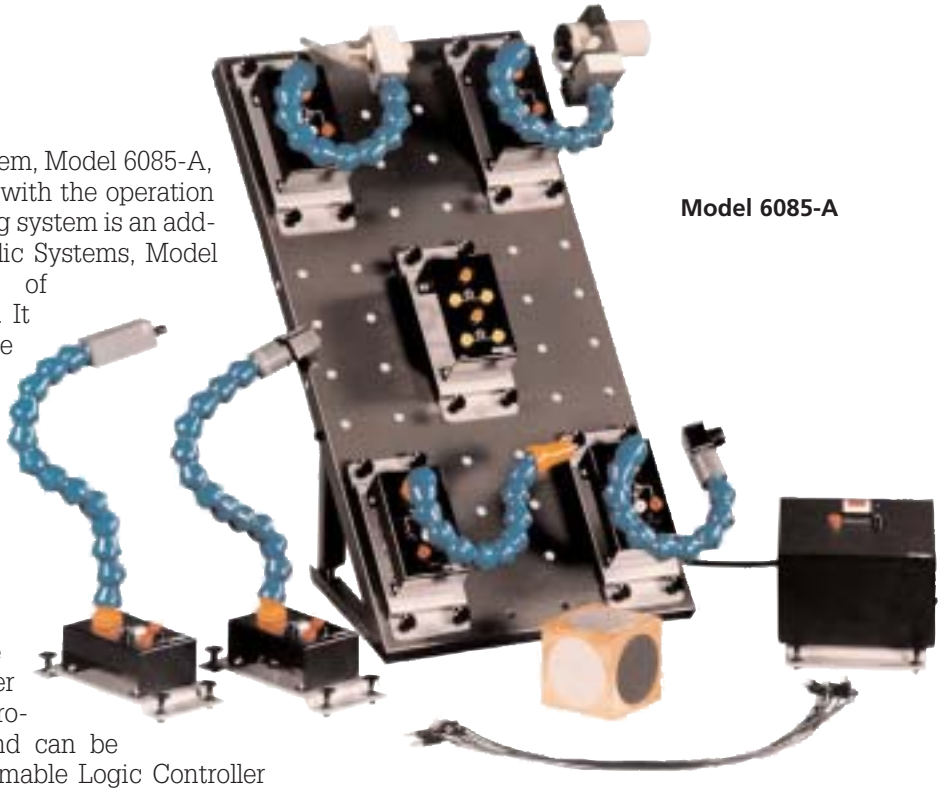
Model 6081-4

ELECTRONIC SENSORS SET Model 6085

The Lab-Volt Sensors Training System, Model 6085-A, is designed to familiarize students with the operation of various sensor types. This training system is an add-on to Electrical Control of Hydraulic Systems, Model 6080-2 and Electrical Control of Pneumatic Systems, model 6081-2. It is also available as a stand-alone system. The Sensors Training System contains a selection of photoelectric, inductive and capacitive sensors representative of what can be found in the industry.

Each sensor is mounted on a flexible support attached to a metallic base which can be snapped into the perforations of the Hydraulics and Pneumatics Trainer work surfaces. The sensors are protected against reverse polarity and can be used in conjunction with Programmable Logic Controller to achieve advance fluid control applications.

As a stand-alone system, the Sensors Training System includes also a power supply, pilot lamps, leads, and a work surface.



Model 6085-A

TOPIC COVERAGE

- Introduction to Sensors
- Diffuse Reflective Photoelectric Switches
- Background Suppression Photoelectric Switches
- Fiber-Optic Photoelectric Switches
- Polarized Retroreflective Switches
- Capacitive Proximity Switches
- Inductive Proximity Switches

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
18 hours

LANGUAGE VARIATIONS
English, French, Spanish

HYDRAULICS AND PNEUMATICS SIMULATION SOFTWARE (LVSIM®-HYD & LVSIM®-PNEU)

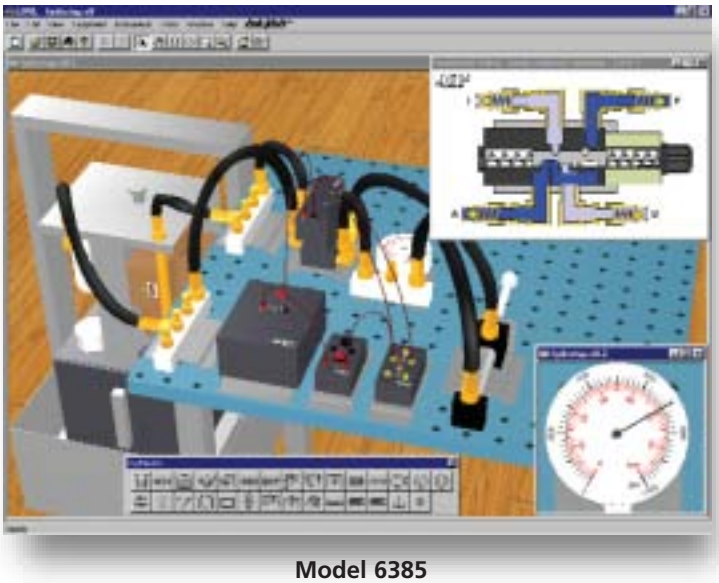
Model 6385 and 6485

The Hydraulics (LVSIM®-HYD) and Pneumatics (LVSIM®-PNEU) Simulation Software are Windows®-based programs that cover the same courseware as Hydraulics and Pneumatics Fundamentals (Models 6080-1 and 6081-1) and Electrical Control of Hydraulic and Pneumatic Systems (Models 6080-2 and 6081-2).

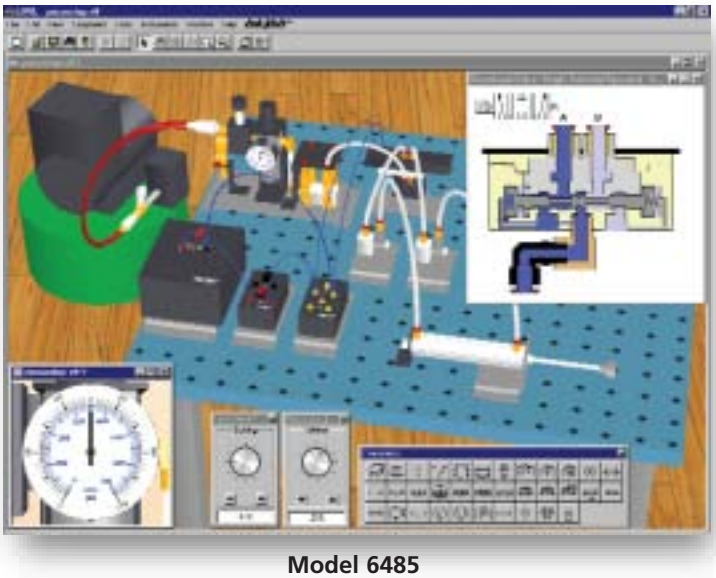
LVSIM®-HYD and LVSIM-PNEU® recreate a three-dimensional classroom laboratory on a computer screen. The actual equipment of the Lab-Volt Hydraulics & Pneumatics Training Systems is replaced with three-dimensional images, which students can manipulate on the computer screen. Using the mouse, students can install virtual hydraulic and pneumatic equipment in the laboratory, interconnect the equipment, perform a lab exercise, and obtain the same results as with the actual Lab-Volt training equipment.

Sophisticated mathematical models accurately simulate the mechanical and electrical characteristics of the hydraulic and pneumatic components (valves, cylinders, motors, flowmeter, and others) and electrical control devices (switches, relays, pilot lamps, etc.) in the actual Lab-Volt Hydraulics and Pneumatics Training Systems. All components and devices contained in the LVSIM®-HYD and LVSIM-PNEU® software feature the same functionality and appearance as the actual equipment. Detailed cutaway views of the components can be displayed to observe fluid flow inside components.

Used either as a complement to the actual Hydraulics or Pneumatics Training System or as a stand-alone product, LVSIM®-HYD and LVSIM®-PNEU are cost-effective tools that enable students to perform the experiments provided in the courseware mentioned above. Students may copy the LVSIM®-HYD or LVSIM®-PNEU software onto their own personal computers in order to practice and prepare in advance for their lab exercises. However, measurement capability is restricted by means of a security device.



Model 6385
Hydraulics Simulation Software LVSIM®-HYD.



Model 6485
Pneumatics Simulation Software LVSIM®-PNEU.

FEATURES

LVSIM®-HYD and LVSIM®-PNEU enable students to perform the following tasks:

- Install, move, and remove hydraulic and pneumatic components and electrical control devices
- Modify or remove connections at any time
- Zoom in or out to adjust the view
- Perform measurements of flow, pressure, force, velocity and rotation speed
- Observe motor rotation, as well as the extension and retraction of cylinder rods
- Observe fluid flow inside hydraulic and pneumatic components
- Save and restore equipment setups (including the virtual classroom laboratory environment)

VIRTUAL EQUIPMENT

All components from the subsystems for Fundamentals (Hydraulics-6080-1; Pneumatics-6081-1) and Electrical Control (Hydraulic Systems-6080-2; Pneumatic Systems-6081-2) are simulated in LVSIM®-HYD and LVSIM®-PNEU.

PERSONAL COMPUTER REQUIREMENTS

A Pentium personal computer, running under one of the following Microsoft® operating systems, Windows® NT, Windows® 98, Windows® ME, Windows® 2000, or Windows® XP is required to run this software.

LANGUAGE VARIATIONS

English, French, Spanish

FUNDAMENTAL FLUID POWER TRAINER
Model 6059

The Fundamental Fluid Power Trainer, Model 6059, is an introductory program in fluid power concepts, devices, and circuits. The comprehensive Fundamental Fluid Power Trainer includes two instructional trainer modules, and a correlated, two-volume set of student manuals plus instructor guides.

The Fundamental Fluid Power Trainer can be purchased as a complete training program (volumes 1 and 2), or in stages by purchasing Volume 1 and the Volume 2 at a later time. Volume 1 introduces fluid power principles. Volume 2 expands on these principles and covers new fluid power components.

Fluid power components are permanently mounted on removable trays that are stored in a lockable cabinet. Valves and cylinders are made of clear plastic to allow students to view internal parts and better comprehend component functions.

The two-volume set of manuals is presented in eight and six instructional units, respectively. Each unit covers a broad area of fluid power, and contains an objective, a discussion of fundamentals, and several practical exercises that present the material in small instructional segments. Following step-by-step procedures, each student builds simple fluid power circuits using pneumatic components that demonstrate the principles explained in the discussion.

TOPIC COVERAGE

Volume 1, Fundamentals of Fluid Power

- Getting to Know the Trainer
- Fluid Power Fundamentals
- Introduction to Fluid Power
- Compressors and Pumps
- Pressure-Control Valves
- Directional Controls
- Actuators
- Flow Measurement and Control

Volume 2, Fundamentals of Fluid Power

- Getting to Know the Trainer
- Pilot-Operated Valves
- Cam Operated Valves
- Solenoid Operated Valves
- Special Components
- Advanced Applications

FEATURES

- Self-contained cabinet with electric power supply and air compressor
- Easy-to-use controls
- SI and imperial units of measurements
- "Fix-it Shops" that illustrate everyday applications of concepts covered
- Manual, electric, and pilot control
- Clear plastic components to allow viewing of internal parts
- Transparent cabinet top to allow visual inspection and observation of pneumatic power source components

SYSTEM VOLTAGES

120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS

46 hours

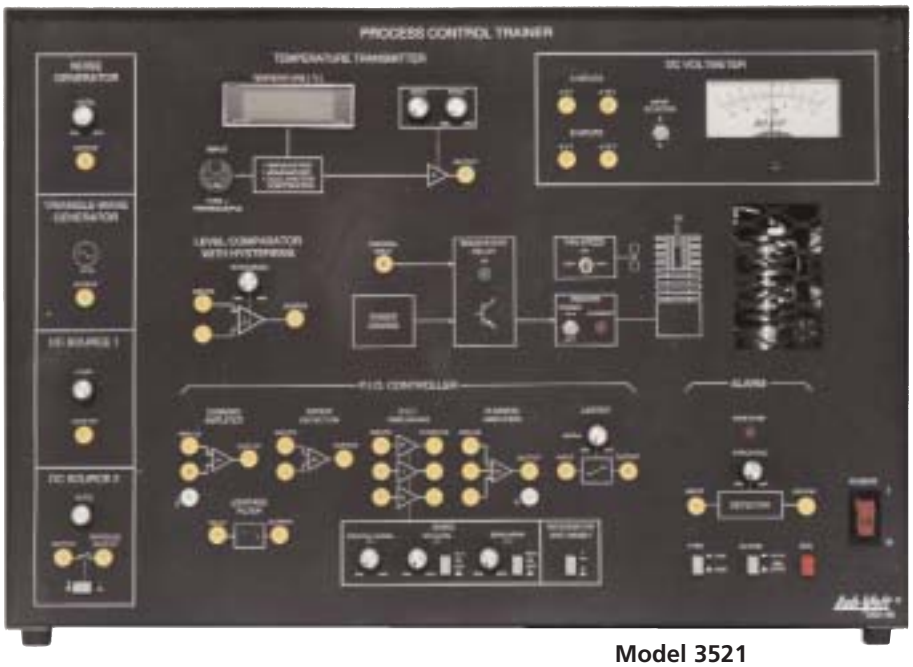
LANGUAGE VARIATIONS

English

INSTRUMENTATION AND PROCESS CONTROL
Sophisticated Training Systems for Measurement and Control of Flow, Level, Pressure, and Temperature
PRODUCT PROFILES

PROCESS CONTROL TRAINER
Model 3521

The Process Control Trainer, Model 3521, is a portable, bench-top unit designed to familiarize students with the fundamentals of Instrumentation and Process control. The trainer uses a temperature process whose characteristics can be altered to provide several degrees of stability and damping.



Model 3521

TOPIC COVERAGE
- Open-Loop Process Control
- Positive and Negative Feedback in Closed-Loop Process Control
- Basic Measurement Channel
- Basic Measurement Channel Instrument Characteristics
- Process Characteristics
- Two-Position Controller
- Proportional Controller
- Proportional Plus Integral Controller
- Proportional Plus Derivative Controller
- Proportional Plus Integral Plus Derivative Controller
- Alarms in Process Control Systems
- Troubleshooting

FEATURES
- Standard industrial grade components
- Silk-screen diagrams on module
- Temperature process with overheat protection
- Digital temperature meter
- Level comparator with adjustable hysteresis for on-off control
- Solid state relay able to supply up to 50 watts to the heating element and able to modify output power to alter the process dynamics
- Adjustable process dynamics
- Equipped for thermoelectric cooling/heating processes
- Temperature transmitter to introduce the concept of zero and span adjustments
- Proportional, Integral, Derivative (PID) controller with low pass filter, error detector, independent P, I and D amplifiers, summing amplifier and limiter, and integrator anti-reset
- Alarms capability, with selectable high-low alarm type and selectable latching/non-latching action
- DC source and DC voltmeter
- Triangle-wave generator
- Noise generator to study the effect of noise and filtering in process control
- Fault insertion capabilities
- Easy interface with computer for data acquisition or direct digital control through standard 0 to 5 Vdc input and output voltages

SYSTEM INTERFACES WITH
Lab-Volt Process Control Simulator (LVPROSIM), Model 3674

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
Open

LANGUAGE VARIATIONS
English, French, Spanish

TEMPERATURE/FLOW PROCESS TRAINING SYSTEM
Model 3522

The Temperature/Flow Process Training System, Model 3522, is a portable, bench-top unit designed to familiarize students with the fundamentals of instrumentation and process control. Advanced concepts such as cascade and feed-forward control can also be studied. The trainer provides a temperature process and a flow process. Process control is achieved through an external controller that is compatible with either standard 4-20 mA or 0-5 V signals.

TOPIC COVERAGE
- Familiarization with the Trainer
- Open-Loop Process Control
- Closed-Loop Process Control
- Measurement Channel Characteristics
- Process Characteristics
- Proportional (P) Control
- Proportional plus Integral (PI) Control
- Proportional plus Integral plus Derivative (PID) Control
- Open-Loop Tuning Method
- Ultimate-Cycle Tuning Method
- Troubleshooting Temperature and Flow Processes

FEATURES
- Temperature process including temperature sensor and transmitter, heater, and heater driver
- Temperature process control using either heating or cooling
- Flow process including venturi element, flow transmitter, fan, and fan driver
- Process control achieved through any external controller compatible with either standard 4-20 mA or 0-5 V signals
- Temperature and flow transmitters to introduce the concept of zero and span adjustments
- Fault insertion capabilities
- Easy interface with a computer for data acquisition
- Built-in power supply

SYSTEM INTERFACES WITH
Lab-Volt Process Control Simulator (LVPROSIM), Model 3674, through the Lab-Volt I/O Interface, Model 9065

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
Open

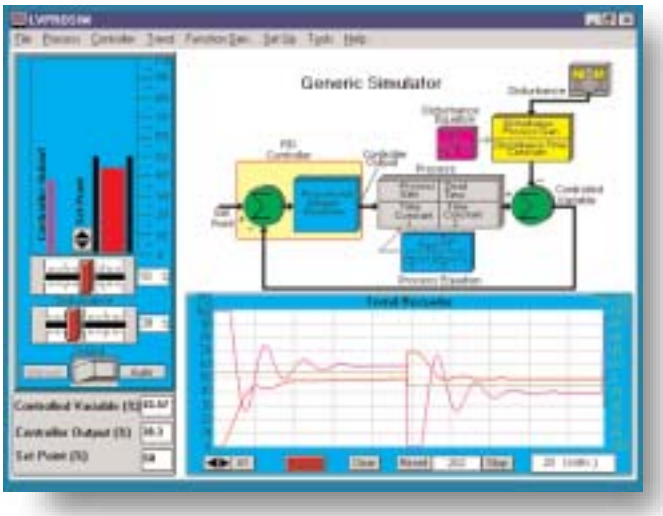
LANGUAGE VARIATIONS
English, French, Spanish

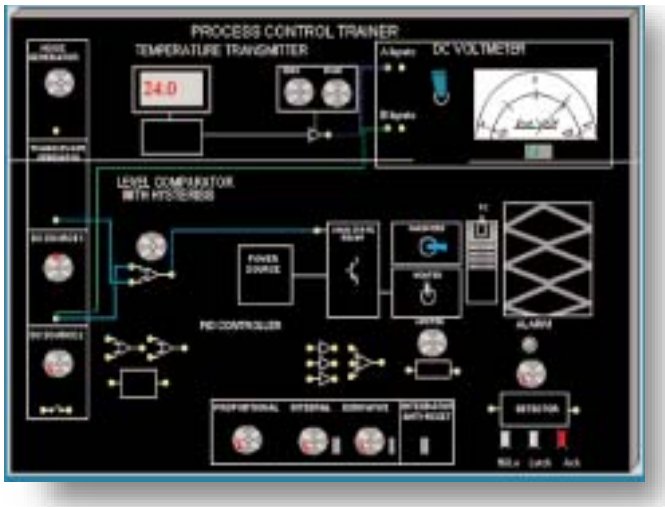
LVPROSIM - PROCESS CONTROL AND SIMULATION SOFTWARE
Model 3674

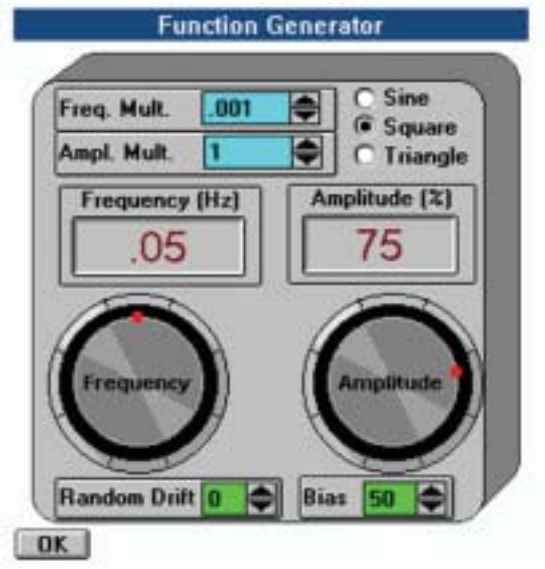
The Lab-Volt LVPROSIM - Process Control and Simulation Software, Model 3674, provides computer-based training in generic process control and simulation of the Lab-Volt Model 3521 Process Control Trainer.

Using the LVPROSIM software, students can simulate a generic process with system configurations for adjustable process time constants, dead time, process gain, and disturbance time constant. At the same time, students can use the software to study and simulate process dynamics and regulation, which they can later apply with the Lab-Volt Model 3521 Process Control Trainer.

LVPROSIM offers a selection of preconfigured experiments for the generic process simulator, as well as for the 3521 Process Control Trainer simulator. The students can also design new experiments for the generic process simulator. A series of pre-programmed tests can be selected from the main menu. User-defined tests and experiments can also be created using the test generator and experiment creator, which can be password protected to limit access to the instructor.







TOPIC COVERAGE
- Introduction to process control
  - Closed-loop control
- Process dynamics
  - Reaction curve of a first-order process
  - Frequency response of a first-order process
  - Reaction curve of a second-order process
  - Frequency response of a second-order process
- Proportional plus integral control mode
  - Open-loop response of a PI controller
  - Frequency response of a PI controller
  - Proportional plus integral control
- Proportional plus derivative control mode
  - Open-loop response of a PD controller
  - Frequency response of a PD controller
- The PID controller
  - Open-loop response of a PID controller
  - Tuning of a PID controller

FEATURES
- Trend recorder
- PID (Proportional, Integral, Derivative) Controller
- Function Generator
- Test function
- Self-tuning
- FOPDT (First Order Plus Dead Time) modeling

COMPUTER REQUIREMENTS
- Pentium type
- Windows® 95, Windows® 98, Windows® NT, Windows® 2000, or Windows® ME

ESTIMATED PROGRAM HOURS
35 hours

LANGUAGE VARIATIONS
English

PROCESS CONTROL TRAINING SYSTEM
Model 6090

The Lab-Volt Process Control Training System, Model 6090, familiarizes students with the fundamentals of instrumentation and process control. It demonstrates the control of pressure, flow, level, temperature, and pH processes. It can also demonstrate advanced process control techniques, such as feed-forward control, second-order control, and cascade control when used with a controller featuring these functions.

The basic trainer demonstrates PID (proportional, integral, derivative) control of flow, pressure, and level processes. It comes with a variable-speed pump, a tank, a column, two-way valves, pressure gauges, flexible hoses, a venturi tube, an orifice plate, a rotameter, a paddle wheel flow transmitter, and a differential pressure transmitter. A work surface, consisting of a solid metal perforated plate hinged to a drip tray, provides a large area on which components can be mounted.

Mounting and removal of the components are made especially easy with push-lock fasteners that snap effortlessly into the perforations of the work surface. The components can be interconnected by means of flexible hoses equipped with quick disconnect fittings that permit easy and fast component connections without the use of tools. The hose fittings contain check valves to prevent water from running out of the hoses when they are disconnected.

The trainer processes can be controlled by a computer-based PID Controller implemented with a personal computer, the included Process Control and Simulation Software (LVPROSIM), Model 3674, and the I/O Interface, Model 9065. Any conventional PID controller compatible with standard 4-20 mA or 0-5 V signals can also be used.

Model 6090-1
Shown with optional equipment

To demonstrate PID control of temperature process, additional components can be added to the basic trainer. The additional components include a heating unit, a cooling unit, and temperature transmitters. Cascade and second-order process control can also be studied with the basic trainer by having the students from two workstations work together at a single workstation.

The pH Process Control System allows students to learn fundamentals of pH control by studying acidic, basic, and buffer solutions. They also learn how to characterize pH processes and how to control basic and complex pH processes using different methods. The system includes sampling pumps, chemical tanks, pH transmitter, pH controller, and many accessories.

TOPIC COVERAGE

Pressure, Flow, and Level Process Control

- Introduction to Process Control
  - Familiarization with the Training System
- Pressure Processes
  - Pressure Measurement
  - Pressure Losses
  - Centrifugal Pumps
  - Characterization of a Pressure Process
- Flow Processes
  - Rotameters and Paddle Wheel Flow Meters
  - Orifice Plates
  - Venturi Tubes
  - Permanent Pressure losses Compared
  - Characterization of a Flow Process
- Level Processes
  - Float Switches
  - Differential-Pressure Level Meters
  - Zero Suppression and Zero Elevation
  - Wet Reference Legs
  - Characterization of a Level Process
  - Bubblers (Optional Exercise)
- PID Process Control
  - Pressure Process Control
  - Flow Process Control
  - Level Process Control
  - Cascade Process Control (Optional Exercise)
  - Second-Order Process Control (Optional Exercise)

Lab-Volt Process Control Training System, Model 6090
(Continued)

Model 6090-2

Model 6090-3

Temperature Process Controls

- Introduction to Temperature Process Control
  - Familiarization with the Training System
- Temperature Measurement
  - Resistance Temperature Detectors (RTD's)
  - Thermocouples
  - Thermal Energy Transfer in Temperature Processes
- Characterization of a Temperature Process
  - Characterization of a Temperature Process in the Heating Mode
  - Characterization of a Temperature Process in the Cooling Mode
- PI Control of Temperature Processes
  - PI Control of a Temperature Process in the Heating Mode
  - PI Control of a Temperature Process in the Cooling Mode

pH Process Control

- Introduction to pH Process Control
  - Familiarization with the Training System
- pH Processes
  - pH Measurement
  - Titration Curves of Strong Solutions
  - Titration Curves of Weak Solutions
  - Titration Curve of Buffer Solutions
- Characterization of pH Processes
  - pH Characterization of a Strong Solution
  - pH Characterization of a Weak Solution
  - pH Characterization of a Two-Stage Reactor
- pH Process Control
  - pH Process Control Using a PID Controller
  - pH Process Control Using a On-Off Controller
  - pH process Control Using Two Controllers

FEATURES

- Modular design
- Pressure, flow, and level processes
- Optional sets of components are available to implement temperature process
- Designed for use with any PID controller compatible with either 4-20 mA or 0-5 V signals
- Work surface can be configured to accommodate a wide variety of space and training needs
- Components mount easily on the work surface through push-lock fasteners
- Easy component interconnection through flexible hoses terminated with quick-connect fittings
- Optional equipment (Models 3674 and 9065) provides interface with a computer for data acquisition and process control
- Optional workbench and dressing panels are available to provide the work surface with mobility and storage space
- Comprehensive courseware
- Cost-effective alternative to systems using industrial grade components

ESTIMATED PROGRAM HOURS

Pressure, Flow, and Level Process Control:	50 hours
Temperature Process Control:	30 hours
pH Process Control:	30 hours

MOBILE INSTRUMENT & PROCESS CONTROL TRAINING SYSTEM
Model 3500-MO

Model 3501

Model 3503

Model 3502

Model 3504

The Mobile Instrumentation and Process Control Training System, Model 3500-M0, is a series of self-contained mobile workstations that provide hands-on training in the measurement, control, and troubleshooting of Pressure, Flow, Level, Temperature, Heat Exchanger, and Analytic Process Loops.

Each workstation, which is constructed on a sturdy steel frame with casters, can operate independently or in combination configurations to simulate complex processes which simulate real-world time lag and process responses.

The course begins with the basic characteristics of the major process variables: pressure, flow, level, and temperature - and progresses to measurement devices and calibration of sensors, transducers, and transmitters. From there, students learn the principles and operation of the microprocessor-based controller and progress to the basics of closed loop control and methods of controller tuning.

FEATURES
- Fault-insertion capabilities
- Patch-connected signal conditioners, controllers, and transmitters to permit alternate control schemes and for flexibility in incorporating new technology as it is developed
- Realistic process response times
- Multi-element and ratio control capability
- Microprocessor-based controllers
- Comprehensive courseware

COMPRESSED AIR REQUIREMENT
700 kPa (100 psi) at 0,95 l/s (2 SCFM) of dry air to each station

COMPUTER CONTROL SYSTEM
- Supervisory Control and Data Acquisition (SCADA)
- Alarms
- Graphics

SYSTEM ENHANCEMENTS
- Calibration Station
- Computer Process Control Trainer
- Flow Elements - Flow and Level Stations
- Flow Assemblies - Flow Station

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

PRESSURE PROCESS STATION
Model 3501-MO

The Pressure Process Station, Model 3501-M0, consists of two air tanks that can be patch-connected individually, in series, or in parallel. Used individually, each tank demonstrates a single capacity process with single volume and minimal lag; connected in parallel, the tanks demonstrate a single capacity process with dual volume; and connected in series, the tanks show a dual capacity process, both with interacting lag.

The process load consists of an exhaust assembly connected to a muffler. Needle valves at the tank connections and exhaust assembly permit the introduction of demand and supply disturbances and allow for varying degrees of restriction to all loop configurations, thereby providing a variety of process rates and responses. An I/P converter, electronic pressure transmitter, and diaphragm-actuated valve have all supply and signal lines terminated at quick-connect fittings on the main control panel. Mounted on the main panel are the microprocessor-based controller, strip chart recorder, pressure gauges, flowmeter, orifice assembly, and two alarm lamps.

Supporting courseware is written specifically for the Mobile Pressure Process Station.

TOPIC COVERAGE
- Pressure Transmitter Time Response Characteristics
- Pressure Process Characteristics
- Pressure Process Proportional Control
- Pressure Process Proportional and Integral Control
- Pressure Process Proportional and Integral and Derivative Control
- Notch Tuning of a Pressure Process
- Ultimate Period Tuning of a Pressure Process
- Open Loop Tuning of a Pressure Process
- Operation of a Pressure Measurement Channel
- Troubleshooting a Pressure Measurement Channel
- Operation of a Pressure Control Channel
- Troubleshooting a Pressure Control Channel
- Calibration of an Air Flow Transmitter
- Air Flow vs Differential Pressure for an Orifice
- Operation of an Air Flow Measurement Process
- Troubleshooting an Air Flow Measurement Process
- Operation of an Air Flow Control Process
- Troubleshooting an Air Flow Control Process

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
40 hours

LANGUAGE VARIATIONS
English, French, Spanish

FLOW PROCESS STATION
Model 3502-MO

The Flow Process Station, Model 3502-M0, has clear PVC pipes in series with two header assemblies, a flowmeter, and a water reservoir. The header can receive optional, interchangeable assemblies for the measurement of flow, including orifice plates, pitot tubes, and other flow measuring instruments or transmitters. The large header allows for differential pressure measurement across customer-specific assemblies, such as a series of 90-degree elbows or sudden enlargement pipe. Mounted on the main control panel are the microprocessor-based controller and strip chart recorder with all connections terminated at banana jacks.

Coupling unions allow the Flow Process Station to be directly coupled with the Level Process Station, thereby creating Flow control using a diaphragm-actuated control valve as the control element, or level control using the variable frequency pump drive. Coupling the two stations also provides for the two differential transmitters necessary to configure more advanced interactive control loops such as feedforward or cascade control. A venturi element mounted in a header assembly is included with the station.

Supporting courseware for this system is written specifically for the Flow Process Trainer.

TOPIC COVERAGE
- Flow Transmitter Time Response Characteristics
- Flow Process Characteristics
- Flow vs Differential Pressure for a Venturi
- Calibration of a Flow Transmitter
- Flow Process Proportional Control
- Flow Process Proportional and Integral Control
- Flow Process Proportional and Integral and Derivative Control
- Ultimate Period Tuning of a Flow Process
- Notch Tuning of a Flow Process
- Open Loop Tuning of a Flow Process
- Operation of a Flow Measurement Channel
- Troubleshooting a Flow Measurement Channel
- Operation of a Flow Control Process
- Troubleshooting a Flow Control Process
- Bottom Drain Level Control
- Emergency Feed Water Injection System

FEATURES
- All required, switches, manometers, patchcords, hoses, and flow elements included in process stations
- Transparent piping for student observation of system operation
- Interconnectable workstations to allow training in complex systems
- Quick disconnects for rapid system configuration
- Multi-element and ratio control capability
- Standard industrial instrumentation

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
45 hours

LANGUAGE VARIATIONS
English, French, Spanish

LEVEL PROCESS STATION
Model 3503-MO

The Level Process Station, Model 3503-M0, contains a Plexiglas cylinder with diaphragm-actuated control valve, pipe-mounted differential transmitter and I/P converter mounted on the side of the cabinet and terminated at quick-connect fittings on the main control panel. Also mounted on the main panel are the microprocessor-based controller, strip chart recorder, and two alarm lamps. A regulator needle valve controls air flow to a bubbler pipe for level measurement. In addition, at the base of the level column are two valved taps to permit connection of the D/P cell, optional manometers low-pressure gauges, and wet leg standpipe.

Coupling unions allow the Level Process Station to be directly coupled with the Flow Process Station, thereby permitting flow control using a diaphragm-actuated control valve as the control element. Coupling of these two stations provides the two differential transmitters necessary to configure more advanced interactive control loops such as feed-forward and cascade control.

Supporting courseware is written specifically for the Mobile Level Process Station.

TOPIC COVERAGE
- Level Transmitter Time Response Characteristics
- Level Process Characteristics
- Calibration of a Level Transmitter
- Level Measurement with a Bubbler
- Level Measurement with an Open Tank
- Level Measurement with Zero Suppression
- Level Measurement with a Wet Reference Leg
- Level Process Proportional Control
- Level Process Proportional and Integral Control
- Level Process Proportional Integral and Derivative Control
- Notch Tuning of a Level Process
- Ultimate Period Tuning of a Level Process
- Open loop Tuning of a Level Process
- Operation of a Level Measurement Channel
- Troubleshooting a Level Measurement Channel
- Operation of a Level Control Process
- Troubleshooting of Level Control Process
- Operation of a Flow Measurement Channel
- Operation of Flow Control Process
- Operation of a Two-Element Control Process
- Operation of a Three-Element Control Process

FEATURES
- All required gauges, switches, manometers, patch-cords, hoses, and flow elements included in process station
- Transparent piping and valves for student observation of system operation
- Interconnectable workstations to allow training in complex systems
- Quick disconnects for rapid system configuration
- Multi-element and ratio control capability
- Standard industrial instrumentation

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

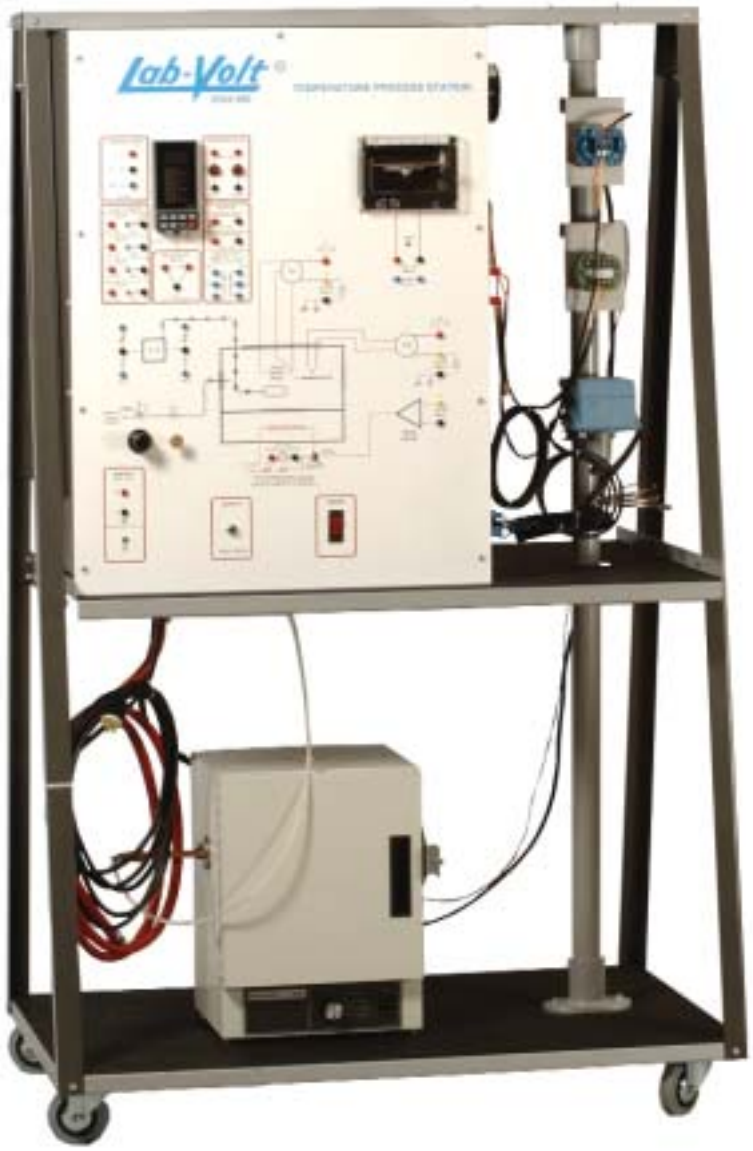
ESTIMATED PROGRAM HOURS
Open

LANGUAGE VARIATIONS
English, French, Spanish

TEMPERATURE PROCESS STATION
Model 3504-MO

The Temperature Process Station, Model 3504-M0, consists of a 20-200^0 C (70-400^0 F) oven operated manually as an on-off process using a 24 Vdc relay, or proportionally controlled by a triac driver with 4-20 mA input. The oven is modified with an air cooling injector and adjustable damper for load and process disturbances.

The unit features a pipe-mounted on-off capillary bulb temperature controller with two sets of contacts terminated at banana jacks on the main control panel. Also featured are a pipe-mounted thermocouple to current temperature transmitter, complete with type "J" thermocouple, and RTD to current transmitter, complete with 100-Ω platinum RTD, with all supply and signal connections terminated at banana jacks on the main control panel. Mounted on the control panel are the microprocessor-based controller, strip chart recorder, two alarm lamps, and a pneumatic air regulator.



TOPIC COVERAGE
- Temperature Transmitter Time Response Characteristics
- Temperature Process Characteristics
- Calibration of a Temperature Transmitter
- Temperature Measurement with a Thermocouple
- Temperature Measurement with an RTD
- On-Off Temperature Control
- Temperature Process Proportional Control
- Temperature Process Proportional Plus Integral Control
- Temperature Process Proportional, Integral, Plus Derivative Control
- Notch Tuning of a Temperature Process
- Ultimate Period Tuning of a Temperature Process
- Open Loop Tuning of a Temperature Process
- Operation of a Temperature Measurement Channel
- Troubleshooting a Temperature Measurement Channel
- Operation of a Temperature Control Process
- Troubleshooting a Temperature Control Process
- Hard-wired Alarms Using Capillary Bulb Switch
- Microprocessor-Based Controller Software Alarms

FEATURES
- Quick disconnects for rapid system configuration
- Standard industrial instrumentation

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
Open

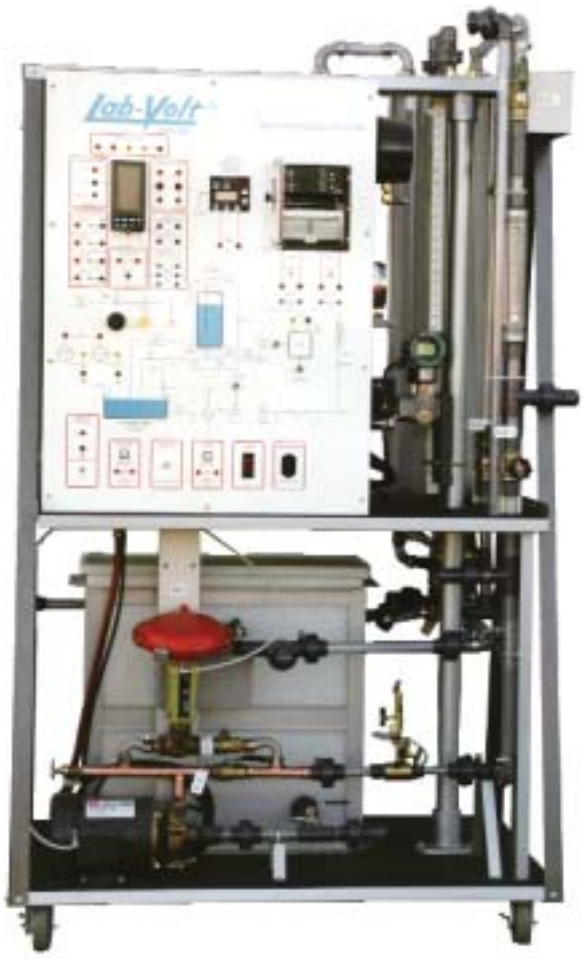
LANGUAGE VARIATIONS
English, French, Spanish

MULTI-PROCESS STATION
Model 3505

The Multi-Process Station, Model 3505, consists of a Plexiglas cylinder, an inner column for dual volume process characteristic, a pump, a diaphragm-actuated control valve, two pipe-mounted differential pressure (D/P) transmitters, and a current-to-pressure (I/P) converter. A microprocessor-based controller, a variable frequency AC drive, a dual-pen strip chart recorder, and two alarm lamps are also mounted on the main panel. A regulator needle valve controls air flow to a bubbler pipe for level measurement.

In addition, at the base of the level column are two valve taps that permit connection of the D/P cell or optional manometers. A low-pressure gauge and a compound-pressure gauge are mounted on the side of the control cabinet. A pressure cap on the level process tank permits level control of a pressurized vessel. Two headers allow insertion of flow measurement devices on both the inflow and the outflow of the level process tank. The station includes a rotameter flow indicator in series with the process piping, and a Venturi flow-element.

Coupling unions allow the Multi-Process Station to be directly coupled to other stations to achieve more advanced interactive control loops such as temperature, pH, and ratio control. Pressure taps are provided on the system piping to permit measurement of pressure drops around the system and to thoroughly evaluate system performance.



TOPIC COVERAGE
- Level Measurement I - Dry Method using a Bubble Pipe
- Level Measurement II - Calibration of a Level Transmitter
- Pressure Measurement
- Flow Measurement: Differential Pressure vs Flow Using a Venturi or Orifice Plate
- Level Process Characteristics with Control Valve
- Level Process Characteristics with Variable Speed Pump
- Flow Process Characteristic with Control Valve
- Pressure Process Characteristics
- Proportional Control - Level Process with Control Valve
- Proportional Control - Flow Process with Variable Speed Pump
- Proportional Plus Integral Control - Level Process with Control Valve
- Proportional Plus Integral Control - Pressure Process
- Proportional Plus Integral Plus Derivative Control - Level Process with Control Valve
- Proportional Plus Integral Plus Derivative Control - Flow Process with Variable Speed Pump
- Ultimate Period Tuning of a Level Process
- Ultimate Period Turning of a Flow Process-Approximation Method
- Open Loop Tuning of a Level Process using the Reaction Rate Method
- Open Loop Tuning of a Pressure Process
- Troubleshooting a Level Control Process
- Operation of a Two-Element Control Process
- Three-Element Control Process
- Auto-Tune Controller

FEATURES
- All required gauges, switches, manometers, patch cords, hoses, and flow elements are included
- Transparent piping and valves for student observation of system operation
- Interconnectable workstations to allow training in complex systems
- Quick-disconnect fittings for a rapid system configuration
- Multi-element and ratio control capability
- Standard industrial instrumentation

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
Open

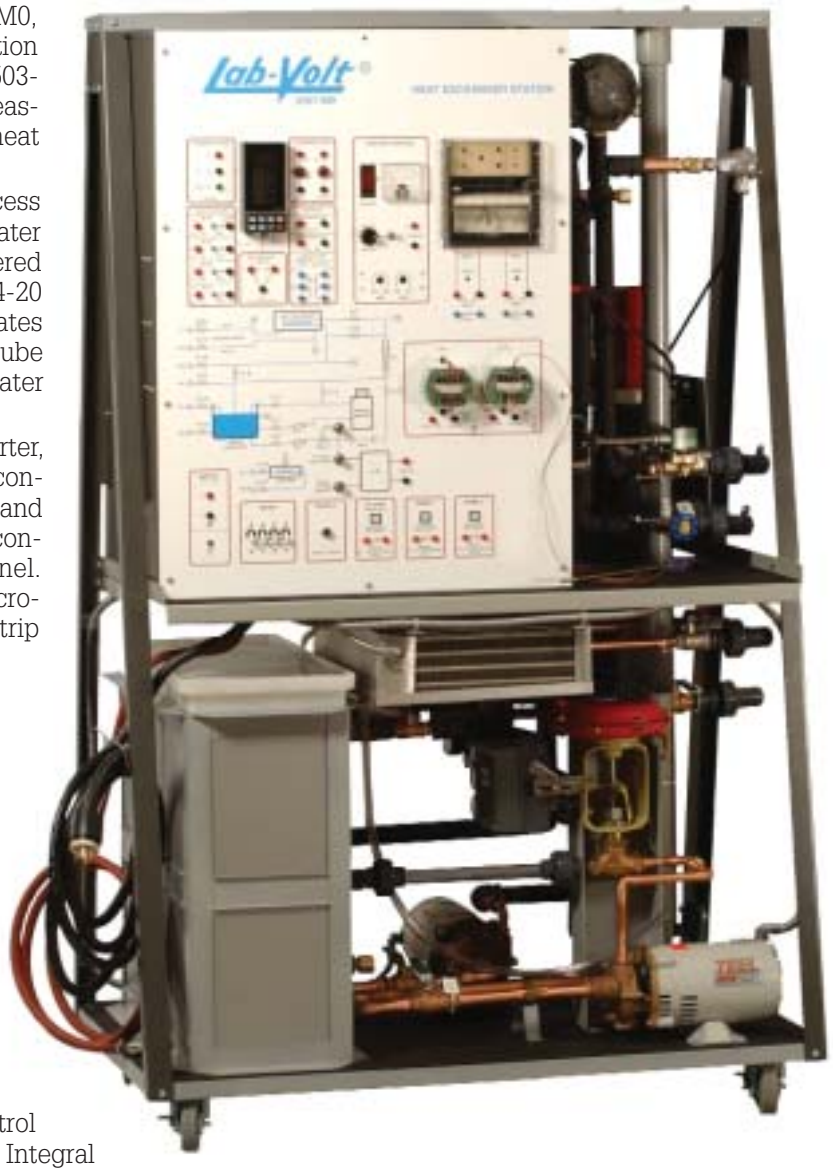
LANGUAGE VARIATIONS
English

HEAT EXCHANGER STATION
Model 3507-MO

The Heat Exchanger Station, Model 3507-M0, is an add-on station requiring interconnection with the Level Process Station, Model 3503-MO, providing hands-on training in the measurement and control of temperature and heat exchanger processes.

The process consists of a water process tank with two pumps: one circulates water through a 6-kW electric water heater powered by a three-phase solid state drive with a 4-20 mA driver control circuit; the other circulates water through the tube side of a shell and tube heat exchanger, and then returns it to the water process tank.

Supply and signal lines to an I/P converter, RTD to current, thermocouple to current converters, diaphragm-actuated control valve, and solid state drive are terminated at quick-connect fittings on the main control panel. Mounted on the main panel are the microprocessor-based controller, a two-pen strip chart recorder, and pump controls.



TOPIC COVERAGE
- Temperature Measurement Using a Thermocouple
- Temperature Measurement Using an RTD
- Calibration of a Thermocouple Transmitter
- Calibration of a RTD Transmitter
- Response Time Comparison: Thermocouple vs RTD
- Temperature Process Characteristics
- Operation of a Temperature Measurement Channel
- Temperature Process - Proportional Control
- Temperature Process - Proportional Plus Integral Control
- Temperature Process - Proportional Plus Derivative Control
- Temperature Process - Proportional Plus Integral Plus Derivative Control
- Temperature Process - Triac Drive Heater Control
- Calibration of a Control Valve
- Temperature Control Loop - Cooling Process
- Two-Element Temperature/Flow Control Loop
- Two-Element Temperature/Level Control Loop
- Cascade Control Loop
- Feed-Forward Control

FEATURES
- Industrial shell and tube heat exchanger
- Self-contained, cold water supply with fan-cooled chiller and separate recirculating pump
- Self-contained, hot water supply with a triac-controlled heater and separate recirculating pump
- Diaphragm control valve to control the hot water process
- Manual valves to select and disturb processes
- Thermowells to monitor temperature
- Capable of demonstrating most common boiler control systems when connected to the Level Process Station, Model 3503-MO

SYSTEM VOLTAGES
120/208 V, 60 Hz, 3 phases
220/380 V, 50 Hz, 3 phases
240/415 V, 50 Hz, 3 phases

ESTIMATED PROGRAM HOURS
Open

LANGUAGE VARIATIONS
English

ANALYTIC PROCESS STATION
Model 3508-MO

The Analytic Process Station, Model 3508-M0, is an add-on system process station which requires interconnections with the Lab-Volt Model 3503-MO Level Process Station.

The add-on unit offers an alternative for classes small enough to allow use of the level station as part of the analytic process. The trainer consists of a main water circulation system with a water heater, pump, cartridge-type demineralizer, and water reservoir. A variable-speed sampling pump draws water from the reservoir and circulates it through a path containing one pH and one conductivity transmitter, then returns it to the reservoir.

The unit features expanded microprocessor-based PID Controller, two-pen recorder, pH transmitter, conductivity monitor, one sampling pump, two chemical metering pumps, pH and temperature meter, dissolved oxygen meter, temperature transmitter, electric water heater, thermostat control, two chemical reservoirs, piping, and valving.

TOPIC COVERAGE
- Measurement of pH
- Relationship of pH and Temperature
- Measurement of Dissolved Oxygen
- Manual pH Control for Acid Range 0-7
- Manual pH Control for Base Range 7-14
- Automatic pH Control
- Automatic pH Control Near Neutral pH 7.0

FEATURES
- Variable-speed, recirculating pump, for processing and mixing
- Two tanks for acid and base feeds that are piped into the main process tank by variable-speed, electronically controlled, metering pumps
- Demineralizer
- Conductivity and pH transmitters
- Microprocessor-type Water Analyzer with measurements in temperature, dissolved oxygen, pH, and conductivity

SYSTEM INTERFACES WITH
Lab-Volt 3503-MO Level Process Control Trainer

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
21 hours

LANGUAGE VARIATIONS
English

INSTRUMENTATION AND CALIBRATION STATION
Model 3550-MO

The Instrumentation and Calibration Station, Model 3550-M0, is a workstation designed for basic study of the operation and calibration of instruments. Complete with its own regulated instrument power supply, this workstation functions as a two-student instrument bench.

The station has a pipe stand for instrument mounting, a digital multimeter with analog bar graph display (Fluke), a digital instrument calibrator for mV, mA and V inputs, and an AC Duplex receptacle with a lighted circuit breaker. The station has two regulated-pressure air outputs with large pressure indicator.

Options such as a mobile bench or other calibrators are also available.

TOPIC COVERAGE
- Calibration of a Pressure Gauge
- Calibration of a Pressure Transmitter
- Calibration of a Differential Pressure Transmitter
- Calibration of a Temperature Transmitter
- Calibration of a Current to Pressure Converter
- Calibration of a Strip Chart Recorder
- Alignment of a Control Valve

SYSTEM VOLTAGES
120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS
15 hours

LANGUAGE VARIATIONS
English, French, Spanish

WEB-BASED INDUSTRIAL TRAINING

Delivering the Difference in Industrial Training with E-learning and CD-ROM-Based Courses

Industrial Training Zone by Lab-Volt delivers a broad range of online and CD-ROM-based fundamental and specialty industrial training courses designed to help instructors build a more competent, qualified, and efficient workforce.

Engaging training systems feature 3D simulations, course narrations, a virtual guide, testing, and quizzes to promote learning retention and use on the job.

Courses are available online or via CD-ROM. Each Online CoursePack™ contains one training pass (good for one student to take one course), an online reference manual, online assessment and certification passes, and a ToolBox™ user account. Each CD CoursePack™ contains a CD training perpetual license, course-specific CD and printed reference manual, online assessment and certification passes, and a ToolBox™ user account.

Mechanical, Electrical, and Fluid Power training programs for both industry and mobile systems are available online or via CD-ROM.

FEATURES

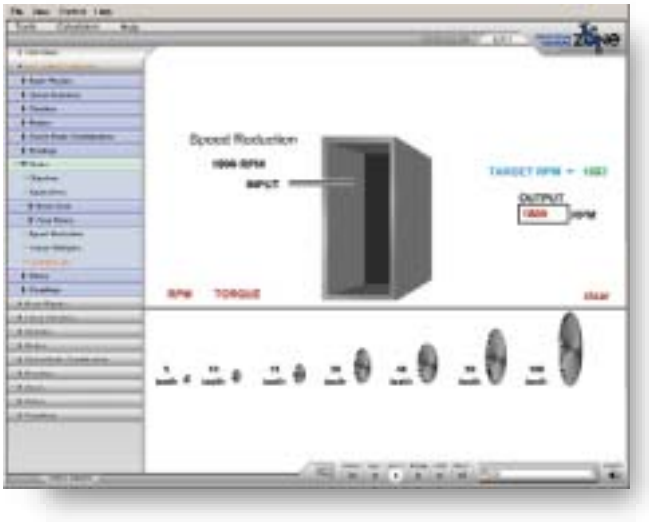
- Premier training interface organizes curriculum in a logical sequence
- Interactive learning builds content mastery and troubleshooting expertise
- Pre- and post-test certification ensures mastery of skills
- 3D animations illustrate in real time how equipment works
- Self-paced learning increases retention and job skills
- Video narrations guide training step by step
- Courseware is updated and reviewed regularly to ensure accuracy

MECHANICAL TRAINING

Lab-Volt's Industrial Mechanical Course, Model 47904, gives trainees an overview of the basic physics laws, schematics, and systems design associated with mechanical power transmissions. Trainees learn about the various components found in a typical mechanical system, and how these components function and interact with each other.

TOPIC COVERAGE

- Review energy, torque, and horsepower
- Learn how linear actuators convert rotational motion into linear motion



Model 47904
Mechanical Speed Reduction Learning Lab

- Compare clutches and their components, capabilities, and applications
- Understand how bearings are used within mechanical power transmissions
- Review gears, how they operate, and when they are best used to transmit power
- Review belt and chain drives, how they are designed, and their operation
- Study the features, applications, and functions of different couplings

PLC FUNDAMENTALS

The Programmable Logic Controller (PLC) course delivers an interactive training experience designed to teach trainees PLC operation, how to connect devices to a PLC, and how to read and write basic PLC ladder-logic software programs.

TOPIC COVERAGE

- Learn how PLC hardware differs from other computers
- Discover the math functions related to PLCs
- Learn how PLC systems store data, memory processes, and data operations
- Master the language of PLCs and learn how to upload to and download from a PLC
- Apply logic to a process by connecting your PLC to another device
- Link your PLC to your production time, and control when operations happen
- Tally the quantity of your automated processes with PLC counters

WEB-BASED INDUSTRIAL TRAINING
For Fluid Power Applications

HYDRAULICS TRAINING

Lab-Volt offers online and CD-ROM-based hydraulics training for both industrial and mobile markets. The Industrial Hydraulics course familiarizes students with the components, functions, and interactions of hydraulic systems. Mobile Hydraulics covers the basics of hydrostatic transmissions, valves, and maintenance systems common to most combustion engines.

TOPIC COVERAGE

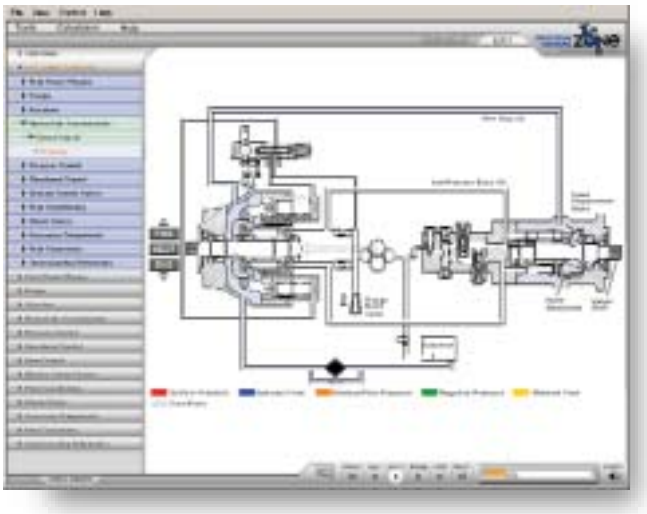
Industrial Hydraulics, Model 47901

- Review horsepower, torque, heat, flow, and pressure
- Study gear, vane, and piston pumps, and their fluid displacement capabilities and applications
- Study force manipulation using control valves, the two basic designs and their operation
- Observe how directional control valves operate, start, stop, and change the direction of fluid flow
- Study fluid conditioning and temperature implications
- Understand the function of different valves and where they are used
- Study conductors and how they carry fluid to various components in hydraulic circuits
- Review basic symbols and layout of a hydraulic schematic
- Study components, pictures, and labeling of hydraulic power units

Mobile Hydraulics, Model 47906

- Learn how actuators convert hydraulic horsepower into mechanical horsepower
- Study the basic operation of hydrostatic circuits
- Study force manipulation using control valves
- Experience the application and location of flow control valves
- Learn how modular control valves enhance system design
- Study fluid conditioning and temperature implications
- Study how conductors carry fluid to various components in hydraulic circuits
- Review basic symbols and layout of a hydraulic schematic

3D Simulation of a Piston Pump



Cutaway View of a Closed Circuit Hydrostatic Transmission

WEB-BASED INDUSTRIAL TRAINING
For Fluid Power Applications

PNEUMATICS TRAINING

Lab-Volt's Industrial Pneumatics course focuses on the basic physics laws, schematics, and system design associated with pneumatic systems and fluid power.

In addition to this course, a Pneumatic Specialist course has been developed in collaboration with the Fluid Power Society and CFC-Solar to help trainees understand the concepts related to the successful design and interaction of pneumatic systems as a Certified Pneumatic Specialist.

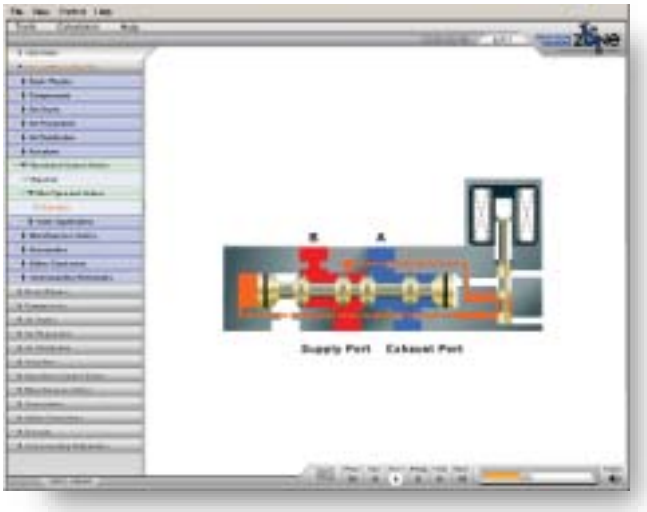
TOPIC COVERAGE

Industrial Pneumatics, Model 47902

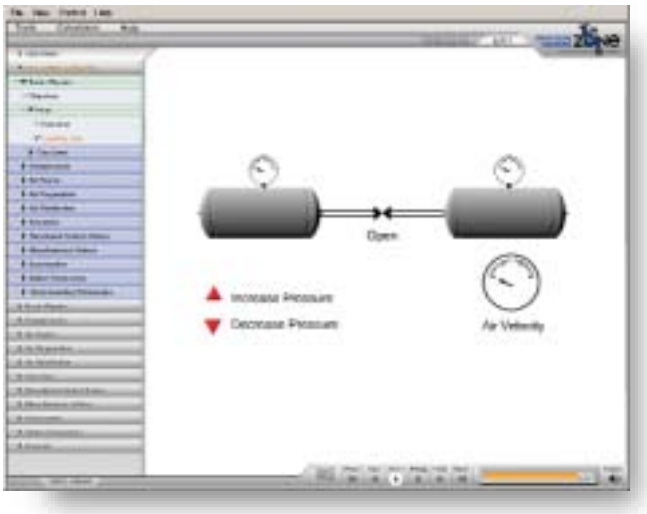
- Review energy, torque, and horsepower
- Safely and efficiently operate compressors
- Discover the way air is dried to help preserve metal parts exposed to air pressure
- Study the steps to filter, regulate, and lubricate air before use
- Review the designs, techniques, port layouts, and pressure configurations for operation
- Learn interface components that convert pneumatic energy into mechanical energy
- Review airline conductors and how they carry air throughout the pneumatic circuit
- See demonstrations on how vacuum is created to help systems work
- Identify the basic symbols of a pneumatic schematic and learn to read system layouts

Pneumatic Specialist, Model 47909

- Review ratios, torque, speed, and friction
- Compute air cylinder pressure and identify the fault in a pneumatic circuit
- Study air cylinder velocity, circuits, conductor sizes, and input components
- Calculate pressure, cfm, oil flow rate and pressure, torque output, and kinetic energy
- Analyze control components and systems such as electrical, position feedback, series-parallel, pneumatic, and logical control circuits
- Prepare for the certification exam using the study guide and other references



Overview of Pilot-Operated Valves



Pressure Differential Learning Lab

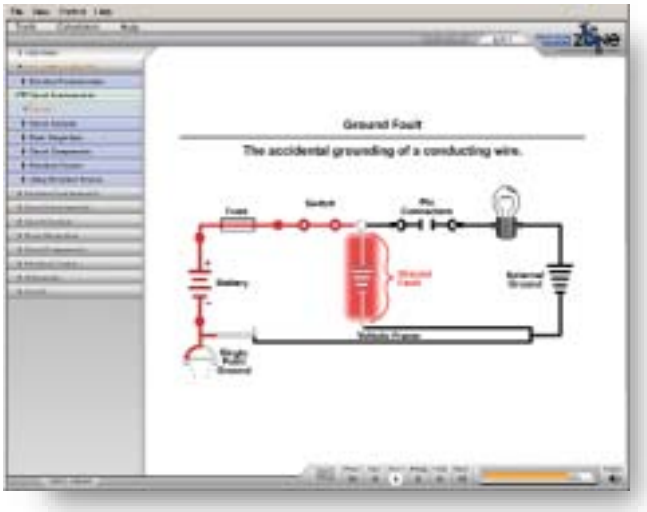
WEB-BASED INDUSTRIAL TRAINING
Electricity & Electronics

Electrical Training

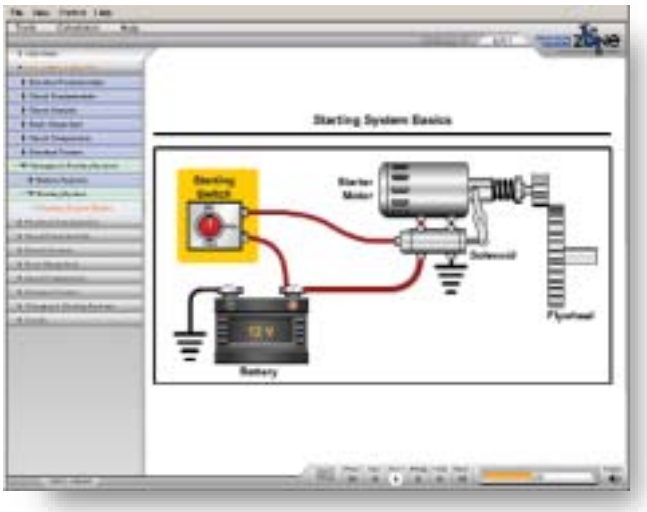
Lab-Volt's Industrial Electrical course delivers an interactive training experience designed to help trainees understand the fundamental concepts of electrical systems. This course is popular among those who need to understand the workings of electrical systems on the production floor.

Mobile Electrical covers electrical systems of mobile equipment, including the basic electrical system common to most combustion engine vehicles.

AC/DC Motor and Drives helps trainees understand how electrical motors and drives work with each other and other systems. Trainees also learn about the safety considerations associated with operating electromechanical systems.



Demonstration of a Ground Fault



Overview of Charging & Starting Systems

TOPIC COVERAGE

Industrial Electrical, Model 47903

- Review basic physics laws that govern electrical systems
- Study circuit components and laws governing circuit voltage and current
- Analyze the effects of circuit components connected in various configurations
- Learn how magnetic fields interact with each other
- Understand how electrical circuit components convert electrical energy into other energy forms
- Review how technology has improved electrical testing, and study safety guidelines

Mobile Electrical, Model 47907

- Review basic physics laws that govern electrical systems
- Study circuit components and laws governing circuit voltage and current
- Analyze the effects of circuit components connected in various configurations
- Learn how magnetic fields interact with each other
- Understand how electrical circuit components convert electrical energy into other energy forms
- Study how lead-acid batteries operate, and how charging and starting systems work in most combustion engine vehicles

AC/DC Motors and Drives Model 47908

- Basic terms and principles of motors and drives
- How torque and magnetism produce power
- Learn what to consider when selecting a replacement drive
- Review fuses and filtering devices
- Learn what causes electrostatic discharge and how to avoid this
- Learn about the functions, components, and firmware of different drives
- Compare different braking methods and their advantages and disadvantages
- Study five different electrical measuring tools used to diagnose problems
- Program, maintain, and troubleshoot drives using a human interface module (HIM)

The Ultimate Manufacturing/Mechatronics Training System

For Jobs in CAD/CAM, Robotics, and CNC

As a long-standing leader in industrial technical training systems, Lab-Volt is proud to offer this line of products for hands-on training in automation and robotics. This line of equipment, software, courseware, and accessories is designed to provide students with industry-standard training in integrated manufacturing technology and processes that will prepare them for entry-level jobs in an automated manufacturing environment.

All Lab-Volt Automation products are designed for use in a variety of classroom configurations. They are safe, table top applications, and include high-precision equipment, integrated software, and comprehensive courseware that encompass a wide range of manufacturing applications. The complete line of Lab-Volt Automation products includes:

PLC TRAINING SYSTEM
Model 3240

MANUFACTURING CONVEYOR SYSTEM
Model 3509

FLEXIBLE MANUFACTURING SYSTEM
Series 5900

PROGRAMMABLE ROBOTS
- Model 5100
- Model 5150
- Model 5250

CNC LATHES
- CNC Lathe, Model 5300
- CNC Lathe, Model 5500

CNC MILLS
- CNC Mill, Model 5400
- CNC Mill, Model 5600

SOFTWARE
- File Transfer software for the Teach Pendant-Controlled Robot System, Model 5100
- ROBOTUS® software for the Computer-Controlled Robot System, Model 5150
- RoboCIM software for the Servo Robot System, Model 5250
- Lab-Volt CNC software for Mill and Lathe systems
- Fabricus software for the Mill system
- CAD/CAM Software for Mill and Lathe systems

COURSEWARE
- User Guides and Manuals
- Quick Start Manuals
- Student Manuals
- Instructor Guides
- Computer-Based Learning (CBL)

Large and Mid-Sized Robots

For Heavy and Light Automated Tasks

The Lab-Volt Automation robots are powerful, precision-built, articulated arm, 5-axes micro robots designed in every way to emulate industrial robots in their programming and operating features. The Lab-Volt Robots, Models 5100 and 5150, are similar. However, the Model 5100 is controlled by a hand-held Teach Pendant, while the Model 5150 is controlled by a PC host computer. The Servo Robot, Model 5250, is controlled by either a hand-held Teach Pendant or by a PC host computer.

Through the curriculum and hands-on exercises, students learn to create automated workcells ideal for flexible manufacturing systems (FMS) and computer integrated manufacturing (CIM).

Models 5100 and 5150 are driven by six stepper motors. They have a 432-mm (17-in) reach, 0.45-kg (16-oz) load capacity, and a 3.2-mm (0.125-in) resolution. The 5100 controller is equipped with a serial port to connect to a personal computer for uploading and downloading programs using the File Transfer software.

The larger robot, Model 5250, is driven by six DC servo motors and can operate within a maximum radius of 732 mm (28.5 in). It has a 1.4-kg (3-lb) load capacity and weighs 20.4 kg (45 lb). The controller is a microprocessor based unit with 4 MB RAM and a floppy disk drive for saving task/point programs. The hand-held Teach Pendant has a four-line, 20-character LCD display, and a 40-key membrane keypad for manual control. A serial communication port is used to connect the robot controller to a host computer for remote operation and task editing with the host software.

An extensive list of optional equipment is available for the robots to accommodate a variety of teaching objectives. Equipment comprising a variety of feed mechanisms and conveyors enables students to set up workcells for computer-integrated manufacturing (CIM) or flexible manufacturing systems (FMS). All components are provided with location devices that allow a setup to be repeated when needed.

The robots feature advanced capabilities that distinguish them as high-precision, industrial quality systems, ideal for training in state-of-the-art manufacturing technology.

ROBOT SOFTWARE

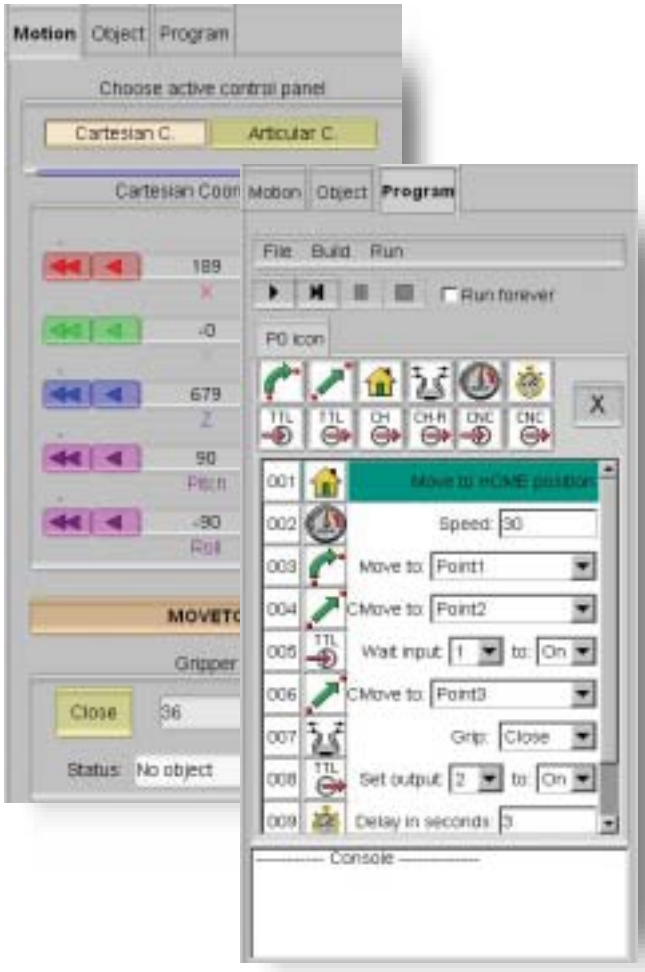
The Teach Pendant-Controlled Robot System, Model 5100, comes with the File Transfer software that enables students to download and upload programs created with the Teach Pendant. The ROBOTUS® software for the Computer-Controlled Robot System, Model 5150, allows the robot to be directly controlled from the computer. This software provides a real-time 3D simulation of the robot and its immediate environment. Through an intuitive drag-and-drop interface, users can directly control the position and movement of the robotic arm.

RoboCIM Software

Menu-Driven Software for the Servo Robot

RoboCIM is a software used to simulate and control the operation of the Servo Robot System, Model 5250, and external devices such as a gravity feeder and a linear slide. The software is also used to create programs. In RoboCIM, the actual equipment is replaced with three dimensional-images. Sophisticated mathematical models accurately simulate the mechanical and electrical characteristics of the equipment.

One of the RoboCIM characteristics is to control and to visualize the motion of the system interactively. Two types of motion are available: joint motion and Cartesian motion.



ROBOCIM SOFTWARE FEATURES

- Easy to use menu-driven software
- Simulation and control modes
- 3 dimensional (3D) virtual environment
- 7 predefined layout/camera view settings
- Control the movements of the Servo Robot using "articular" and "Cartesian" coordinates
- Programming without actual equipment
- Point recorder panel to easily record, rename, inform, hide, and delete points
- Create and run simple task programs using icons and graphical tools (no typewriting required)
- Create and run simple and complex task programs by typewriting all necessary commands
- Powerful set of task commands such as: Delay, DO-Until, If-Else, Gosub, Home, Input, Output, While-Repeat, and many others

CNC Lathes and Mills

Offering Flexibility, Variety, Safety and Accuracy

The skills required to perform simple to more sophisticated Computer Numerical Controlled (CNC) turning and milling tasks are the focus of the Lab-Volt Automation lathes and mills. All of these machines share many features that contribute to a superior CNC training system.

Each machine has an on-board microprocessor that stores downloaded part programs, thereby eliminating the need for a dedicated computer for operation. The easy-to-use membrane keypad enables students to operate and control the machine by simply pressing buttons on the control panel.

Each machine connects directly to an Ethernet or RS-232 port of a personal computer to provide simultaneous programming and parts processing.

Each machine can be programmed using the Lab-Volt CNC Lathe/Mill software and CAD/CAM software.

The CNC Lathes and Mills, Models 5300, 5400, 5500, and 5600, are designed to support low-voltage communications with robotic units and accessories to create automated workcells ideal for flexible manufacturing systems (FMS) and computer integrated manufacturing (CIM). In addition, they feature TTL connectors for communication to an automation workcell. The TTL I/O and solenoid driver connectors are supported through the standard software. Also, on the rear or side panel are the main power switch and fuses for easy maintenance, and the serial and Ethernet ports for downloading part programs.

CONTROL PANEL FEATURES

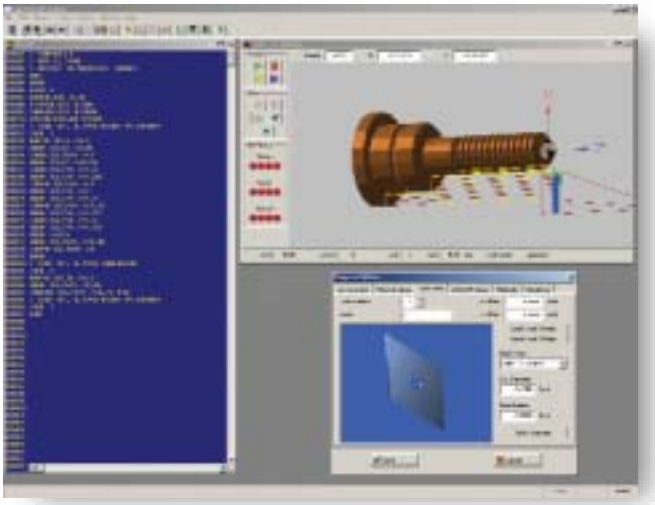
- Key-released emergency stop push-button
- Ability to restart programs from stopping point after a safety interruption
- 20-character by four-line LCD display
- Manual mode controls for:
  - X-and Z-Axis positions on lathes; X-, Y- and Z-axis positions on mills
  - Feed rate override
  - Spindle speed override
  - Tool change
  - TTL and solenoid outputs
  - Machine setup
- During execution, display of:
  - X and Z positions on lathes; X-, Y-and Z-axis positions on mills
  - Feed rate
  - Spindle Speed
  - Tool change
  - Current G and M codes
  - TTL outputs status on lathes and mills
- Stall light indicator/push-button abort key

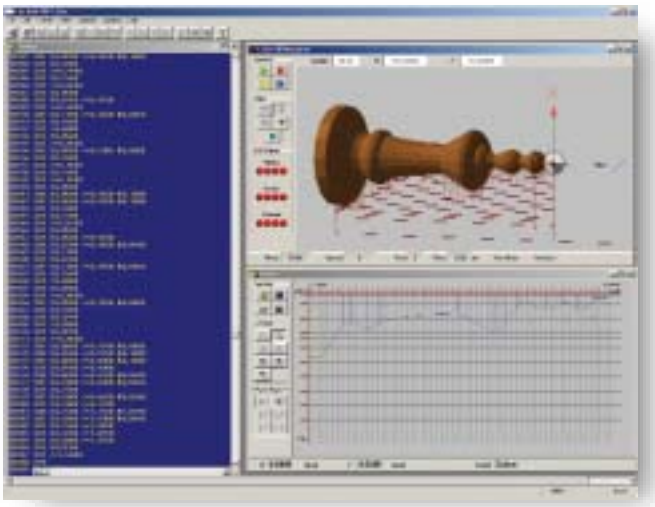
SAFETY FEATURES

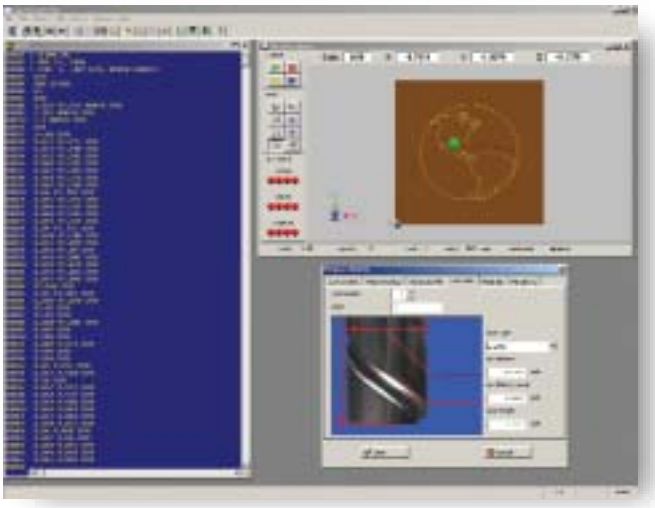
- Full cover over bed and work area
- Key-released emergency stop push-button
- Sensor switches monitored by the machine for:
  - Safety cover open
  - Tool post too close to chuck
  - Protection from over-travel on all axes
- Ability to restart programs from stopping point after operator abort or safety interruption

While these machines do not require a dedicated computer for operation, they do require an external computer for creating and downloading the part programs.

Lab-Volt CNC Lathe/Mill Software







Lab-Volt CNC Lathe/Mill Software enlivens CNC programming with colorful graphics and quick-paced navigation

Enhances Instruction With Advanced Graphics and Editing Features

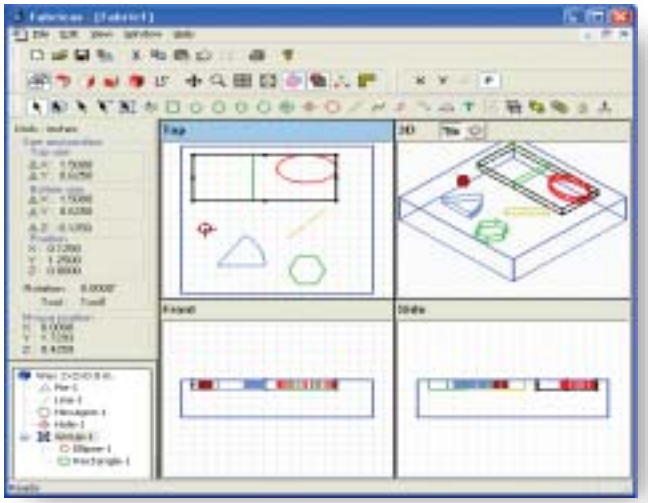
Lab-Volt CNC Lathe/Mill software is a Windows®-based, 32-bit application with the standard look and feel of the Windows® 98, Windows® NT, Windows® 2000, and Windows® XP operating systems. The software features a parametric-based graphical tool editor, 3D wireframe Tool Path Emulator with tool conflict view, a wizard-style part program creation mode, and standard Windows® interface.

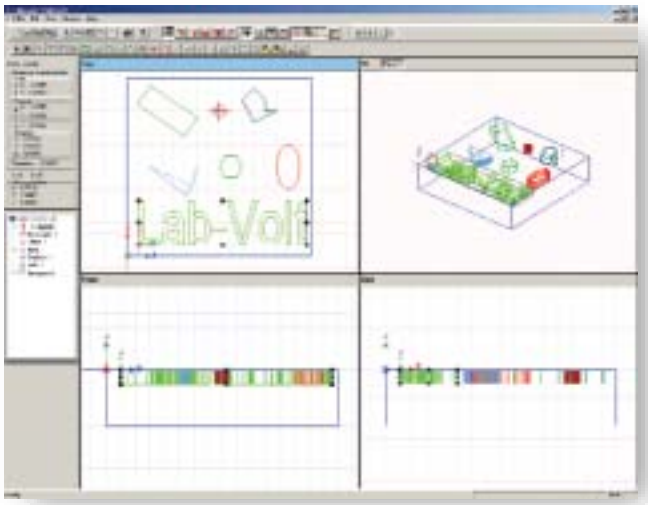
Lab-Volt CNC Lathe/Mill software is compatible with G and M part programs, which can be imported from Computer-Aided Manufacturing (CAM) programs that support the EIA standard G and M codes. The software is supported by a complete curriculum, which includes teacher and student manuals, worksheets, course materials, and sample stock for milling and turning.

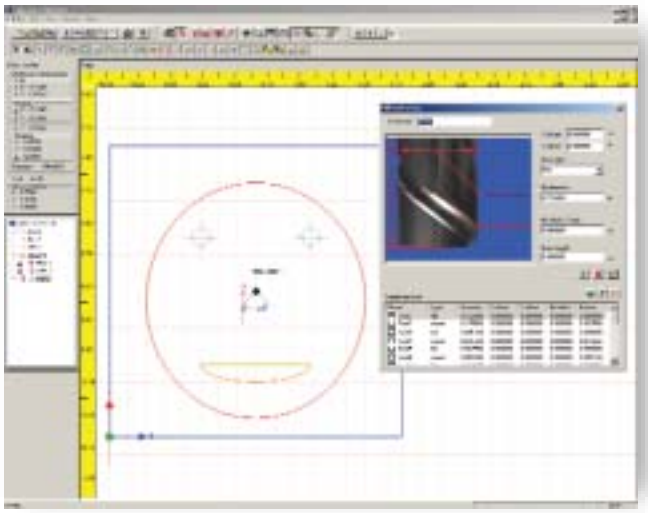
LAB-VOLT CNC LATHE/MILL SOFTWARE FEATURES

- EIA-274-D standard G and M code programming
- Parametric, graphical view tool editor with support for 20 tools
- Full G and M code help with graphical display
- Loading and saving tool offsets capability for the lathes
- Editable material database with load and save features
- Full 3D tool path emulator with wireframe user-defined 3D perspective
- Wizard-style block part editor
- Selection of basic G and M codes from a drop-down list
- AutoCAD.dxf file format import for the mills
- Simple CAD/CAM graphical development of part programs for the lathes
- Integrated CIM/FMS cell support options and commands
- Serial and Ethernet download capabilities for the Lab-Volt Automation CNC lathes and mills
- Support for custom machine configurations

Fabricus Software







Easy-To-Use CAD/CAM Software

Fabricus is an entry level CAD/CAM software program used to easily create GM code files. The generated codes are then used by CNC devices to repeatedly manufacture complex parts.

FABRICUS SOFTWARE FEATURES

- Direct interface to Lab-Volt CNC Lathe/Mill Software
- Simultaneously displays 4 screen views: top, front, right side and 3D. Can display any view in full screen. Zoom in and out, selection zooming, panning, fit to window and camera rotation (in 3D)
- Shows tool path & PRZ position
- Predefined stock selection or custom sizing
- Defined geometries include: rectangles, pentagons, hexagons, heptagons, octagons, other polygons (up to 20 sides), holes, ellipses, lines, polylines, Bezier curves, arcs, pies
- Chamfers
- Draws pocket, grooves, ellipse cups and islands
- Outputs G & M code programs
- Program feed, speed and increments
- Mouse position, shape position, rotation angle, tool and dimensions in a convenient toolbar
- A tree list of all the shapes present in the stock identified by names and icons and selectable for setting properties
- Validation of tool paths given a tool diameter
- Multiple document interface: work on more than one stock at a time
- Geometry right-click menu for most used commands
- Limit movement to x, y or z axes
- Shapes locking to prevent accidental movement
- 20 predefined tools and possibility to add more
- 2 predefined milling machines and possibility to add more

CAD/CAM Software for Mill and Lathe

Integrated, Industrial-Grade Software for Computer-Aided Design and Computer-Aided Manufacturing

CAD/CAM Software is a fully integrated, industrial grade software package that makes it easy to teach, learn, and use Computer-Aided-Design (CAD) and Computer-Aided Manufacturing (CAM) programs. CAD/CAM Software features colorful, graphical icons and dialogue boxes that make commands visual and intuitive. It has DXF and IGES translators that make it possible to use geometry from other CAD programs. CAD/CAM Software has extremely powerful editing tools for both CAD and CAM. As an integrated software package, CAD/CAM Software does not require students to switch back and forth between CAD and CAM applications. Both are available from the same screen menus.

CAD/CAM SOFTWARE GEOMETRY EXPERT

Geometry Expert allows geometry creations by both freehand and spreadsheet methods. With a full set of geometry editing tools, parts can be created in either 2D or 3D. Geometry Expert supports many types of geometry, including NURBS splines. Text creating is easy and contains a rich set of tools for spacing, formatting, and placing text around arcs and circles.

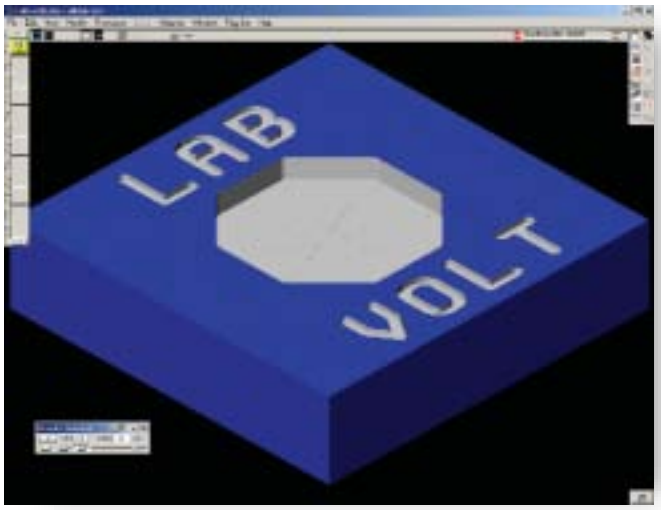
Geometry Expert enables the student to perform facing, pocketing, drilling, contouring, swept, and tapers.

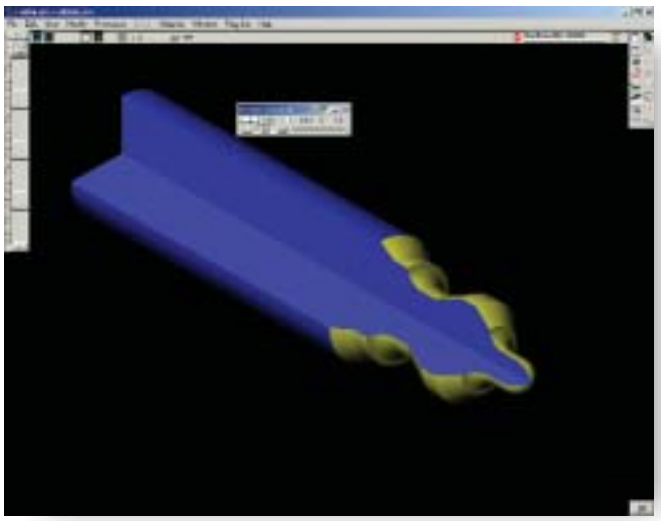
CAD/CAM SOFTWARE FOR MILL AND LATHE

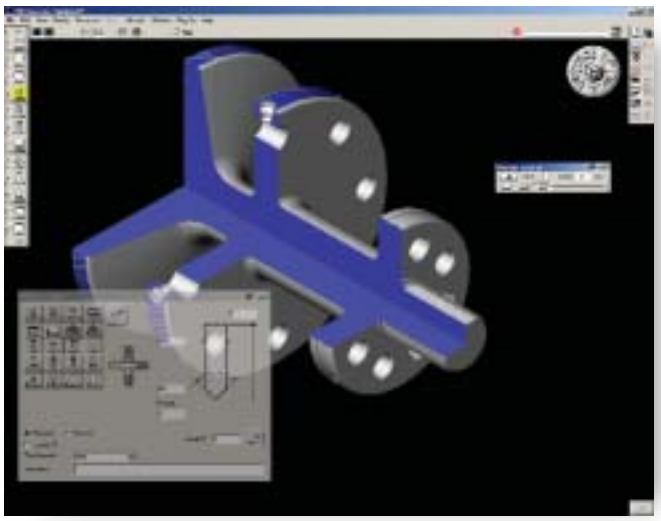
CAD/CAM Software is an easy-to-use, extremely flexible and powerful program featuring editable tool and material libraries. Creating, redoing, and reordering tool paths are made simple with the use of icons, dialogue boxes, and simple drag-and-drop capabilities. The software includes powerful real-time renderings of tool paths while displaying mill marks, with the result that very few bad parts are produced. Post-processors are available for all the popular educational and industrial CNC machines. Lathe processes include roughing, finishing, and threading.

FEATURES

- Industrial grade software
- Dynamic viewing of parts from any direction
- Part previewing
- English and metric units
- Multiple software platforms
- Estimated run times
- Object-based graphic interface







CAD/CAM Software brings CAD and CAM to life on the computer screen with vibrant images, high color, quick response, and easy controls.

PRODUCT PROFILES

TEACH PENDANT- AND COMPUTER-CONTROLLED ROBOT SYSTEMS
Models 5100-20 and 5150-10

The Teach Pendant- and Computer Controlled Robot Systems, Models 5100-20 and 5150-10, are low-cost solutions that provide a platform for training in the programming and operation of industrial-style robots. They are ideally suited for use in high schools, vocational schools, colleges, and universities.

The precision-built, articulated arm robot provides a scale version of modern industrial counterparts. A stepper motor, located in the base of the unit, provides horizontal rotation while five additional stepper motors, located in the shoulder, provide precision movement of the additional axes and end effector. The robot has five axes of rotational freedom plus a gripper and is able to move all axes simultaneously to perform a programmed move sequence. Movement of the elbow joint, wrist, and gripper mechanism is accomplished with cables and belts that link with a series of gears and belt-driven pulleys.

The base of the unit includes one connector for an external stepper motor, which can be used for further experimentation, such as operating the Rotary Carousel. The robot has four external TTL outputs and four TTL inputs located on the base. Additionally, there are four 12 Vdc solenoid outputs, one located in the shoulder and the remaining three in the base. The shoulder-mounted output is provided for controlling end tooling. The I/O capabilities can be used to allow the robot to interact with external hardware and conditions.

Four feedback switches provide the ability to locate a repeatable hard home position. The robot connects to a lightweight 12 Vdc switching power supply. A USB port interface on the robot base allows for direct control from a standard computer printer port.

ROBOT FEATURES

- Six stepper motor drives
- Two-finger gripper
- Power transferred from the stepper motor to the joints through mini HTP timing belts with anti-backlash design
- 432-mm (17-in) reach, 0.45-kg (16-oz) load capacity, 3.2-mm (0.125-in) resolution, and 6.4-kg (14.0 lb) unit weight
- Provided with push-lock fasteners for installation on perforated work surfaces
- Hard sided carrying case

TOPIC COVERAGE

- Introduction and Familiarization
- Programming
- Program Editing and Control Instructions
- Industrial Activity Simulation 1
- Industrial Activity Simulation 2
- Industrial Activity Simulation using a Belt Conveyor
- Industrial Activity Simulation using a Rotary Carousel
- Industrial Activity Simulation using a Gravity Feeder

TEACH PENDANT-CONTROLLED ROBOT SYSTEM MODEL 5100-20

The Teach Pendant-Controlled Robot System, Model 5100-20, is controlled by a teach pendant, which consists of a 24-key membrane hand-held keypad. It has a four-line, 20-character LCD display for feedback to the operator.

COMPUTER-CONTROLLED ROBOT SYSTEM MODEL 5150-10

The Computer-Controlled Robot System, Model 5150-10, includes the Robotus® software that allows the robot to be simulated offline and directly controlled from the computer. This software provides a real-time 3-D simulation of the robot. Through an intuitive drag and drop interface, users can control the position and movements of the robot. A mouse-driven graphical environment allows the user to create robot tasks consisting of point-to-point robot movement, input-and-output control, and simple logic decisions.

SERVO ROBOT SYSTEM
Model 5250

The Servo Robot System, Model 5250, provides complete training in the programming and operation of industrial robots. Through the curriculum and hands-on experience gained in working with the Model 5250, students learn to create automated workcells ideal for flexible manufacturing systems (FMS) and computer integrated manufacturing (CIM).

A precision-built, articulated-arm robot, Model 5250, has five axes of rotation and six servo drives with closed-loop control via optical encoders. The continuous path robot uses several joints simultaneously to perform a programmed move sequence controlled by the controller unit or a PC host computer.

Movement of the shoulder, upper arm, forearm, and wrist is accomplished with belts through a series of gears and belt-driven pulleys.

The controller unit is an embedded microprocessor with connections for inputs and outputs as well as a floppy disk drive for saving task/point programs. The hand-held teach pendant has a four-line, 20-character LCD display and a 40-key membrane keypad for manual control. A serial communication port is used to connect the 5250 controller to a host computer for remote operation and task editing with the host software.

TOPIC COVERAGE
- Introduction
- Familiarization with the Servo Robot System
- Point-to-Point Programs
- Task Programs
- Program Editing
- Control Overview
- Industrial Application Simulation Using a Gravity Feeder
- Industrial Application Simulation Using a Belt Conveyor
- Industrial Application Simulation Using a Pneumatic Feeder
- Industrial Application Simulation Using a Rotary Carousel
- Industrial Application Simulation Using a Linear Slide

FEATURES
Servo Robot
- High torque servo motors
- Steel and aluminum construction
- Timing belts for power transfer (enclosed for safety)
- Easily adjustable belt tension pulleys to maintain positional accuracy
- Oilite and UHMW (Ultra-High Molecular Weight) bushings for durability, minimum maintenance, and lubrication
- Boundary and current limit protection on all axes
- Push-lock fasteners for installation on perforated work surfaces

Robot Controller
- On-board microprocessor
- 8 TTL input ports, color coded, and LED status indicators
- 8 TTL output ports, color coded, and LED status indicators
- 4 relays, each provided with a set of normally open and normally closed contacts and LED status indicators
- Servo Robot and external motor release switch, and LED status indicator
- Floppy disk drive for program storage
- Hand-Held Terminal communication port

Safety Features
Key-Activated Emergency Stop Button module

RoboCIM Software
- Easy-to-use menu-driven software
- Direct keyboard control over all robot axes and functions
- Control output ports and read instruction channels
- Task commands include do, if-else, gosub, input, output, while-repeat conditions, and many others
- Point-to-point and task programming

ROBOT EQUIPMENT OPTIONS
Various Models

ROTARY CAROUSELS
Models 5208-10 and 5113-10

The Rotary Carousels demonstrate how parts can be transferred to and from the robot in a repetitive, rotational pattern. The Rotary Carousel, Model 5208-10, is driven by a DC servo motor and has a closed-loop feedback system and a limit switch feedback for hard home capabilities. The Rotary Carousel, Model 5113-10, is driven by a stepper motor. Model 5113 interfaces with the 5100 and 5150 robots, and Model 5208 interfaces with the 5250 robot.

ROTARY CAROUSEL
Model 5208-10

ROTARY CAROUSEL
Model 5113-10

BELT CONVEYORS
Models 5210 and 5118

Used in material handling experiments, the Lab-Volt Belt Conveyors can interface with the 5100-20, 5150-10 and 5250 robots, or they can be used as stand-alone units. The inputs enable the motor power, stepper motor clock signal, and the direction of the belt movement to be remotely controlled.

BELT CONVEYOR
Model 5210

BELT CONVEYOR
Model 5118

GRAVITY FEEDERS
Models 5119 and 5121

The Gravity Feeders are used in exercises that require square or cylindrical stock. They have sensor switches and feedback cables for connections to other devices. They interface with the 5100-20, 5150-10, and 5250 robots.

GRAVITY FEEDER
Model 5119

GRAVITY FEEDER
Model 5121

LINEAR SLIDE
Model 5209

The Linear Slide provides a track on which the 5250 robot can move to perform programmed tasks. The slide is driven by a DC servo motor, direct-coupled to a precision ballscrew. It has a closed-loop feedback system and a limit switch feedback for hard home capabilities. The slide is constructed of steel and has a precision ballscrew with a recirculating ball nut, guideways, and linear sealed bearings. It connects to either of the external motor ports on the rear of the 5250 Controller.

LINEAR SLIDE
Model 5209

PNEUMATIC FEEDER CONTROLLER
Model 5122-1

PNEUMATIC FEEDER CONTROLLER
Model 5149

The Pneumatic Feeder Controller is used to control the Pneumatic Feeders, Models 5122-1 and 5142-1. It includes a pneumatic valve, which supplies compressed air to the feeders. The operation of the Pneumatic Feeder Controller is controlled by limit switches in the feeder and storage sections of the Pneumatic Feeders.

PNEUMATIC FEEDERS
Models 5122-1 and 5142-1

The Pneumatic Feeders have micro-switch triggers to signal the Pneumatic Feeder Controller, which will activate the feeder to push a block into the receiving port once the previous block has been removed. Model 5122-1 feeds square stock and Model 5142-1 cylindrical stock to the 5100-20, 5150-10, and 5250 robots.

PNEUMATIC FEEDER
Model 5122-1

PNEUMATIC FEEDER
Model 5142-1

BENCHES
Various Models

Lab-Volt offers many types of benches to set up and store equipment. They can be joined when extra space is required, and configured to accommodate a wide variety of space and teaching needs. They come in many sizes and are provided with heavy-duty, lockable casters.

The top of the benches consists in perforated work surfaces on which the components are mounted. Optional shelves, storage surfaces, dressing panels, and lockable doors can be added to the benches.

Mounting and removal of the components are especially easy with push-lock fasteners that snap effortlessly into the perforations of the work surfaces. Many Lab-Volt models are provided with location pins that fit into the perforations to locate the components with precision. This location system is very useful when a setup has to be repeated.

CNC LATHE
Model 5300

The CNC Lathe, Model 5300, is a mid-sized turning system that provides complete, safe, and affordable training in computer-aided manufacturing (CAM), and computer-numerical controlled (CNC) turning. The Lab-Volt curriculum gives students experience with industry-standard software and high-precision equipment designed to prepare them for jobs in manufacturing.

The 5300 CNC Lathe is a slant-bed lathe constructed with a machined high-grade alloy bed, headstock, and tailstock. Each axis on the Lab-Volt lathe is driven by its own DC stepper motor whose speed can be programmed from 0 to 36 cm/min (0 to 14 in/min). The spindle motor is programmable from 0-to 2800-r/min chuck speed.

The included Lab-Volt CNC Lathe software uses today's industry-standard G&M codes. The software features Tool Path Emulation and CAD/CAM design, which allow the programmer to make a drawing of a part, set up the tool paths and cut steps, create the part program, and simulate tool motion on a monitor to check the finished part prior to the actual cutting.

TOPIC COVERAGE

- History of CNC
- Identify Components of a CNC Lathe
- Safety
- Tool Movement
- Speed, Feed, and Cut Steps
- Lathe Program Codes
- The PRZ
- Lathe Setup
- On-Screen Emulation
- Turning a Part
- Input a Part Program
- Editing Commands
- CNC Programming
- Understanding and Using CAD/CAM
- Create a Part Using CAD/CAM Programming
- Careers in Turning

FEATURES

- Key-released emergency stop push-button
- Ability to restart programs from stopping point after safety interruption
- On-board embedded microprocessor
- Stand-alone manual mode operation
- Batch mode for independent operation or operation in CIM cells
- Software allowing the programming of up to 20 tools
- Tool post with HSS tool bit
- Three-jaw self-centering manufacturer-supplied recommended chuck
- Side panel with connectors for TTL communication with the 5250 robot, M-code supported solenoid drivers, connects to host computer through RS-232 or Ethernet port
- Lathe constructed with a machined high-grade alloy bed, headstock, and tailstock
- Each axis driven by its own DC stepper motor
- Programmable speeds from 0 to 36 cm/min (0 to 14 (in/min)
- 1/3-HP, DC variable speed spindle motor
- Spindle motor programmable from 0- to 2800-r/min chuck speed

CNC LATHE
Model 5500

The CNC Lathe, Model 5500, is a heavy-duty, industrial-grade training system for computer-aided manufacturing (CAM), and computer-numerical controlled (CNC) turning. The 5500 CNC Lathe is constructed with heavy-duty cast-iron bed, headstock, and tailstock. The lathe features stepper motor drives with ribbed timing belts that operate recirculating anti-backlash ball screws on the X and Z axes, providing maximum positional accuracy. For ease of maintenance, telescoping helical covers protect the Z axis ballscrew. Each axis on the 5500 CNC Lathe is driven by its own stepper motor, whose speed can be programmed from 0 to 76 cm/min (0 to 30 in/min). The spindle speed is also continuously variable from 0 to 3400 r/min and no belt or gear changes are required.

The included Lab-Volt CNC Lathe software uses today's industry-standard G&M codes. The software features Tool Path Emulation and CAD/CAM design, which allow the programmer to make a drawing of a part, set up the tool paths and cut steps, create the part program, and simulate tool motion on a monitor to check the finished part prior to the actual cutting.

TOPIC COVERAGE
- History of CNC
- Identify Components of a CNC Lathe
- Safety
- Tool Movement
- Speed, Feed, and Cut Steps
- Lathe Program Codes
- The PRZ
- Lathe Setup
- On-Screen Emulation
- Turning a Part
- Input a Part Program
- Editing Commands
- CNC Programming
- Understanding and Using CAD/CAM
- Create a Part Using CAD/CAM Programming
- Careers in Turning

FEATURES
- Key-released emergency stop push-button
- Ability to restart programs from stopping point after safety interruption
- On-board embedded microprocessor
- Using optical encoder feedback, the lathe is also capable of reading
- An optional 10-tool automatic tool changer is available
- Stand-alone manual mode operation
- Batch mode for independent operation or operation in CIM cells
- Software allowing the programming of up to 10 tools
- Tool post with HSS tool bit
- 1-HP constant torque DC spindle motor controlled from within the program
- Three-jaw self-centering manufacturer-supplied recommended chuck
- Rear panel with connectors for TTL communication with the 5250 robot, M-code supported solenoid drivers, connects to host computer through RS-232 or Ethernet port
- Main power indicator
- Heavy-duty DC spindle motor
- Cast iron chassis
- Recirculating anti-backlash industrial-grade ball nuts and screws on X and Z axes
- Magnetic safety interlock

OPTIONAL EQUIPMENT
- 10-Tool Automatic Tool Changer

CNC MILL
Model 5400

The CNC Mill, Model 5400, is a state-of-the-art milling system that provides complete training in computer-aided manufacturing (CAM), and computer numerical controlled (CNC) milling.

The 5400 CNC Mill is built to support safe, low-voltage communications with robots and devices to create automated workcells ideal for flexible manufacturing systems (FMS). On the side panel of the mill are connectors for interacting to an automation workcell. A connector is provided for standard TTL I/O communications with robotics equipment. The TTL I/O and solenoid driver connectors are "M" code supported through the standard software supplied. Also on the side panel are the main power switch, and the serial and Ethernet ports for downloading programs.

Each of the mill's three axes is driven by its own DC stepper motor which can be programmed from 0 to 36 cm/min (0 to 14 in/min) movement rates which meet the requirements of basic and advanced milling. The spindle speed is continuously variable and programmable to a range of 0 to 2800 r/min.

The included Lab-Volt CNC Mill software uses today's industry standard G&M codes. The software features Tool Path Emulation so students can check the finished part prior to the actual cutting. The software is also capable of directly importing an AutoCAD.DXF file and the computer will automatically generate the codes to cut the drawing on the mill.

TOPIC COVERAGE

- History of CNC
- Identify Components of a CNC Mill
- Safety
- Speed, Feed, and Cut Steps
- Enter a Program into a Computer
- Identify and Operate Controls on a Mill
- Identify X, Y, and Z Axis Movements on a Mill
- Set-Up Controller and Mill to Machine a Part
- Machine a Part
- Write and Execute a Program to Mill a Shoulder and Drill a Hole
- Write and Execute a Program to Mill a Pocket
- Calculate and Program Cutter Clearances
- Combine Subroutine and Repeat Loop Operations to Machine a Complex Part
- Careers in CNC Machining

FEATURES

- Key-released emergency stop push-button
- Ability to restart programs from stopping point after safety interruption
- On-board embedded microprocessor
- Stand-alone manual mode operation
- Batch mode for independent operation or operation in CIM Cells
- Software allowing the programming of up to 20 tools
- Mill constructed with machined high-grade alloy bed and head stock
- 12-key membrane keypad with 20-character by 4-line LCD display
- Main power indicator
- Feed rate override
- Spindle speed override
- Stall indicator
- Removable side panel for access to robot
- Connects to host computer through RS-232 or Ethernet port

CNC MILL
Model 5600

The CNC Mill, Model 5600, is a heavy-duty, state-of-the-art machining system consisting of a cast iron chassis with recirculating anti-backlash ball nuts and screws for lower maintenance and maximum position accuracy. The 5600 CNC Mill also features R8 tooling, which provides complete compatibility with industrial machine tools. With the 5600 CNC Mill, students can mill parts made of soft materials such as aluminum, mild steel, and brass. Training in the 5600 CNC Mill enables students to gain skills that are directly transferable to jobs in manufacturing.

Each of the mill's axes is driven by its own DC stepper motor which is programmable from 1 to 50 cm/min (1 to 20 in/min). The spindle speed is continuously variable and programmable to a range of 0 to 3400 r/min.

The included Lab-Volt CNC Mill software uses today's industry standard G&M codes. The software features Tool Path Emulation so students can check the finished part prior to the actual cutting. The software is also capable of directly importing an AutoCAD.DXF file and the computer will automatically generate the codes to cut the drawing on the mill.

TOPIC COVERAGE

- History of CNC
- Identify Components of a CNC Mill
- Safety
- Speed, Feed, and Cut Steps
- Enter a Program into a Computer
- Identify and Operate Controls on a Mill
- Identify X, Y, and Z Axis Movements on a Mill
- Set-Up Controller and Mill to Machine a Part
- Machine a Part
- Write and Execute a Program to Mill a Shoulder and Drill a Hole
- Write and Execute a Program to Mill a Pocket
- Calculate and Program Cutter Clearances
- Combine Subroutine and Repeat Loop Operations to Machine a Complex Part
- Program Controller to Cut a Groove, Machine a Pocket, and Drill a Hole
- Print a copy of a Part Program
- Load and Execute a Part Program
- Careers in CNC Machining

FEATURES

- Key-released emergency stop push-button
- Ability to restart programs from stopping point after safety interruption
- On-board embedded microprocessor
- Stand-alone manual mode operation
- Batch mode for independent operation or operation in CIM Cells
- Software allowing the programming of up to 20 tools
- Mill constructed with machined high-grade alloy bed and head stock
- 12-key membrane keypad with 20-character by 4-line LCD display
- Main power indicator
- Feed rate override
- Spindle speed override
- Stall indicator
- 1-HP motor
- Rear Panel Convertion for 5250 TTL Control
- Pneumatic Vise Output
- Connects to host computer through RS-232 or Ethernet port

MANUFACTURING CONVEYOR SYSTEM
Model 3509

The Manufacturing Conveyor System, Model 3509, provides a mechanical manufacturing process comprised of two belt conveyors and two workstations. The outer belt has a rounded rectangular shape. The cross conveyor is reversible and is used for transporting pallets to and from the outer conveyor. It is on the cross conveyor that a drilling operation is simulated, complete with a pneumatic drill which extends toward the pallet while spinning. The second workstation is a stamping procedure, simulating a Quality Control approval stamp.

Simulating the operation of an assembly line, the outer conveyor moves pallets carrying work pieces along the conveyor at a fixed rate of speed. A programmable Logic Controller (PLC) program directs the action of various mechanisms incorporated in the trainer. Based on the inputs from the sensors, the PLC program instructs the mechanisms to stop the pallet at a preset location, rotate the pallet to a correct position and location, and perform simulated drilling and stamping processes. Depending on the application under study, the sensors, gates, stops, transfer, and process stations can be mounted at different locations along both conveyors by means of quick fasteners.

The operator station includes a flat panel with mimic diagram and override switches giving manual and automatic control to the devices. The control station contains a PLC with associated I/O modules.

All necessary connections from the PLC are hardwired to the Operator Station and the Remote Connector Terminal. Sensor connections are made using quick-connect connectors on the Interconnection Panel. The Stop and Gate devices are connected to the Interconnection Panel output jacks using the supplied leads terminated by miniature banana plugs.

TOPIC COVERAGE

The included User Manual instructs students on setup and operation of the Conveyor System. The system does not come with standard courseware. Additional PLC software is optional.

FEATURES

- Fixed speed, oval/rectangular-shaped outer conveyor belt is made of interlocking plastic links for durability and ease of motion
- Fixed speed, reversible, cross conveyor with heavy-duty rubber belt
- Light-weight aluminum framing provides mobility within a classroom setting
- Each device can be mounted anywhere around the conveyor with quick fasteners
- All required electrical leads and pneumatic tubings are supplied
- Pneumatic components come with quick-connect fittings
- A pressure regulator allows adjustment of the process pressure at the desired value

FLEXIBLE MANUFACTURING SYSTEM
Model 5900

The Model 5250 Robot and Model 5400 Mill may be connected to the Manufacturing Conveyor System, Model 3509, to expand the capabilities and advance the sophistication of the Programmable Logic Controller (PLC) programming required.

By programming the PLC to adjust for the presence of the robot and mill, students can signal the robot to pick up a piece of acrylic carried on the workpiece, place it in the pneumatic vise on the mill, and trigger the milling operation to start. The Computer-Numerical Controlled (CNC) milling program, which has been downloaded into the mill's memory, will then be carried out. During the milling procedure, the robot will take a fresh piece of acrylic from the pneumatic feeder and place it on the milling pallet on the outer conveyor. The robot will then signal the conveyor that a fresh piece of acrylic has been placed on the pallet and can be released from Gate 1. After the milling procedure is complete, the robot will remove the milled piece from the mill and place the cut part in a finished goods location.

It is this type of flexibility which allows the 3509 Training System to be used to train students in advanced PLC programming and ladder logic. A multitude of configurations or processes can be completed using 3509, 5250 robot, 5400 CNC Mill, 5300 CNC Lathe, or by incorporating other Lab-Volt training systems.

FLEXIBLE MANUFACTURING SYSTEM
Model 5901

Simulating the operation of a production line, the Lab-Volt Flexible Manufacturing System, Model 5901, allows students to familiarize themselves with the start-up, configuration, programming, optimization, and troubleshooting of manufacturing processes. The modularity of the system enables students to find a variety of creative solutions to solve a situation. Equipped with the most recent industrial components, the training system prepares students to be efficient with various technologies. All system operations are controlled via one or many programmable logic controllers able to be networked together.

The modularity of this system permits the selection of models required to meet the training objectives. Competency based programs may require more wiring skills, electrical schematic comprehension, and troubleshooting while advanced teaching programs will find with this trainer the perfect tool to explore complex control scheme.

Models from the Robotics and Pneumatics product line can also be added to the system to create more sophisticated applications.

FEATURES

- Artificial Vision - Create quality control routines to verify, with advanced mathematical tools, the validity of the products by measuring the shape, color shade and intensity, and more.
- Operator Panel - Develop different operator interfaces to monitor and control the whole process via a touch screen panel or a PC-type computer.
- Sensors - Explore the application of different types of proximity switches and photoelectric sensors, develop applications using a color detection sensor, and build a product identification system with a bar code scanner.
- Power Electronics - Configure and control a 3-phase AC drive through a DeviceNet Network, tune closed loop control of the position of a mobile part feeder with a digital servo drive.
- Wiring - Easy and fast setup using the front panel banana jacks and the provided leads, or realistic wiring using terminal blocks.
- Networks - Explore different communication networks found in the industry such as Ethernet/IP, DeviceNet, and Serial communication.
- Pneumatics - Implement a pneumatic application in a production line.
- Troubleshooting - Enhance troubleshooting skills by electrical fault insertion on the PLC, AC drive, artificial vision system, and part feeder.
- PLC application - Learn how to program a PLC with four different languages (relay ladder, structured text, functional block, and sequential function chart), create new applications or improve existing ones, and use the latest PLC technology.

PROGRAMMABLE LOGIC CONTROLLER
Model 3240

The Programmable Logic Controller (PLC), Model 3240, enables students to develop competence in operating, programming, and troubleshooting modern PLC-controlled circuits. The PLC trainer, Model 3240, is based on the latest Allen-Bradley Micrologix™ 1200 controller, and is supported by Lab-Volt instructional material. Programming is achieved using the Windows®-based RSLogix™ 500 software from Rockwell Software. The PLC trainer can be used to achieve PLC control of typical industrial applications implemented with a Mechanical Process Simulator, and of virtual industrial processes simulated by the PLC Simulation Software (P-SIM 2000).

The PLC trainer can also be used with the Lab-Volt Industrial Controls Training System, Model 3100, as well as the Lab-Volt Electromechanical Systems, Models 8001 and 8006. The training program consists of two courses covering basic programming to advanced applications. The PLC trainer includes 12 fault-insertion switches for troubleshooting training.

TOPIC COVERAGE

Basic Principles

- Familiarization with the PLC Trainer and RSLogix 500
- Programming Basics
- Online Operations
- Latching Instructions
- Timer Instructions
- Counter Instructions
- Sequencer Instructions
- Comparison Instructions
- Shift Register Instructions/The Force Function

Applications

- Introduction to the Mechanical Process Simulator
- Controlling a Line Welding System with a PLC
- Controlling an Automatic Component Insertion Machine with a PLC
- Designing a PLC-Controlled Automated System
- Introduction to the P-SIM Simulation Software
- Controlling a Traffic Light System with a PLC
- Controlling a Filling Line with a PLC
- Controlling a Batch Mixing Process

FEATURES

- Allen-Bradley Micrologix™ 1200 PLC
- 12 Fault switches for troubleshooting
- 14 dual-voltage PLC inputs
- Seven PLC input switches (toggle-and push button-type)
- Ten dual-voltage PLC outputs
- Expansion spacing for the addition of an optional analog input/output module
- RS-232 DF1 full-duplex communication link between the PLC and RSLogix
- Circuit-breaker protected

PLC TRAINING SYSTEM EQUIPMENT
Various Models

P-SIM TO PLC INTERFACE
Model 3243
The Allen-Bradley Micrologix™ 1200 PLC on the PLC Trainer, Model 3240, can be used to control the PLC Simulation software (P-SIM 2000), Model 91773, in order to simulate the operation of typical industrial processes. To do this, an interface is needed: the P-SIM to PLC Interface, Model 3243.

Model 3243

EXPANSION MODULE
Model 3244
The Expansion Module provides greater PLC input/output capability for advanced training by permitting the user to add two analog inputs and two analog outputs to the Micrologix 1200 PLC of the trainer.

Model 3244

RSLogix 500 PROGRAMMING SOFTWARE
Model 3245
The RSLogix 500 Programming Software Model 3245 from Rockwell Software provides the capability to program the PLC with a personal computer. A direct communication link (DF1 full duplex) is used to connect the PLC to the computer, sparing the need for any interface between them.

Model 3245

COMMUNICATION CABLE
Model 3246-40
The Communication Cable is used to connect the computer to the PLC when using programming software.

Model 3246-40

MECHANICAL PROCESS SIMULATOR
Model 3290
The Mechanical Process Simulator, Model 3290, is designed to simulate industrial mechanical processes. It is used with the PLC Trainer to study sequential, on/off control of typical production lines involving linear position control. The process includes seven limit switches providing input signals to the PLC, and four output load solenoids activated through programming of the PLC outputs.

Model 3290

NETWORK INTERFACE DEVICES
The following network interface devices can be added to the PLC for communications: Advanced Interface Converter (AIC+) provides an interface to DH-485 networks from an RS-232 port, DeviceNet Interface (DNI), and Ethernet Interface (ENI).

PLC SIMULATION SOFTWARES (P-SIM 1000 AND P-SIM 2000)
MODELS 91826 and 91773

P-SIM demonstrates the programming and operation of an actual programmable logic controller (PLC). The functionality of P-SIM is representative of current trends employed by PLC manufacturers.

Upon completion of the P-SIM 2000 course, students will understand and will be able to program basic relay inputs, output instructions, counters, timer circuits, compare functions, and debugging procedures.

In order to proceed with P-SIM 2000, students must demonstrate an understanding of basic relay logic control.

PLC SIMULATION SOFTWARE (P-SIM 1000)
Model 91826

P-SIM 1000 is a stand-alone, self-paced, interactive, computer-based introductory tutorial for PLC technology. It serves as a prerequisite to the more advanced PLC Simulation Software P-SIM 2000, Model 91773 and is intended for students who have had no exposure to PLC technology.

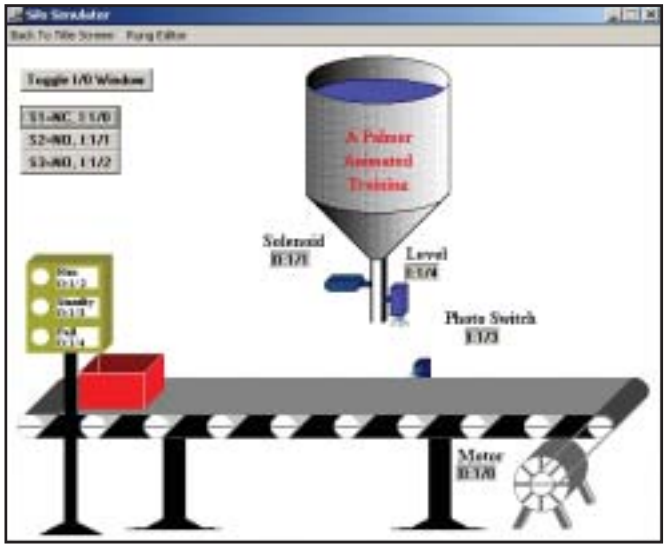
P-SIM 1000 incorporates colorful, animated graphics to display PLC concepts, which are presented as industrial process simulations complete with interactive control functions.

PLC SIMULATION SOFTWARE (P-SIM 2000)
Model 91773

The P-SIM 2000 software enables an IBM-compatible computer to act as a process simulator when demonstrating PLC operations. A built-in ladder logic program editor allows students to create, test and debug industry-standard ladder logic programs to control animated processes. The simulated PLC includes the five basic input and output instructions, counters, timers, and compare function blocks. It also incorporates logical AND/OR operations in PLC programs by means of branching.

Typical processes, such as batch mixing and material transfer, are graphically displayed as animations, which respond to changes to the ladder logic program in the same manner that actual process equipment would respond.

With the optional P-SIM to PLC Interface, Model 3243, or Programmable Logic Controller, Model 3270, students can write programs to control the on-screen P-SIM simulations.



P-SIM I/O INTERFACE

PLC programming may be taught and practiced using the built-in ladder logic program editor or, with the P-SIM I/O interface, any PLC can be easily connected by using industry-standard 24 Vdc I/O. The PLC is then programmed to control the simulations within the P-SIM program.

TOPIC COVERAGE
Model 91826

- Introduction to the PLC
- Introduction to Ladder Logic
- "AND'D" Normally Open Contacts
- "OR'D" Normally Open Contacts
- Normally Open/Normally Closed Contacts
- Interlocked Logic
- Lock-in Using Momentary Contacts
- On-Delay Time
- Traffic Light Logic
- Counter Application

Model 91773

- Familiarization with P-SIM 2000
- Rung Editor
- Basic Input/Output PLC Instructions
- Branching
- Timer and Counter PLC Instructions
- Comparison PLC Instructions
- Silo Simulation
- Batch Mixer Simulation
- Traffic Lights Simulation
- I/O Simulation

EXPLORING MANUFACTURING TECHNOLOGY

Compact Training Modules for a Hands-On Introduction to Manufacturing Technology

Lab-Volt Systems developed the Exploring Technology series of training modules to serve as a hands-on introduction to the principles and basic applications of sensors, mechanisms, and electricity.

Each module in the Exploring Manufacturing Technology series can accommodate two students. Modules can be studied individually and then inter-connected with the use of electrical leads, allowing for further study and problem solving by students who complete the study of a module.

Included with each module is a fully illustrated manual containing ten exercises, written in an easy-to-read, step-by-step format, divided into the following five units:

Objective	- A statement outlining the purpose of the exercise
Discussion	- A topic description with background information
Procedure	- A step-by-step guide for performing experiments
Conclusion	- A brief review of the topic and related practical examples
Questions	- A multiple-choice test to determine the students' comprehension

CHASSIS DIMENSION

Depth	Width	Height
24 cm	49 cm	33.5 cm
9-1/2 in	19-1/4 inc	13-1/4 in

POWER REQUIREMENTS

120, 220, 240 V - 50/60 Hz

ESTIMATED PROGRAM HOURS

Open

PRODUCT PROFILES: Exploring Manufacturing Technology

EXPLORING SENSORS

Model 3341

The Exploring Sensors module, Model 3341, allows students to explore the different uses of mechanical and electronic sensors from a security applications viewpoint.

Students are introduced to the variety and characteristics of sensors. They build a variety of circuits using magnetic sensors, vibration/shock sensor, pulsed infrared sensors, and motion sensors. Students also build alarm circuits using sensors, an electromechanical relay, and a buzzer.

Sensors in this module include an infrared photoelectric beam sensor, an infrared motion detector, a mechanical switch, a vibration detector, and magnetic proximity sensors.

TOPIC COVERAGE

- Getting to Know the Trainer: How to Connect Sensor Circuits
- Control Panels
- Introduction to Mechanical Sensors - The Plunger Switch
- Magnetic Proximity Sensors
- Shock/Vibration Sensors
- Electronic Active Sensors
- Electronic Passive Sensors
- Wiring Installation Techniques
- Automobile Alarm System
- Designing an Alarm System

FEATURES

- Regulated 12 V-DC source
- Proximity sensor, infrared-sensor, shock/vibration sensor, and motion sensor
- Plunger switch
- Electromechanical relay
- Buzzer alarm and indicator lamps

LANGUAGE VARIATIONS

English, Spanish

EXPLORING MECHANISMS
Model 3342

The Exploring Mechanisms module, Model 3342, introduces students to the world of mechanical power transmission. Using a fully operational elevator, the module covers the topics of work, power, force, energy, and torque. The module comes fully equipped with a collection of gears, belt drives, and a chain drive. Other topics include direction of rotation and tension. Practical examples and association with real world examples set this module apart from others.

TOPIC COVERAGE
- Introduction to the Trainer
- Work and Power
- Friction
- Mechanical Advantage
- Inclined Plane
- Gears and Gear Trains
- Friction-Belt Drives
- Synchronous-Belt Drives
- Chain Drive
- Pulley System

FEATURES
- DC driving motor with control switch
- Assortment of gears, O-rings, chains, and belts
- Lift (elevator) with control switch, and upper/lower sensors
- Hex keys and spring scale

LANGUAGE VARIATIONS
English

EXPLORING ELECTRICITY
Model 3343

The Exploring Electricity module, Model 3343, plays a vital role in every area of technology. This module teaches students the basic characteristics of simple electrical circuits.

The module is provided with a built-in regulated 12-Volt DC source. Other components include a digital multimeter, an electromechanical relay, and an assortment of lamps, switches, and resistors.

Students build a variety of circuits using electrical leads. These circuits are series circuits, parallel circuits, and logic circuits. Students also learn how to calculate electric values and measure then with the digital multimeter.

TOPIC COVERAGE
- Electric Circuits
- Measuring Voltage, Current, and Resistance
- Series Circuits
- Parallel Circuits
- Logic Circuits
- Three-Way Switching Circuits
- Ohm's Law
- Ohm's Law for Series Circuits
- Ohm's Law for Parallel Circuits
- Electromechanical Relays

FEATURES
- Regulated 12 V-DC source
- Digital Multimeter
- Assortment of resistors, switches, relays, and indicator
- Fan used as a circuit load

LANGUAGE VARIATIONS
English, Spanish

MANUFACTURING/MECHATRONICS COURSEWARE ORDERING INFORMATION

MODEL DESCRIPTION	120 V - 60 HZ			220 V - 50 HZ			240 V - 50 HZ
	ENGLISH	FRENCH	SPANISH	ENGLISH	FRENCH	SPANISH	ENGLISH
46101-10 Mechanical Training System, Level 1							
Introduction to Mechanical Drive Systems	46603-00	46603-01	46603-02	46603-00	46603-01	46603-02	46603-00
Student Job Sheets (20)	36737-20	N/A	N/A	36737-20	N/A	N/A	36737-20
Instructor Job Sheets (30)	36737-30	N/A	N/A	36737-30	N/A	N/A	36737-30
Student Work Orders (60)	36737-60	N/A	N/A	36737-60	N/A	N/A	36737-60
Instructor Work Orders (70)	36737-70	N/A	N/A	36737-70	N/A	N/A	36737-70
Belt Drives 1	46612-00	46612-01	46612-02	46612-00	46612-01	46612-02	46612-00
Student Job Sheets (20)	36891-20	N/A	N/A	36891-20	N/A	N/A	36891-20
Instructor Job Sheets (30)	36891-30	N/A	N/A	36891-30	N/A	N/A	36891-30
Student Work Orders (60)	36891-60	N/A	N/A	36891-60	N/A	N/A	36891-60
Instructor Work Orders (70)	36891-70	N/A	N/A	36891-70	N/A	N/A	36891-70
Chain Drives 1	46613-00	46613-01	46613-02	46613-00	46613-01	46613-02	46613-00
Student Job Sheets (20)	36892-20	N/A	N/A	36892-20	N/A	N/A	36892-20
Instructor Job Sheets (30)	36892-30	N/A	N/A	36892-30	N/A	N/A	36892-30
Student Work Orders (60)	36892-60	N/A	N/A	36892-60	N/A	N/A	36892-60
Instructor Work Orders (70)	36892-70	N/A	N/A	36892-70	N/A	N/A	36892-70
Gear Drives 1	46614-00	46614-01	46614-02	46614-00	46614-01	46614-02	46614-00
Student Job Sheets (20)	36893-20	N/A	N/A	36893-20	N/A	N/A	36893-20
Instructor Job Sheets (30)	36893-30	N/A	N/A	36893-30	N/A	N/A	36893-30
Student Work Orders (60)	36893-60	N/A	N/A	36893-60	N/A	N/A	36893-60
Instructor Work Orders (70)	36893-70	N/A	N/A	36893-70	N/A	N/A	36893-70
46101-20 Mechanical Training System, Level 2							
Belt Drives 2	46612-10	46612-11	46612-12	46612-10	46612-11	46612-12	46612-10
Student Job Sheets (20)	36963-20	N/A	N/A	36963-20	N/A	N/A	36963-20
Instructor Job Sheets (30)	36963-30	N/A	N/A	36963-30	N/A	N/A	36963-30
Student Work Orders (60)	36963-60	N/A	N/A	36963-60	N/A	N/A	36963-60
Instructor Work Orders (70)	36963-70	N/A	N/A	36963-70	N/A	N/A	36963-70
Chain Drives 1	46613-10	46613-11	46613-12	46613-10	46613-11	46613-12	46613-10
Student Job Sheets (20)	36964-20	N/A	N/A	36964-20	N/A	N/A	36964-20
Instructor Job Sheets (30)	36964-30	N/A	N/A	36964-30	N/A	N/A	36964-30
Student Work Orders (60)	36964-60	N/A	N/A	36964-60	N/A	N/A	36964-60
Instructor Work Orders (70)	36964-70	N/A	N/A	36964-70	N/A	N/A	36964-70
Alignment and Couplings	46615-00	46615-01	46615-02	46615-00	46615-01	46615-02	46615-00
Student Job Sheets (20)	36965-20	N/A	N/A	36965-20	N/A	N/A	36965-20
Instructor Job Sheets (30)	36965-30	N/A	N/A	36965-30	N/A	N/A	36965-30
Student Work Orders (60)	36965-60	N/A	N/A	36965-60	N/A	N/A	36965-60
Instructor Work Orders (70)	36965-70	N/A	N/A	36965-70	N/A	N/A	36965-70
Lubrication	46616-00	46616-01	46616-02	46616-00	46616-01	46616-02	46616-00
Student Job Sheets (20)	36966-20	N/A	N/A	36966-20	N/A	N/A	36966-20
Instructor Job Sheets (30)	36966-30	N/A	N/A	36966-30	N/A	N/A	36966-30
Student Work Orders (60)	36966-60	N/A	N/A	36966-60	N/A	N/A	36966-60
Instructor Work Orders (70)	36966-70	N/A	N/A	36966-70	N/A	N/A	36966-70
46101-30 Mechanical Training System, Level 3							
Gear Drives 2	46614-10	46614-11	46614-12	46614-10	46614-11	46614-12	46614-10
Student Job Sheets (20)	37855-20	N/A	N/A	37855-20	N/A	N/A	37855-20
Instructor Job Sheets (30)	37855-30	N/A	N/A	37855-30	N/A	N/A	37855-30
Student Work Orders (60)	37855-60	N/A	N/A	37855-60	N/A	N/A	37855-60
Instructor Work Orders (70)	37855-70	N/A	N/A	37855-70	N/A	N/A	37855-70
Bearings	46617-00	46617-01	46617-02	46617-00	46617-01	46617-02	46617-00
Student Job Sheets (20)	37856-20	N/A	N/A	37856-20	N/A	N/A	37856-20
Instructor Job Sheets (30)	37856-30	N/A	N/A	37856-30	N/A	N/A	37856-30
Student Work Orders (60)	37856-60	N/A	N/A	37856-60	N/A	N/A	37856-60
Instructor Work Orders (70)	37856-70	N/A	N/A	37856-70	N/A	N/A	37856-70
Gaskets and Seals	46618-00	46618-01	46618-02	46618-00	46618-01	46618-02	46618-00
Student Job Sheets (20)	37857-20	N/A	N/A	37857-20	N/A	N/A	37857-20
Instructor Job Sheets (30)	37857-30	N/A	N/A	37857-30	N/A	N/A	37857-30
Student Work Orders (60)	37857-60	N/A	N/A	37857-60	N/A	N/A	37857-60
Instructor Work Orders (70)	37857-70	N/A	N/A	37857-70	N/A	N/A	37857-70
46101-40 Mechanical Training System, Level 4							
Clutches and Brakes	46619-00	46619-01	46619-02	46619-00	46619-01	46619-02	46619-00
Student Job Sheets (20)	37858-20	N/A	N/A	37858-20	N/A	N/A	37858-20
Instructor Job Sheets (30)	37858-30	N/A	N/A	37858-30	N/A	N/A	37858-30
Student Work Orders (60)	37858-60	N/A	N/A	37858-60	N/A	N/A	37858-60
Instructor Work Orders (70)	37858-70	N/A	N/A	37858-70	N/A	N/A	37858-70
Ball Screws and Linear Bearings	46620-00	46620-01	46620-02	46620-00	46620-01	46620-02	46620-00
Student Job Sheets (20)	37859-20	N/A	N/A	37859-20	N/A	N/A	37859-20
Instructor Job Sheets (30)	37859-30	N/A	N/A	37859-30	N/A	N/A	37859-30
Student Work Orders (60)	37859-60	N/A	N/A	37859-60	N/A	N/A	37859-60
Instructor Work Orders (70)	37859-70	N/A	N/A	37859-70	N/A	N/A	37859-70

MANUFACTURING/MECHATRONICS COURSEWARE ORDERING INFORMATION

MODEL DESCRIPTION	120 V - 60 HZ			220 V - 50 HZ			240 V - 50 HZ
	ENGLISH	FRENCH	SPANISH	ENGLISH	FRENCH	SPANISH	ENGLISH
46101-50 Mechanical Training System, Level 5							
Laser Alignment	46621-00	46621-01	46621-02	46621-00	46621-01	46621-02	46621-00
Student Work Orders (60)	38606-60	N/A	N/A	38606-60	N/A	N/A	38606-60
Instructor Work Orders (70)	38606-70	N/A	N/A	38606-70	N/A	N/A	38606-70
Vibration Metering	46622-00	46622-01	46622-02	46622-00	46622-01	46622-02	46622-00
Student Work Orders (60)	38607-60	N/A	N/A	38607-60	N/A	N/A	38607-60
Instructor Work Orders (70)	38607-70	N/A	N/A	38607-70	N/A	N/A	38607-70
Vibration Analysis	46623-00	46623-01	46623-02	46623-00	46623-01	46623-02	46623-00
46109 Rigging Training System							
Basic Rigging Student Work Orders (60)	36971-60	N/A	N/A	36971-60	N/A	N/A	36971-60
46102 Industrial Wiring Training System							
Enclosures and Conduits							
Student Job Sheets (20)	37866-20	N/A	N/A	37866-20	N/A	N/A	37866-20
Instructor Job Sheets (30)	37866-30	N/A	N/A	37866-30	N/A	N/A	37866-30
Student Work Orders (60)	37866-60	N/A	N/A	37866-60	N/A	N/A	37866-60
Instructor Work Orders (70)	37866-70	N/A	N/A	37866-70	N/A	N/A	37866-70
Electrical Wiring							
Student Job Sheets (20)	37867-20	N/A	N/A	37867-20	N/A	N/A	37867-20
Instructor Job Sheets (30)	37867-30	N/A	N/A	37867-30	N/A	N/A	37867-30
Student Work Orders (60)	37867-60	N/A	N/A	37867-60	N/A	N/A	37867-60
Instructor Work Orders (70)	37867-70	N/A	N/A	37867-70	N/A	N/A	37867-70
46106 Pumps Training System							
Basic System	46106-00	46106-01	46106-02	46106-00	46106-01	46106-02	46106-00
Student Job Sheets (20)	37894-20	N/A	N/A	37894-20	N/A	N/A	37894-20
Instructor Job Sheets (30)	37894-30	N/A	N/A	37894-30	N/A	N/A	37894-30
Student Work Orders (60)	37894-60	N/A	N/A	37894-60	N/A	N/A	37894-60
Instructor Work Orders (70)	37894-70	N/A	N/A	37894-70	N/A	N/A	37894-70
Multiple Pump System	46106-10	46106-11	46106-12	46106-10	46106-11	46106-12	46106-10
Student Job Sheets (20)	37895-20	N/A	N/A	37895-20	N/A	N/A	37895-20
Instructor Job Sheets (30)	37895-30	N/A	N/A	37895-30	N/A	N/A	37895-30
Student Work Orders (60)	37895-60	N/A	N/A	37895-60	N/A	N/A	37895-60
Instructor Work Orders (70)	37895-70	N/A	N/A	37895-70	N/A	N/A	37895-70
External Gear Pump	46710-00	46710-01	46710-02	46710-00	46710-01	46710-02	46710-00
Student Work Orders (60)	37896-60	N/A	N/A	37896-60	N/A	N/A	37896-60
Instructor Work Orders (70)	37896-70	N/A	N/A	37896-70	N/A	N/A	37896-70
Vane Pump	46711-00	46711-01	46711-02	46711-00	46711-01	46711-02	46711-00
Student Work Orders (60)	37897-60	N/A	N/A	37897-60	N/A	N/A	37897-60
Instructor Work Orders (70)	37897-70	N/A	N/A	37897-70	N/A	N/A	37897-70
Flexible Impeller Pump	46712-00	46712-01	46712-02	46712-00	46712-01	46712-02	46712-00
Student Work Orders (60)	37898-60	N/A	N/A	37898-60	N/A	N/A	37898-60
Instructor Work Orders (70)	37898-70	N/A	N/A	37898-70	N/A	N/A	37898-70
Progressive Cavity Pump	46713-00	46713-01	46713-02	46713-00	46713-01	46713-02	46713-00
Student Work Orders (60)	37899-60	N/A	N/A	37899-60	N/A	N/A	37899-60
Instructor Work Orders (70)	37899-70	N/A	N/A	37899-70	N/A	N/A	37899-70
Peristaltic Pump	46714-00	46714-01	46714-02	46714-00	46714-01	46714-02	46714-00
Student Work Orders (60)	37900-60	N/A	N/A	37900-60	N/A	N/A	37900-60
Instructor Work Orders (70)	37900-70	N/A	N/A	37900-70	N/A	N/A	37900-70
Pneumatic Diaphragm Pump	46715-00	46715-01	46715-02	46715-00	46715-01	46715-02	46715-00
Student Work Orders (60)	37901-60	N/A	N/A	37901-60	N/A	N/A	37901-60
Instructor Work Orders (70)	37901-70	N/A	N/A	37901-70	N/A	N/A	37901-70
Metering Pump	46716-00	46716-01	46716-02	46716-00	46716-01	46716-02	46716-00
Student Work Orders (60)	37902-60	N/A	N/A	37902-60	N/A	N/A	37902-60
Instructor Work Orders (70)	37902-70	N/A	N/A	37902-70	N/A	N/A	37902-70
Piston Pump	46717-00	46717-01	46717-02	46717-00	46717-01	46717-02	46717-00
Student Work Orders (60)	37903-60	N/A	N/A	37903-60	N/A	N/A	37903-60
Instructor Work Orders (70)	37903-70	N/A	N/A	37903-70	N/A	N/A	37903-70
Stuffing-Box Seal Centrifugal Pump	46721-00	46721-01	46721-02	46721-00	46721-01	46721-02	46721-00
Student Work Orders (60)	37904-60	N/A	N/A	37904-60	N/A	N/A	37904-60
Instructor Work Orders (70)	37904-70	N/A	N/A	37904-70	N/A	N/A	37904-70
Multi-Stage Vertical Centrifugal Pump	46723-00	46723-01	46723-02	46723-00	46723-01	46723-02	46723-00
Student Work Orders (60)	37905-60	N/A	N/A	37905-60	N/A	N/A	37905-60
Instructor Work Orders (70)	37905-70	N/A	N/A	37905-70	N/A	N/A	37905-70
Magnetic-Drive Centrifugal Pump	46724-00	46724-01	46724-02	46724-00	46724-01	46724-02	46724-00
Student Work Orders (60)	37906-60	N/A	N/A	37906-60	N/A	N/A	37906-60
Instructor Work Orders (70)	37906-70	N/A	N/A	37906-70	N/A	N/A	37906-70

MANUFACTURING/MECHATRONICS COURSEWARE ORDERING INFORMATION

MODEL DESCRIPTION	120 V - 60 HZ			220 V - 50 HZ			240 V - 50 HZ
	ENGLISH	FRENCH	SPANISH	ENGLISH	FRENCH	SPANISH	ENGLISH
3100 Industrial Controls Training System							
Student Manual	27073-00	N/A	27073-02	27073-00	N/A	27073-02	27073-00
Instructor Guide	27073-10	N/A	27073-12	27073-10	N/A	27073-12	27073-10
3250 DC Variable Speed Drive							
Student Manual	76097-20	N/A	76097-22	N/A	N/A	N/A	N/A
Instructor Guide	76097-30	N/A	76097-32	N/A	N/A	N/A	N/A
3260 AC Variable Speed Drive							
Student Manual	76098-20	N/A	76098-22	N/A	N/A	N/A	N/A
Instructor Guide	76098-30	N/A	76098-32	N/A	N/A	N/A	N/A
6080 Hydraulics Training System							
Student Manuals:							
Hydraulics Fundamentals	30794-00	30794-01	30794-02	30794-00	30794-01	30794-02	30794-00
Electrical Control of Hydraulic Systems	31228-00	31228-01	31228-02	31228-00	31228-01	31228-02	31228-00
Hydraulics Applications -PLC	31305-00	31305-01	31305-02	31305-00	31305-01	31305-02	31305-00
Servo/Proportional Control of Hydraulics Systems	31745-00	31745-01	31745-02	31745-00	31745-01	31745-02	31745-00
Sensors	32606-00	32606-01	32606-02	32606-00	32606-01	32606-02	32606-00
Instructor Guide:							
Hydraulics	30794-10	30794-11	30794-12	30794-10	30794-11	30794-12	30794-10
6081 Pneumatics Training System							
Student Manuals:							
Pneumatics Fundamentals	31290-00	31290-01	31290-02	31290-00	31290-01	31290-02	31290-00
Electrical Control of Pneumatics Systems	31300-00	31300-01	31300-02	31300-00	31300-01	31300-02	31300-00
Pneumatics Applications -PLC	31726-00	31726-01	31726-02	31726-00	31726-01	31726-02	31726-00
Servo/Proportional Control of Pneumatics Systems	31977-00	31977-01	31977-02	31977-00	31977-01	31977-02	31977-00
Sensors	32606-00	32606-01	32606-02	32606-00	32606-01	32606-02	32606-00
Instructor Guide:							
Pneumatics	31290-10	31290-11	31290-12	31290-10	31290-11	31290-12	31290-10
6385 Hydraulics Simulation Software (LVSIM®-HYD)							
Student Manuals:							
Hydraulics Fundamentals	30794-00	30794-01	30794-02	30794-00	30794-01	30794-02	30794-00
Electrical Control of Hydraulics Systems	31228-00	31228-01	31228-02	31228-00	31228-01	31228-02	31228-00
Instructor Guide:							
Hydraulics	30794-10	30794-11	30794-12	30794-10	30794-11	30794-12	30794-10
User Guide:							
Virtual Laboratory and Equipment	32359-E0	N/A	32359-E2	32359-E0	N/A	32359-E2	32359-E0
6485 Pneumatics Simulation Software (LVSIM®-PNEU)							
Student Manuals:							
Pneumatics Fundamentals	31290-00	31290-01	31290-02	31290-00	31290-01	31290-02	31290-00
Electrical Control of Pneumatics Systems	31300-00	31300-01	31300-02	31300-00	31300-01	31300-02	31300-00
Instructor Guide:							
Pneumatics	31290-10	31290-11	31290-12	31290-10	31290-11	31290-12	31290-10
User Guide:							
Virtual Laboratory and Equipment	32359-E0	N/A	32359-E2	32359-E0	N/A	32359-E2	32359-E0

MANUFACTURING/MECHATRONICS COURSEWARE ORDERING INFORMATION

MODEL DESCRIPTION	120 V - 60 HZ			220 V - 50 HZ			240 V - 50 HZ
	ENGLISH	FRENCH	SPANISH	ENGLISH	FRENCH	SPANISH	ENGLISH
6059 Fundamentals of Fluid Power							
Student Manual Vol. 1	81033-00	N/A	N/A	81033-00	N/A	N/A	81033-00
Instructor Guide Vol. 1	81033-01	N/A	N/A	81033-01	N/A	N/A	81033-01
Pre-Test Student	81036-00	N/A	N/A	81036-00	N/A	N/A	81036-00
Pre-Test Answer Key	81036-01	N/A	N/A	81036-01	N/A	N/A	81036-01
Post-Test Student	81037-00	N/A	N/A	81037-00	N/A	N/A	81037-00
Post-Test Answer Key	81037-01	N/A	N/A	81037-01	N/A	N/A	81037-01
Text Book	81047-00	N/A	N/A	81047-00	N/A	N/A	81047-00
Student Manual Vol. 2	81034-00	N/A	N/A	81034-00	N/A	N/A	81034-00
Instructor Guide Vol. 2	81034-01	N/A	N/A	81034-01	N/A	N/A	81034-01
Pre-Test Student	81038-00	N/A	N/A	81038-00	N/A	N/A	81038-00
Pre-Test Answer Key	81038-01	N/A	N/A	81038-01	N/A	N/A	81038-01
Post-Test Student	81039-00	N/A	N/A	81039-00	N/A	N/A	81039-00
Post-Test Answer Key	81039-01	N/A	N/A	81039-01	N/A	N/A	81039-01
3521 Process Control Trainer							
Student Manual	30416-00	30416-01	30416-02	30416-00	30416-01	30416-02	30416-00
3522 Temperature/Flow Process							
Student Manual	32081-00 32081-10	N/A N/A	32081-02 N/A	32081-00 32081-10	N/A N/A	32081-02 N/A	32081-00 32081-10
3674 Process Control Simulator (LV-PROSIM)							
Student Manual	30884-00	N/A	30884-02	30884-00	N/A	30884-02	30884-00
6090 Process Control Training System							
Student Manuals: Process Control Fundamentals Using LVPROSIM Software Pressure, Flow and Level Process Control Temperature Process Control	 30884-00 32621-00 33336-00	 32621-01 33336-01	 30884-02 32621-02 33336-02	 30884-00 32621-00 33336-00	 32621-01 33336-01	 30884-02 32621-02 33336-02	 30884-00 32621-00 33336-00
3501-MO Mobile Pressure Process Station							
Student Manual Instructor Guide	75941-20 75941-30	75941-21 75941-31	75941-22 75941-32	75941-20 75941-30	75941-21 75941-31	75941-22 75941-32	75941-20 75941-30
3502-MO Mobile Flow Process Station							
Student Manual Instructor Guide	75942-20 75942-30	75942-21 75942-31	75942-22 75942-32	75942-20 75942-30	75942-21 75942-31	75942-22 75942-32	75942-20 75942-30
3503-MO Mobile Level Process Station							
Student Manual Instructor Guide	75943-20 75943-30	75943-21 75943-31	75943-22 75943-32	75943-20 75943-30	75943-21 75943-31	75943-21 75943-31	75943-20 75943-30
3504-MO Mobile Temperature Process Station							
Student Manual Instructor Guide	75944-20 75944-30	75944-21 75944-31	75944-22 75944-32	75944-20 75944-30	75944-21 75944-31	75944-22 75944-32	75944-20 75944-30
3505-MO Mobile Multi-Process Station							
Student Manual Instructor Guide	31446-00 N/A	N/A N/A	N/A N/A	31446-00 N/A	N/A N/A	N/A N/A	31446-00 N/A
3507-MO Heat Exchanger Station							
Student Manual Instructor Guide	75947-20 75947-30	N/A N/A	N/A N/A	75947-20 75947-30	N/A N/A	N/A N/A	75947-20 75947-30
3508-MO Analytic Process Station							
Student Manual Instructor Guide	75948-20 75948-30	N/A N/A	N/A N/A	75948-20 75948-30	N/A N/A	N/A N/A	75948-20 75948-30

MANUFACTURING/MECHATRONICS COURSEWARE ORDERING INFORMATION

MODEL DESCRIPTION	120 V - 60 HZ			220 V - 50 HZ			240 V - 50 HZ
	ENGLISH	FRENCH	SPANISH	ENGLISH	FRENCH	SPANISH	ENGLISH
3550-MO Instrumentation and Calibration Station							
Student Manual Instructor Guide	76015-20 76015-30	76015-21 76015-31	76015-22 76015-32	76015-20 76015-30	76015-21 76015-31	76015-22 76015-32	76015-20 76015-30
Model 5100-20 Teach Pendant Controlled Robot							
User Manual Student Manual Instructor Guide	TBE 34431-00 34431-10	N/A N/A N/A	N/A N/A N/A	TBE 34431-00 34431-10	N/A N/A N/A	N/A N/A N/A	TBE 34431-00 34431-10
Model 5150-10 Computer-Controlled Robot							
User Manual Student Manual Instructor Guide	TBE 34431-00 34431-10	N/A N/A N/A	N/A N/A N/A	TBE 34431-00 34431-10	N/A N/A N/A	N/A N/A N/A	TBE 34431-00 34431-10
Model 5250 Servo Robot							
User Manual Student Manual Instructor Guide	34175-E0 34175-00 34175-10	N/A N/A	N/A N/A	34175-E0 34175-00 34175-10	N/A N/A	N/A N/A	34175-E0 34175-00 34175-10
5300 CNC Lathe							
User Guide: CNC Lathe Software	36188-E0	N/A	36188-E2	36188-E0	N/A	36188-E2	36188-E0
5400 CNC Mill							
User Guide: CNC Mill Software	36189-E0	N/A	36189-E2	36189-E0	N/A	36189-E2	36189-E0
5500 CNC Lathe							
User Guide: CNC Lathe Software Quick-Start Guide: Familiarization with the CNC Lathe	36188-E0 36784-E0	N/A N/A	36188-E2 36784-E2	36188-E0 36784-E0	N/A N/A	36188-E2 36784-E2	36188-E0 36784-E0
5600 CNC Mill							
User Guide: CNC Mill Software Quick-Start Guide: Familiarization with the CNC Mill	36189-E0 36783-E0	N/A N/A	36189-E2 36783-E2	36189-E0 36783-E0	N/A N/A	36189-E2 36783-E2	36189-E0 36783-E0
3240 PLC Training System							
Student Basic Principles Student Programming Software & Applications Instructor's Guide Basic Principles Instructor's Guide Programming Software and Applications	36017-00 32381-00 36017-10 32381-10	N/A N/A N/A N/A	36017-02 32381-02 36017-12 32381-12	36017-00 32381-00 36017-10 32381-10	N/A N/A N/A N/A	36017-02 32381-02 36017-12 N/A	36017-00 32381-00 36017-10 32381-10
3341 Exploring Sensors							
Student Manual	30811-00	N/A	30811-02	30811-00	N/A	30811-02	30811-00
3342 Exploring Mechanisms							
Student Manual	30812-00	N/A	N/A	30812-00	N/A	N/A	30812-00
3343 Exploring Electricity							
Student Manual	30813-00	N/A	30813-02	30813-00	N/A	30813-02	30813-00

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Graymark Information Technology Brochure

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Fluid Power Brochure

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Tech-Design® Foundations in Information Technology (FIT)

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Tech-Design® Technology Education Catalog

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Tech-World®: Manufacturing Demo CD

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