AEROSPACE
TRAINING RANGE

Excellence in education
for over 30 years

Manufactured in the UK 1993

www.matrixtsl.com

AEROSPACE
TRAINING RANGE

The aerospace teaching equipment from Matrix satisfies the requirements of various modules of Part 66 of the European Aviation Safety Agency syllabus which is internationally recognised as the gold standard for training Aviation maintenance engineers. This brochure has been arranged to show where our products meet the needs of certain sections of the syllabus.

Aerospace is a growing area of focus for Matrix, as we are adding more solutions our portfolio all the time. The systems here focus on:

- Electrical and electronic fundamentals in aviation
- Digital techniques and principles
- Avionics EFIS system
- Wind tunnel for study of aerodynamics
- Various mechanical principles including fluids
- Electrical machines and motor drives

Why choose Matrix products? All of our kits are low power, curriculum mapped, rugged, portable and space saving. We offer a full learning package while making affordable kits which are available to all.

BRITISH AIRWAYS

> "We value the Locktronics equipment during the training of apprentices and engineers progressing down the route of EASA part 66 maintenance Engineers Licence. They are invaluable both as demonstration equipment on short courses and apprentices conducting their own experiments, construction of circuits, testing and understanding of electrics, electronics and digital technologies."
>
> *Tony Russell*

MATRIX

We can fulfil all of your engineering teaching requirements

Contact us to find out more

+44 (0) 1422 252 380

sales@matrixtsl.com

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MATRIX LAB

MODULE 2.0
PHYSICS

Statics Fundamentals
CP6368

Statics Fundamentals
FM1883

Materials Fundamentals
CP0876

Materials Fundamentals
FM1292

Dynamics Fundamentals
CP1505

Dynamics Fundamentals
FM3935

Mechanisms Fundamentals
CP2840

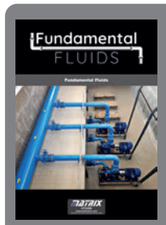
Mechanisms Fundamentals
FM0759

Motion Studies with Light Gates & Wireless Dynamic Carts
CP5099

Linear and Rotational Dynamics
HP5099-2

Thermodynamics
CP4261

Thermodynamics Kit
HP4159



Fundamental Fluids
CP2599

Fluids Fundamentals
FM1000

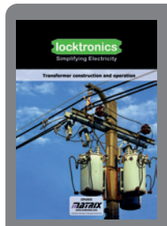
MODULE 3.0
ELECTRICAL FUNDAMENTALS

EASA Electrical Fundamentals 1 - 4
LK7378 / LK7381
LK7393 / LK7415

EASA Electrical Fundamentals (module 3)
LK9339

EASA Electronic Fundamentals 1 - 4
LK7419 / LK7422
LK7426 / LK7430

EASA Electrical and Electronic Fundamentals (modules 3 and 4)
LK9672



Transformer Construction and Operation
CP1933

Transformers
LK1989

Electrical Machines Systems
CP6490

Modern Electrical Machines
EM6637-2

MODULE 4.0
ELECTRONIC FUNDAMENTALS

EASA Electrical Fundamentals 1 - 4
LK7378 / LK7381
LK7393 / LK7415

EASA Electrical Fundamentals (module 4)
LK9282

EASA Electronic Fundamentals 1 - 4
LK7419 / LK7422
LK7426 / LK7430

EASA Electrical and Electronic Fundamentals (modules 3 and 4)
LK9672

Process Control Systems
CP3720

Servo/Pendulum Motor Control System
CT9513

MODULE 5.0
DIGITAL TECHNIQUES/ ELECTRONICS INSTRUMENTATION

Digital Techniques in Aviation
CP7224

FLOWCODE

Digital Techniques in Aviation
BL2976

EFIS Trainer
CP5715

EFIS Trainer
AV3737

MODULE 8.0
BASIC AERODYNAMICS

Aerodynamics
CP0704

Wind Tuunel 125
AV5289

MODULE 11.0
AEROPLANE AERODYNAMICS, STRUCTURES AND SYSTEMS

Pneumatics Essentials
AW2080

Automatics Essentials Solution
AU9020

Electro-pneumatics
AW2079

Automatics Electro-pneumatics Add-on
AU9015

LEARNING CENTRE

Enter the product code on the learning centre to find the curriculum

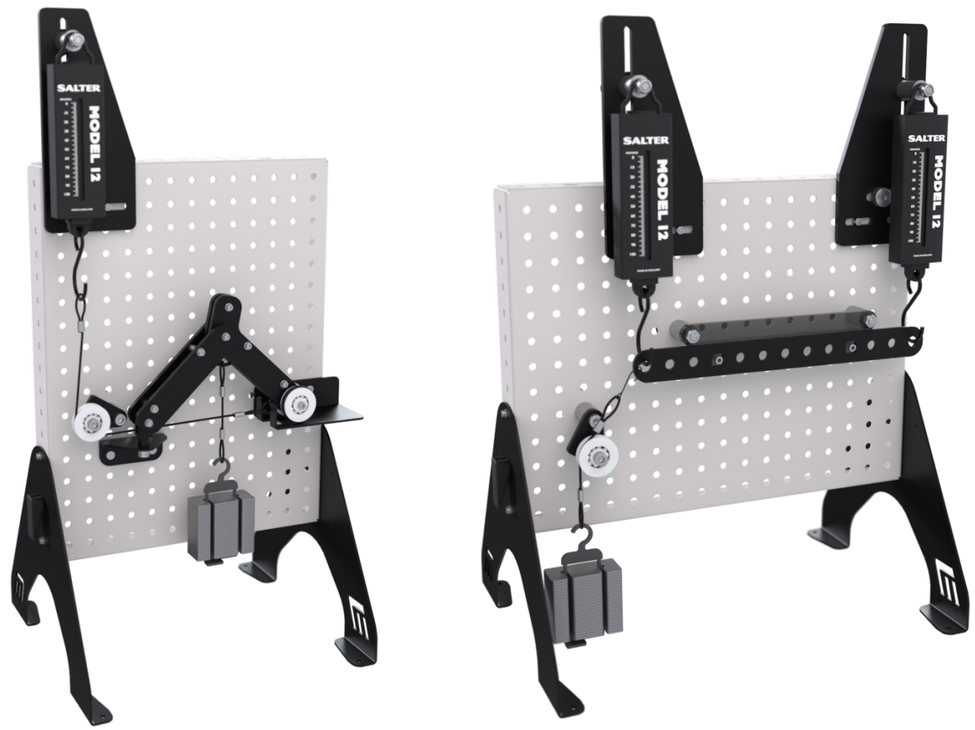
PRODUCT NAME
PRODUCT CODE

MODULE 2.0
PHYSICS

Within Module 2.0 of EASA Part 66 learners are provided with a broad knowledge of mechanics and thermodynamics. Here, we provide equipment from ranges including our Fundamental Mechanics and Fundamental Fluids products to gain a primary understanding of various topical areas including statics, materials, dynamics, mechanisms, thermodynamics and fluids.

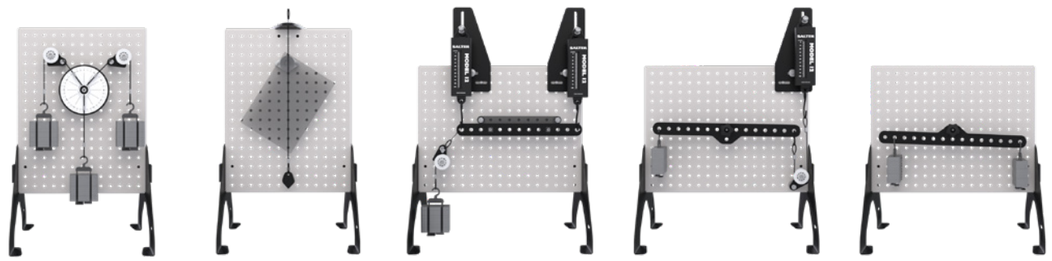
Fundamental MECHANICS

Fundamental mechanics allows aerospace students to study the basic principles of mechanical engineering. Four kits are available in the main fundamentals range covering statics, materials, dynamics and mechanisms. A complete set combines all of these in to one easy to use, robust and storable lab system. Each kit includes a rugged metal panel with removable legs, the components needed for the experiments and a rugged storage tray. The experimental components are hard-wearing and high quality, meaning they stand up to the rigours of an educational lab. We are also able to provide experimentation kits for the study of Linear and Rotational Dynamics – including data-logging – and Thermodynamics principles. Both of which are essential to the learning of aerospace students studying EASA module 2.0.



Statics Fundamentals FM1883

This set of equipment covers the needs of students studying forces, moments, beams and more. Students use the storable work panel (included) to construct a range of experiments, which allow you to study a full course in static engineering systems. A full 10-hour workbook is included free of charge in the Learning Centre for this kit.



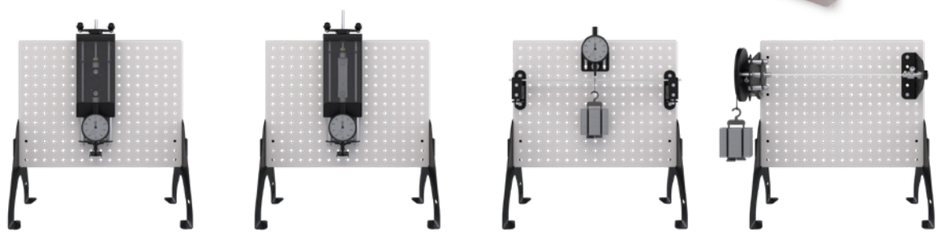
LEARNING OBJECTIVES & EXPERIMENTS:

- Forces (mass, force, weight, combining, parallelogram, triangle and polygon
- Centre of gravity
- Units of weight and mass
- Free body diagrams
- Force vectors
- Coplanar forces
- Bow's notation
- Principles of moments and moment of forces
- Distinguishing between moments and torque
- Equilibrium of forces
- Levers and the term mechanical advantage
- Simply supported beams
- Concentrated and uniform distributed loads
- Different types of pinned supports

SCAN TO VISIT PRODUCT PAGE

Materials Fundamentals FM1292

This set of equipment covers the needs of students studying torsion, stress and strain, elastic constants, Young's Modulus and more. Students use the storable work panel (included) to construct a range of experiments, which allow you to study a full course in material principles. A full 10-hour workbook is included free of charge in the Learning Centre for this kit.



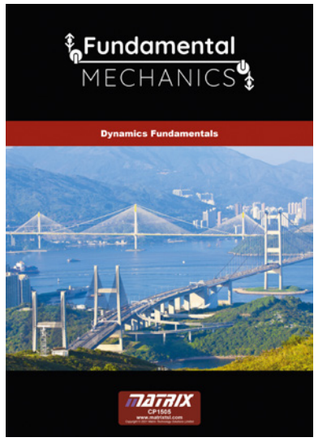
LEARNING OBJECTIVES & EXPERIMENTS:

- Torsion of rods
- What effect has Polar second moment of area on torque and modulus of rigidity
- What effect has torque, shape, length and material on rod deflection
- Tensile test using plastic, aluminium and mild steels
- Understand the terms stress and strain
- Introduction to Youngs modulus for different materials
- Terms elastic deformation and plastic deformation
- Terms yield strength and ductility
- Shear force tests
- Shear stress and shear strain
- What effect has second moment of area on beam deflection
- What effect has load, shape, length and material on beam deflection
- Different types of supports for beams

SCAN TO VISIT PRODUCT PAGE

Dynamics Fundamentals FM3935

This set of equipment covers the needs of students studying pulleys, static and sliding friction, mechanisms and energy conversion. Students use the storable work panel (included) to construct a range of experiments, which allow you to study a full course in dynamic engineering systems. A full 10 hour workbook is included free of charge in the Learning Centre for this kit.



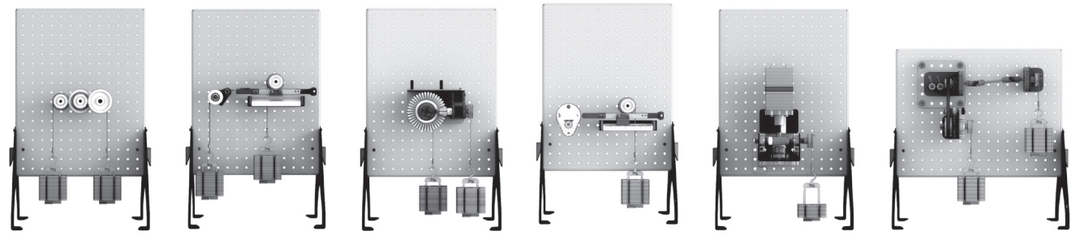
LEARNING OBJECTIVES & EXPERIMENTS:

- Kinetic and gravitational energy parameters and principles
- Dynamic parameters and principles
- Newton's Law of Motion
- Mechanical efficiency and advantage
- Flywheel experimentation
- Toggle mechanisms
- Single and compound Pulley experimentation
- Static and sliding friction on Inclined planes (with frictional surfaces and rollers)

SCAN TO VISIT PRODUCT PAGE

Mechanisms Fundamentals FM0759

This set of equipment covers the needs of students studying gears, cranks, different shapes of cam and drive systems integrated with universal joint using chain/belt transmission system.' Students use the storable work panel (included) to construct a range of experiments, which allow you to study a full course in Mechanisms. A full 10 hour workbook is included free of charge in the Learning Centre for this kit.



LEARNING OBJECTIVES & EXPERIMENTS:

Gears (Mechanical Advantage (MA), Efficiency and Gear Ratio):

- Simple Gear
- Compound Gear
- Rack & Pinion Gear
- Bevel Gear
- Worm Gear
- Screw Jack

Cams (Displacement Analysis):

- Tangent Cam
- Snail Cam
- Eccentric Cam
- Crank (Force and Displacement Analysis)

Drive System (MA, Efficiency and Gear Ratio):

- Universal Joint
- Belt Transmission
- Chain Transmission

SCAN TO VISIT PRODUCT PAGE

Complete Fundamentals FM9458

This full set of equipment allows students to understand the principles of fundamental statics, materials, dynamics and mechanism engineering systems in one portal set of equipment.

Included in this equipment are the full contents of the following kits:

Statics Fundamentals
Materials Fundamentals
Dynamics Fundamentals
Mechanisms Fundamentals

The user receives everything in neat, Gratnell's trays and each solution includes a work panel (4 in total). Four, 10 hour workbooks are included free of charge in the Learning Centre for this kit.

SCAN TO VISIT PRODUCT PAGE

Thermodynamics Kit HP4159

This kit allows engineering students to carry out a wide range of practical experiments in Thermodynamics to help them understand the temperature related behaviour of mechanical systems. The kit includes experimental apparatus including metal blocks with heating elements, linear rods with heaters, Leslie cube and Jolly bulb. The kit also includes measuring instruments such as digital thermometers, energy meter, and infrared thermometer. A downloadable manual covers all experiments and includes teacher's notes. A unique feature of the kit is that all the experiments can be completed just with electricity as the heat source – no Bunsen burner is required.

Additional power supply required. Please enquire for further information.

LEARNING OBJECTIVES & EXPERIMENTS:

- Heat capacity of liquids
- Heat capacity of solids
- Linear expansion of heat
- Heat absorption
- Heat radiation
- Expansion of gases – Charles' law
- Boyle's law

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Linear and Rotational Dynamics HP5099-2

The linear and rotational dynamics kit includes a wireless dynamics system, wireless rotary motion sensor and accessories kit and 2 wireless light gates. Being wireless, the components can be set up anywhere in the room, with results sent straight to your screen and student's devices simultaneously.

This kit allows students and teachers to carry out a range of experiments in dynamics with investigations.

The equipment is supplied with 2 curriculum workbooks, a suite of worksheets and teacher support material.

LEARNING OBJECTIVES & EXPERIMENTS:

- Velocity
- Acceleration
- Newton's law
- Forces
- Collisions
- Conversion of momentum and energy

SCAN TO VISIT PRODUCT PAGE

All solutions from Matrix come with a full free curriculum. This is easily accessed from our Learning Centre on the website and includes full student worksheets and teachers notes.

LEARNING CENTRE

SCAN TO VISIT LEARNING CENTRE

MATRIX

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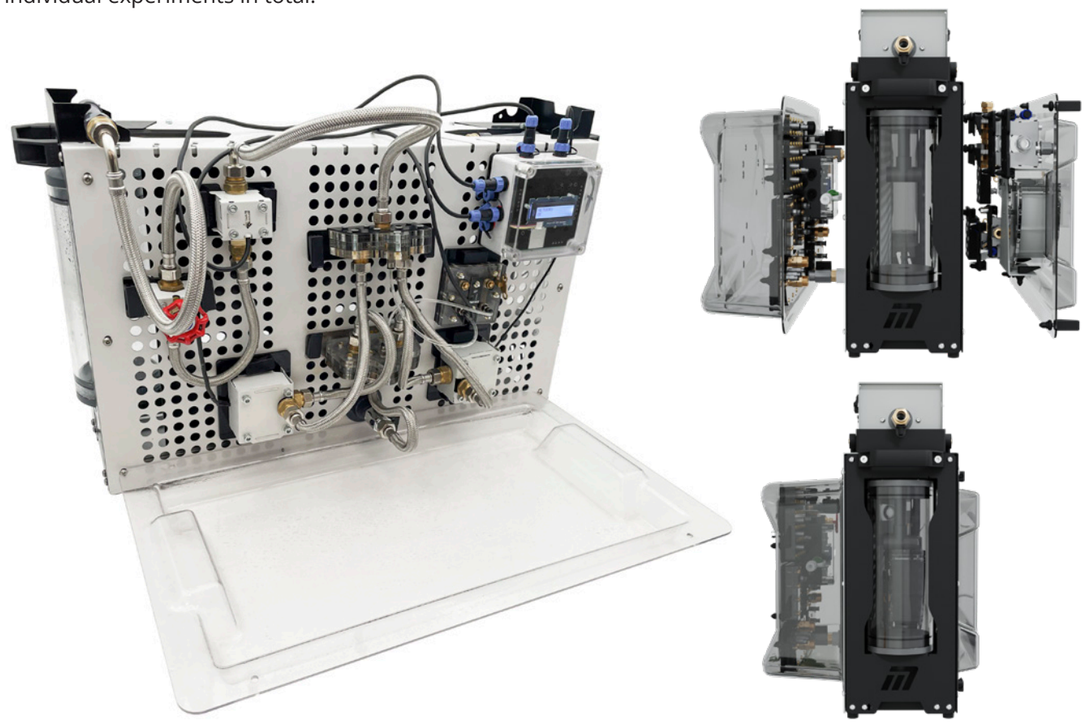
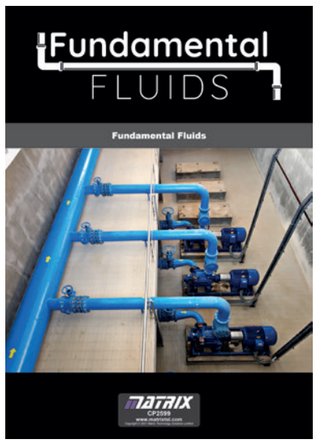
Fundamental FLUIDS

The study of fluid mechanics is essential for aerospace technician training. The Fundamental Fluids training kit from Matrix provides a hands-on understanding of the key principles for aerospace technicians. A main workstation is supplied along with sixteen individual components, which allows students to build nine different experiments. Six of the experiments are connected via USB to the pressure and flow sensors, which allows results to be automatically plotted on a graph for analysis. Results from the remaining three experiments are plotted manually. Students will learn about fluid mechanics principles including viscosity and Bernoulli's theorem, which are specifically outlined as part of EASA module 2.0.
A full free curriculum is provided with easy-to-follow worksheets.

Fundamental Fluids FM1000

Our Fundamental Fluids kit is designed to meet the needs of those studying fluid mechanics principles at college and university level. The system is supplied with a series of learning apparatus (see outlined on the following pages), hoses with robust gaskets and a rugged metal workstation. The system can be packed away and stored when not in use. Each of the apparatus is attached within the workstation and two protective covers are attached to the front and back to offer protection. The flow pipes drop down into the unit and the viscosity apparatus attaches to the top of the workstation to create one compact storable unit. This kit provides nine individual experiments in total.





LEARNING OBJECTIVES & EXPERIMENTS:

- Calibration of a Bourdon gauge
- Centre of pressure on a partially and fully submerged plane
- Viscosity apparatus, demonstrating Stoke's law
- Use of manometers and different types (multitube manometer, U-tube manometer and inclined manometer)
- Bernoulli's equation and using a Venturi tube as a flow meter
- Losses in bends, measuring and comparing pressure losses of different bend geometries
- Centrifugal pump characteristics, experimentally determining the pressure/flow rate characteristics of a pump and determining the overall efficiency
- Series pumps, experimentally determining the pressure/ flow characteristics of 2 pumps connected in series configuration
- Parallel pumps, experimentally determining the pressure/ flow characteristics of 2 pumps connected in parallel configuration

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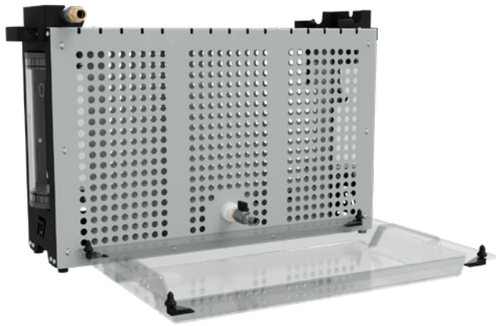
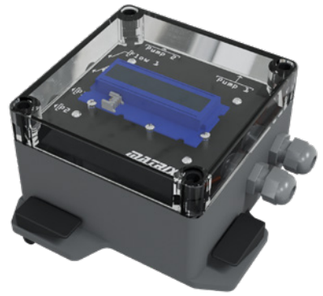


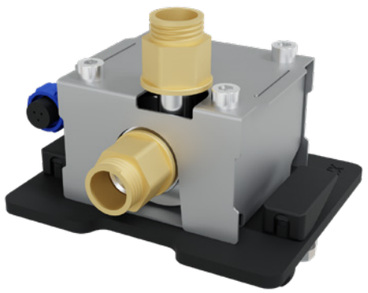
Main Workstation

The main workstation is built of rugged steel and has a built-in panel which allows you to easily clip on the required component. Two water tanks, with a combined capacity of 3L, along with inbuilt connectors, allows students to quickly set up each experiment. When in storage, the flow pipes drop down into the frame, all components are stored within, the drip tray doubles as a back panel to enhance protection.

Control Box

Working with a PC connection, the control box is the brain of the apparatus. Allowing simultaneous control of 2 pumps, while taking readings from 2 flow and 2 pressure sensors, the LCD screen gives students an instantaneous readout. The readings are passed from the control box to the PC software, which plots results for student analysis. The data can also be logged and loaded into Excel for further investigation by students.





Pump Module

The Pump module has an operating voltage of 6-24v and produces a free-flow flow rate of 13 litres/min. It works alongside the control box, to pump water around the apparatus. It features brass connection points for increased longevity

Differential Pressure Sensor

The Differential pressure sensor module is used to measure pressure in the fluid circuits, it features:

- True wet/wet differential sensing
- Easy-to-use, built-in air bleeding system
- Pressure sensing range 0-30 PSI (0-200000 Pa)
- Robust construction, simple push fit fittings using 4mm tube

Flow Sensor

The Flow sensor module houses a calibrated turbine flow sensor. It is used to provide flow rate readout in the app and on the control module screen.

It can measure 0-30l/min

It has robust brass fittings for repeated assembly/ disassembly.

Bourdon Gauge

The Bourdon gauge calibration module is used to compare a known, dead-weight acting through a piston/cylinder of known diameter with the reading on the Bourdon gauge.

The apparatus allows students to determine the accuracy of the Bourdon gauge and highlights the limitations of using these devices.

Multitube Manometer

The multitube manometer module permits comparative pressure measurement between 0 and 120mm of water (0-1200Pa).

The module features:

- Three input pressure ports at the bottom, each connecting to a single vertical limb.
- One reference pressure port that is common to all three limbs at the top.
- A pipette filler (supplied) as a convenient method of applying a reference pressure to the top pressure port.

The pressure ports are self-sealing, push-in fittings and connections are made using 4mm push-in pneumatic tubing. This allows direct comparative measurements to be made between the three input pressure ports.

U-Tube & Inclined Manometer

The U-tube and inclined manometer has a measurement range of 0-110mm.

4mm tubing is attached to the pressure ports using easy-to-use push-in fittings. The inclined manometer indexes to positions at 30°,60° and 90° from horizontal.

Losses in Bends Module

The losses in bends module consists of a clearly visible fluid path with 3 different 90° bend geometries.

Each of the bends have self-sealing pressure ports before and after each bend so the pressure drop can be measured using the multitube manometer module.

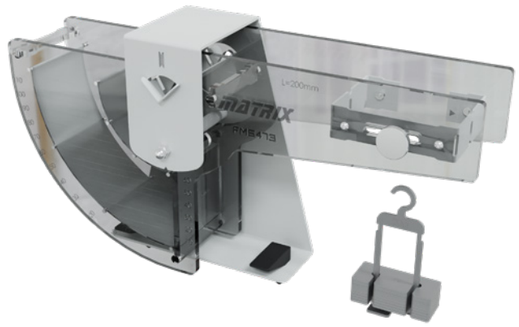
Viscosity Apparatus

The viscosity apparatus consists of a 100mm diameter clear acrylic tube filled with vegetable glycerine.

This assembly is housed in a sturdy metal enclosure which protects it whilst in storage or being transported.

It features ¼-turn valves at the top and bottom to enable releasing and retrieving spherical samples used in the experiment.

The experiment demonstrates Stoke's law. Students determine the viscosity of the glycerine by measuring the terminal velocity of spherical samples through the fluid.



Centre of Pressure Module

The Centre of pressure module is used for determining the centre of pressure of partially and fully submerged surfaces. This experiment is carried out manually by students who are able to take readings and plot them within the curriculum for analysis.

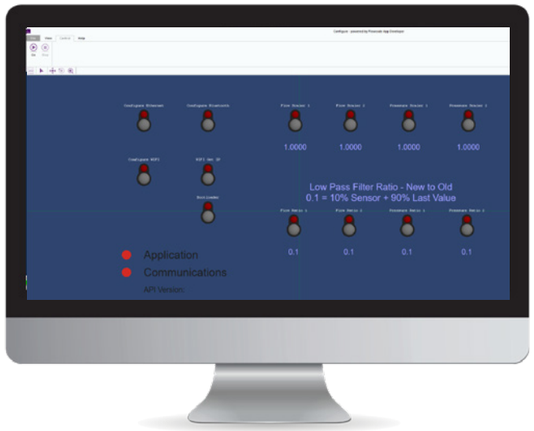
Venturi Tube Module

The Venturi tube module is used to investigate Bernoulli's principle.

The flow section is constricted resulting in a pressure drop.

Pressure ports at the widest and narrowest section permit attaching the differential pressure sensor for automated readings or the manometer module can be attached to enable manual readings.

Fundamental Fluids FM1000



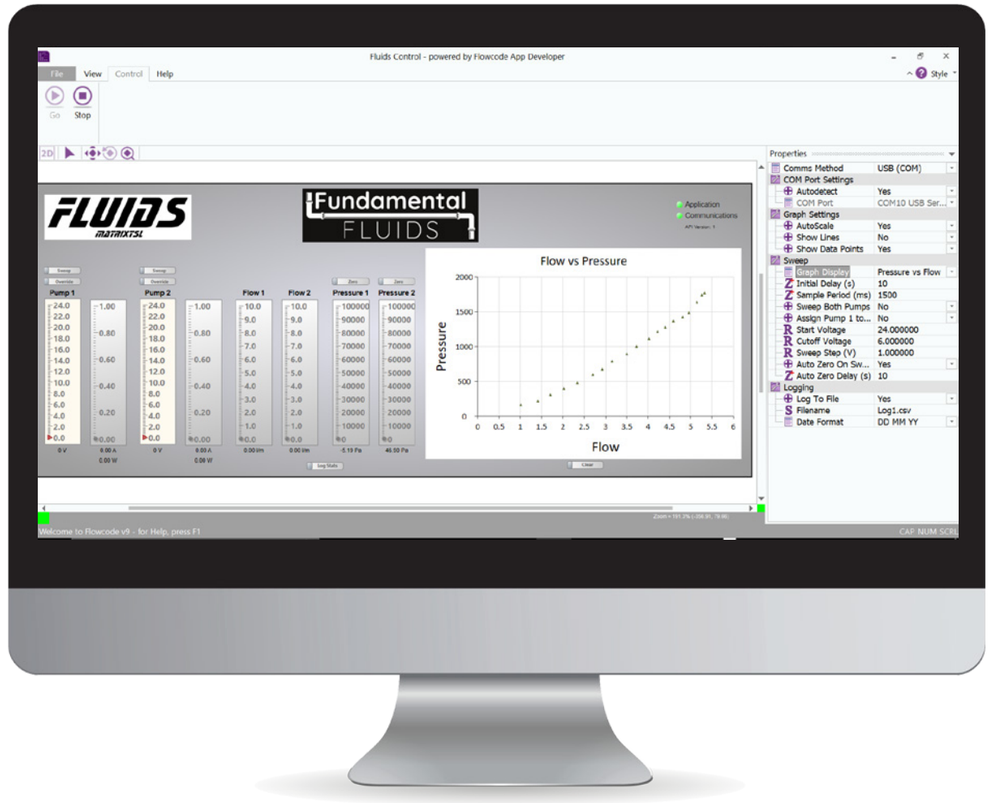
Fluids Configure Application

Each of the sensors are calibrated prior to shipping and the electronic control module is sent with these calibration values.

The user can re-calibrate each of the sensors in situ using the fluids configure application.

This application also allows the user to alter the filter that is applied to the instantaneous sensor readings.

Each of the buttons shown above opens a dialog box for changing the values for each of the settings.



Fluids Control Application

Readouts for pumps show instantaneous voltage, Current and Power as well as live displays for flow and pressure sensors.

Manual control of the pumps is provided by clicking and dragging the red slider, alternatively the exact pump voltage(s) can be set using the override button

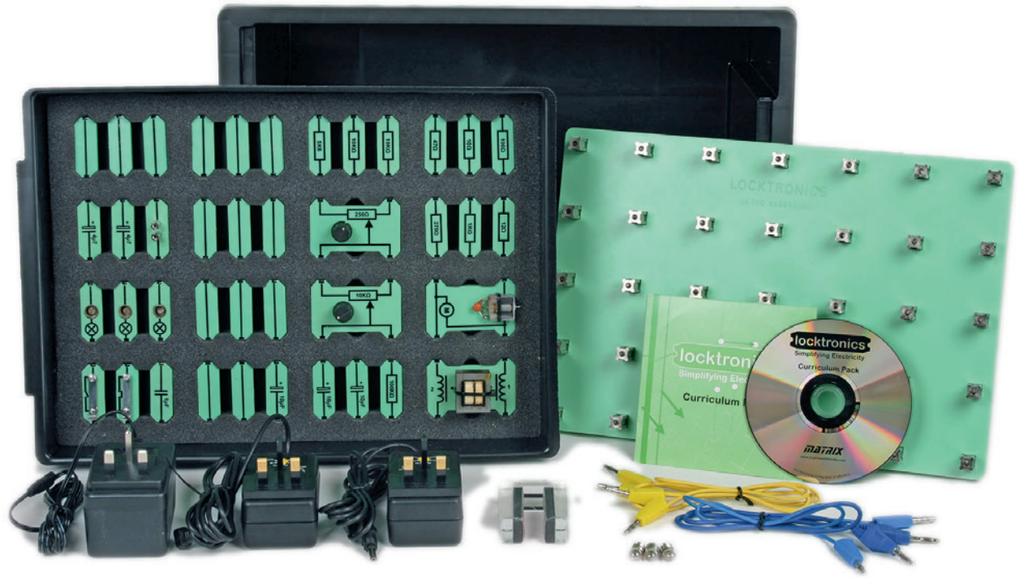
User can alter parameters to suit their experiment. The sweep function automatically sets the pump voltage to 24V and decreases in steps defined by the user. Data for each sensor is recorded and the resulting graph is plotted live. This data can also be logged in a time stamped .CSV file for more thorough analysis.

MODULE 3.0
ELECTRICAL FUNDAMENTALS

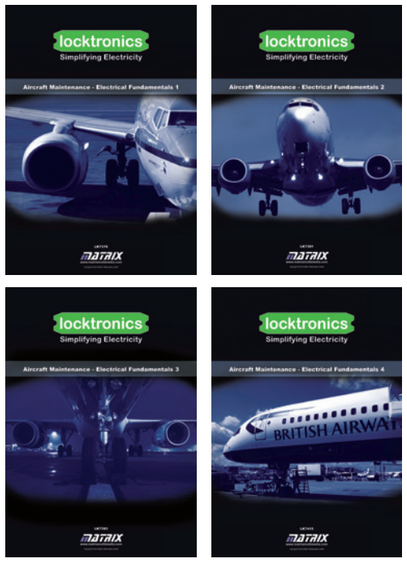
Within Module 3.0 of EASA Part 66 learners gain a key understanding of the electrical fundamentals required by aerospace technicians. Here, we provide equipment from ranges including our Locktronics and Electrical Machines products. These allow students to gain an understanding not only for the underlying circuit principles behind electrical fundamentals, but also of different motor characteristics including DC, AC and Three Phase Motors.

EASA Electrical Fundamentals (module 3) LK9339

This comprehensive solution is designed to fulfil the learning requirements of the European Safety Agency (EASA) module 3 - electrical fundamentals - for aircraft maintenance engineers. The solution contains all the Locktronics parts needed as well as 4 separate workbooks covering each of the sub-modules in the EASA specification.



ANSI version also available **LK9339A**



LEARNING OBJECTIVES & EXPERIMENTS:

- Series and parallel circuits
- Measuring voltage and current
- Cells and batteries
- Thermocouples
- Photocells
- Ohm's law

- Resistors in series and in parallel
- Series/parallel networks
- Voltage and current dividers
- Kirchoff's laws
- Power in DC circuits
- Power transfer

- Capacitors and electrostatics
- Inductors and inductance
- DC motors
- Generator principles
- Transformers and their construction
- Transformer losses

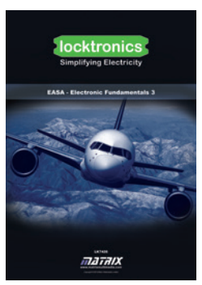
- AC measurements
- Inductance and capacitance
- LR and CR series AC circuits
- LCR series AC circuits
- LR and CR parallel AC circuits
- LCR parallel AC circuits
- Q factor and bandwidth
- Low pass and high pass filters
- Band pass and band stop filters

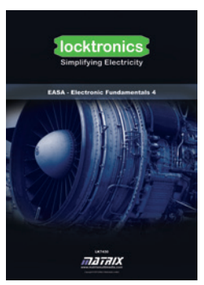
SCAN TO VISIT PRODUCT PAGE

EASA Electrical and Electronic Fundamentals (modules 3 and 4) LK9672

This comprehensive solution is designed to fulfil the learning requirements of the European Safety Agency (EASA) module 3 - electrical fundamentals - for aircraft maintenance engineers. The solution contains all the Locktronics parts needed as well as 4 separate workbooks covering each of the sub-modules in the EASA specification.

ANSI version also available **LK9672A**





LEARNING OBJECTIVES & EXPERIMENTS:

This kit includes all of the learning objectives included in LK9339 plus the following:

- Testing a diode
- Diode characteristics
- Diode clipping
- Diode clamping
- Half-wave rectifier
- Full-wave (bridge) rectifier
- Voltage multiplier
- Thyristor
- Zener diode characteristics
- Zener diode voltage regulator
- Light emitting diodes

- Testing transistors
- BJT transistor characteristics
- Transistor as a switch
- Transistor as an amplifier
- Transformer coupled amplifier
- Stabilised common-emitter amplifier
- Two-stage amplifier
- Push - pull amplifier
- Twin - T oscillator
- Ladder oscillator
- Astable multivibrator

- Operational amplifier principles
- Comparator vs Schmitt trigger
- Non-inverting amplifier
- Voltage follower
- Inverting amplifier
- Summing amplifier
- Differential amplifier
- Differentiator
- Integrator
- Logic gates
- AND and OR logic
- Fibre optics

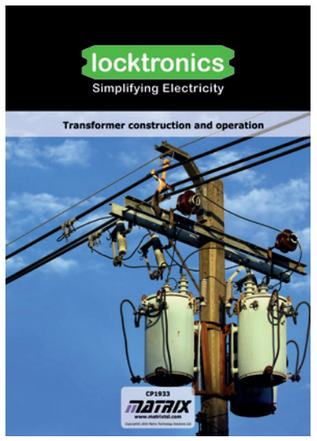
- LVDT principles
- Controlling capacitive sensors
- Relaxation oscillator
- Motor controller
- Feedback control system

SCAN TO VISIT PRODUCT PAGE

Transformer Construction and Operation LK1989

The Transformer construction and operation pack allows students to study not only how transformers work, but also study several different properties of induced magnetism. This kit consists of a plastic base, a laminated iron core, mounting fixtures, and six coils protected in a heat resistant film. Topics covered include Lenz' Law, Faraday's Law, how iron cores increase magnetic field strength, and electromagnetic induction itself. This versatile piece of equipment can also be used to teach about how transformers used by power companies carry electrical energy. Extensive instructions on how to use the apparatus as a demonstration as well as inquiry based lessons surrounding electromagnetic induction and transformers are included.

ANSI version also available **LK1989A**



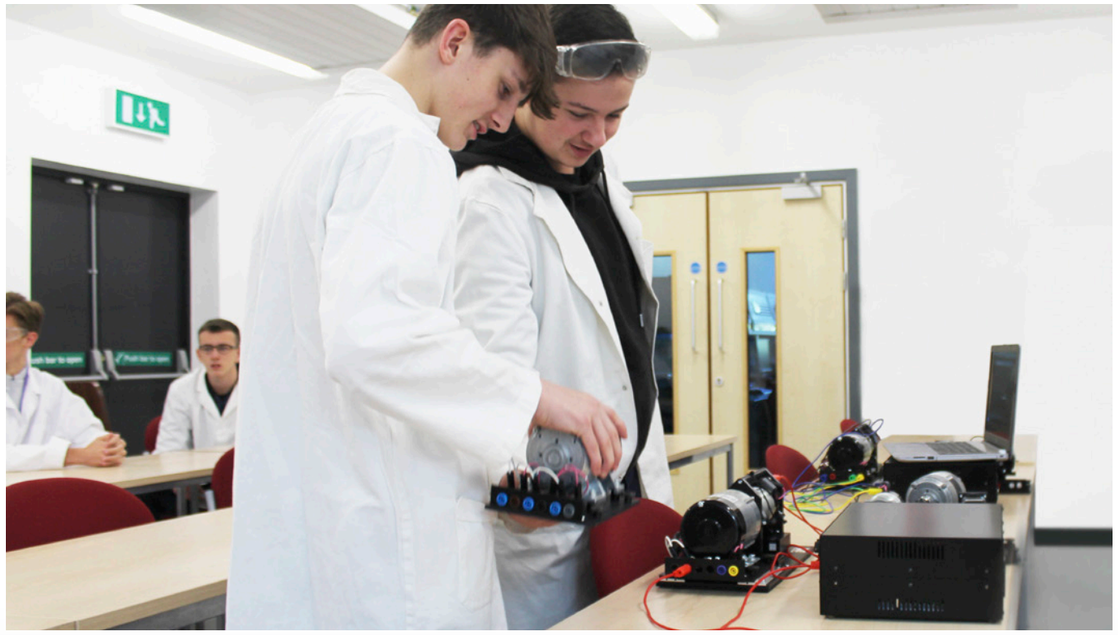
LEARNING OBJECTIVES & EXPERIMENTS:

- Power and energy in DC systems
- Power in AC systems, power factor, losses
- Transformer construction
- Reactive loads

SCAN TO VISIT PRODUCT PAGE

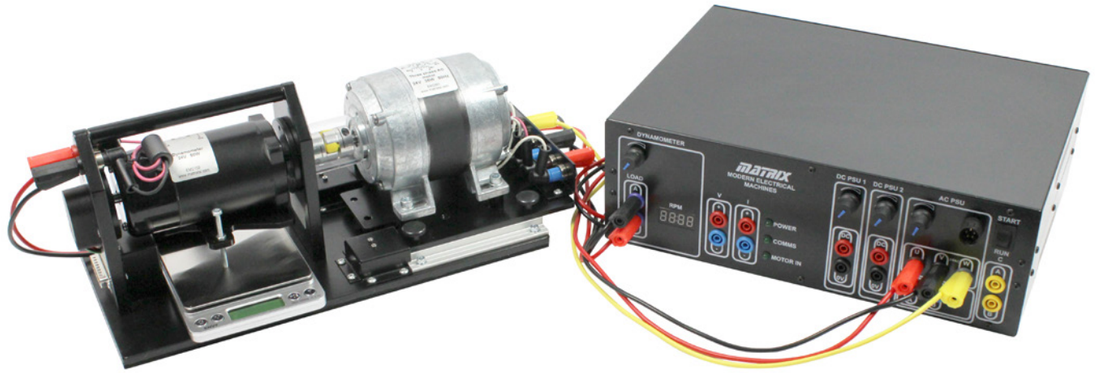
EM ELECTRICAL MACHINES

Our modern electrical machines training system is a revolutionary way of safely studying the characteristics of different motor types in a learning environment. This solution includes ten different types of machine, integrated power supply, control box and PC-based applications for advanced control of the different machine types. Further to this, we provide four separate curriculum manuals for teaching electrical machines principles using manual control with external meters, using PC control or using MATLAB.



Why choose Electrical Machines:

- Makes learning easier
- Extensive free curriculum
- Rugged and reliable
- Covers range of subject areas
- 10 different machines
- Sturdy storage for solutions
- Minimal assembly required
- MATLAB and LABview control



THIS KIT INCLUDES:

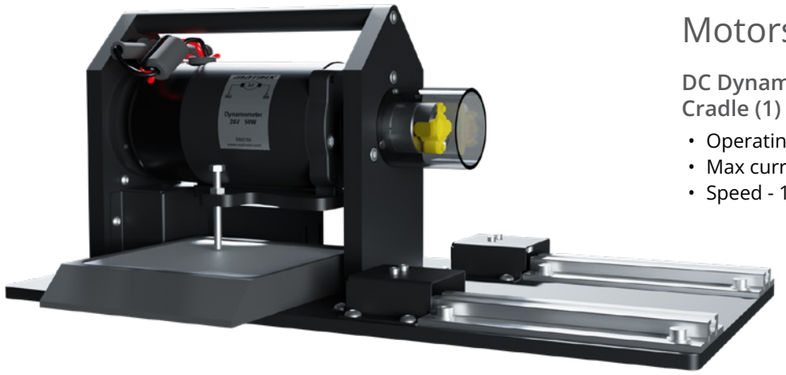
- Safe Operation; all moving parts covered
- Operates on 24V power, AC or DC
- Use manual or full PC Controls for the motors
- Measure voltage, current and power in DC and AC
- All machines are small footprint and low power
- Equipment can be easily stored and packed away

Control Box

At the heart of both manual and PC control of the machines is our control box. The control box houses all of the electronics including motor drivers, to control the modern electrical machines training system.

CONTROL BOX FEATURES

- Select DC, single-phase AC and 3-phase AC outputs
- Integrated voltage and current measurement
- Adjustable dynamometer load
- Switchable start and run capacitor
- 14 different instruments embedded within it
- A unique API, allowing connection to be made to the MATLAB environment
- A small size, around the size of a laptop, making it small enough to sit on a desk along with the rest of the kit and PC



Motors

DC Dynamometer / Motor and Cradle (1)

- Operating voltage – 24V
- Max current - 2A
- Speed - 1500rpm

The aluminium cradle which houses our dynamometer features a rugged and safe sliding mechanism into which each of the other six motors in the range fix into position. The motor coupling meets the dynamometer in a protected housing and allows for safe study of each machine type at 24 volts. When using our system in manual mode, it is likely you will require two (per set) HP1324 Fluke 115 True RMS Digital Multimeter and one HP8067 Tektronix Digital oscilloscope.

Three Phase Induction Motor (2)

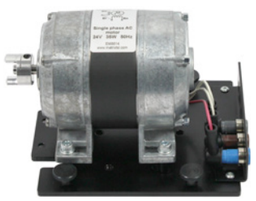
Operating voltage – 24V AC
Frequency – 40-80Hz
Max current – 1.4A
Speed – 1400rpm

Shunt Motor (3)

Operating voltage – 24V AC
Max current – 12A
Speed – 1500rpm

Single Phase Induction Motor (4)

Operating voltage – 24V AC
Frequency – 40-80Hz
Max current – 1.4A
Speed – 1400rpm



Universal (5) / Series (6) Machine

Operating voltage – 24V AC
Frequency – 50Hz
Max current – 6A
Speed – 1500rpm

DC Motor (7) / Dynamo (8)

Operating voltage – 24V AC
Frequency – 40-80Hz
Speed – 1500rpm

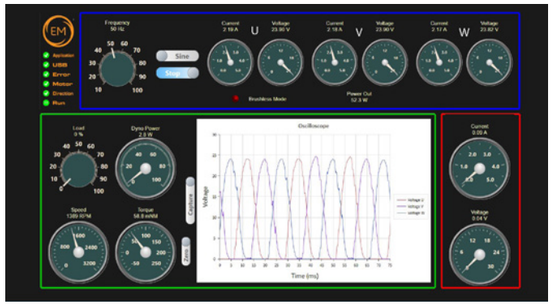
Brushless DC Motor (9) / Synchronous Phase Generator (10)

Operating voltage – 24V AC
3 Phase
Max current – 2A
Speed – 1500rpm

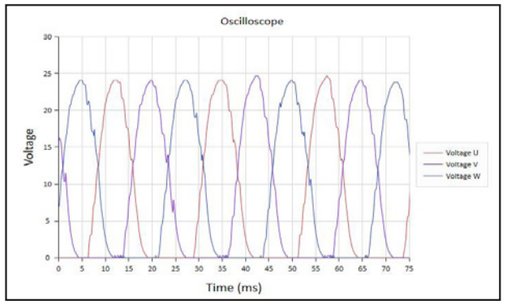
PC Software

The system is designed to be used manually or via connection to a laptop or PC. When utilising the PC control option, the user should download the app from the Resources page on the website. Below are a range of screenshots showcasing the ways the proprietary software can be used to control each type of machine in the range.

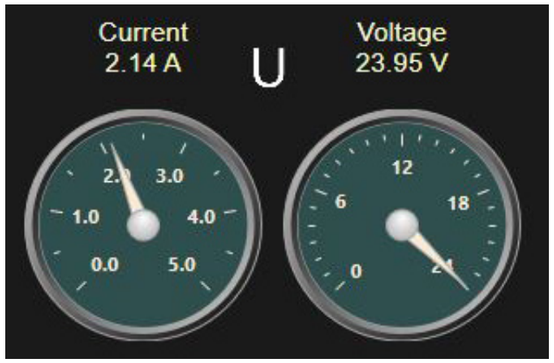
Through experimentation, users can review the results of altering the voltage, load etc of each machine and the subsequent effect this has on each machine's current, torque etc. over time.



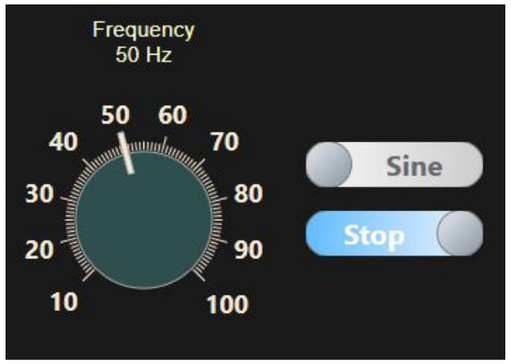
Three phase control software with integrated oscilloscope.



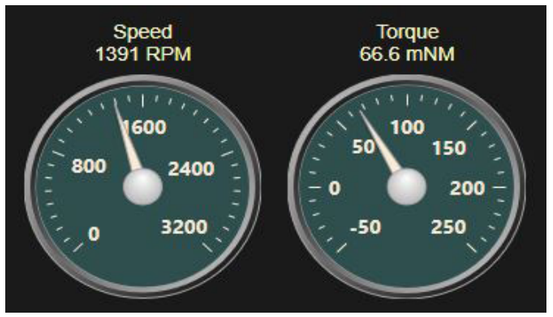
Close up of oscilloscope plot – users can select from one of 14 on-board instruments.



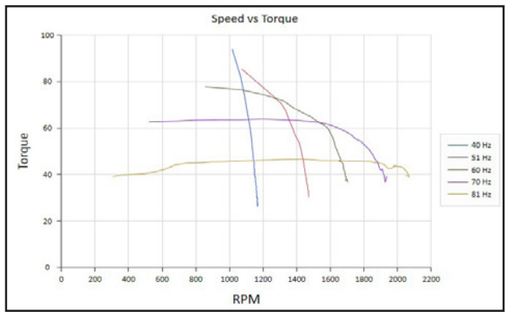
Gauges show key values such as current and voltage.



Set output frequency and waveform type – in this case digital or pseudo-sine.



Software allows you to monitor RPM and torque in real time.



Automatic speed torque graph for any of the machines can be generated by the software.

Optional Add Ons

Transformer Add On — EM4425

This add-on allows users to add transformer construction study to the electrical machines system from Matrix. This add-on is used with the Advanced Electrical machines curriculum and with this kit, students can study:

- Open and short circuit characteristics of transformers
- Circuit modelling of transformers using MATLAB or LabVIEW

LEARNING OBJECTIVES & EXPERIMENTS:

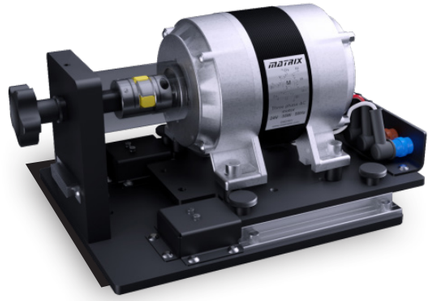
- Transformer open circuit test
- Transformer short circuit test

SCAN TO VISIT PRODUCT PAGE

Locked Rotor Add On — EM2551

This locked rotor add-on allows higher level students to ascertain the equivalent circuit of an electrical machine through the locked rotor and free running rotor tests, students can study:

- Open and short circuit characteristics of induction motors
- Circuit modelling of transformers using MATLAB or LabVIEW



LEARNING OBJECTIVES & EXPERIMENTS:

- Induction machine locked rotor test
- Induction motor free running test

SCAN TO VISIT PRODUCT PAGE

Electrical Machines — EM6637-2

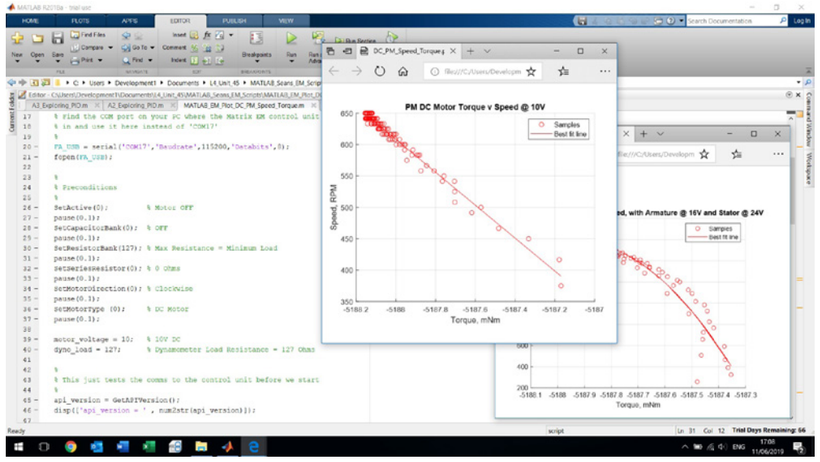
The electrical machines system is supplied with internet-based control as standard. This means the system can be used remotely by students, for distance or blended learning purposes.

Featuring Internet Control

MATLAB and LABVIEW

A suite of API calls are provided which allows the system to be used with both MATLAB and LabVIEW software.

This allows students to understand the characterisation of electromechanical systems using mathematical formulae and to compare simulated results with real world values.



Electrical Machines

EM6637-2

We have created 4 curriculum packs to go with our range of modern electrical machines. They follow the learning required within different courses and come complete with learning instructions, worksheets and a teacher's section. They come equipped with all the learning required for the course, along with the software required.

Electrical Machines System

Teaches students the basics of electrical machine operation, their speed / torque characteristics, relevant mathematical relationships including torque, power, and slip, and details of the circuits and power supplies needed to drive them.

Electrical Machines, Electrical Installation & HVAC

Teaches Electrical Installation students the basics of electrical machine operation, their speed / torque characteristics and the circuits and power supplies needed to drive them.

MATLAB and Electrical Machines

Teaches students how to use MATLAB to measure the characteristics of electrical machines, how to define the characteristics using a mathematical model and to verify that model using test results.

Advanced Electrical Machines

Introduces students to more advanced concepts and models of electrical machines and focuses particularly on building equivalent circuits of machines.

Easily packed away and stored solution

"The electrical machines kit from Matrix is provided with storage trays. The kit is easily disassembled and packed in trays which can be stacked and stored away, leaving space for a multi use classroom"

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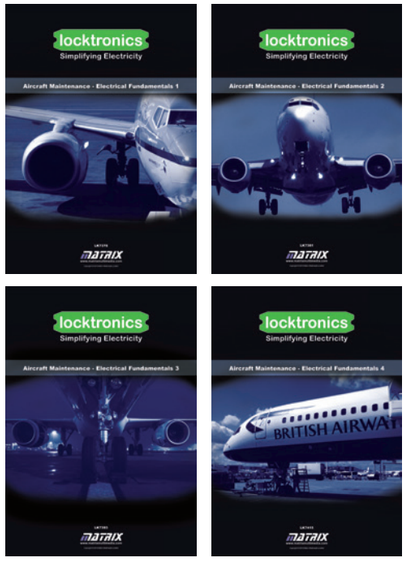
MODULE 4.0
ELECTRONIC FUNDAMENTALS

Within Module 4.0 of EASA Part 66 learners continue their learning from module 3.0 by gaining an understanding of electronic fundamentals. In this section we include equipment from our Locktronics range as well as our Servo pendulum control system which is ideal for teaching open and closed loop systems, motor speed, position and more.

EASA Electrical Fundamentals (module 4) LK9282

This solution is designed to fulfil the learning requirements of the European Safety Agency (EASA) module 4 - electronic fundamentals for aircraft maintenance engineers. The solution contains all the Locktronics parts needed including 4 separate workbooks covering each of the sub-modules in the EASA specification.

ANSI version also available **LK9282A**



LEARNING OBJECTIVES & EXPERIMENTS:

- Testing a diode
- Diode characteristics
- Diode clipping
- Diode clamping
- Half-wave rectifier
- Full-wave (bridge) rectifier
- Voltage multiplier
- Thyristor
- Zener diode characteristics
- Zener diode voltage regulator
- Light emitting diodes

- Testing transistors
- BJT transistor characteristics
- Transistor as a switch
- Transistor as an amplifier
- Transformer coupled amplifier
- Stabilised common-emitter amplifier
- Two-stage amplifier
- Push - pull amplifier
- Twin - T oscillator
- Ladder oscillator
- Astable multivibrator

- Operational amplifier principles
- Comparator vs Schmitt trigger

- Non-inverting amplifier
- Voltage follower
- Inverting amplifier
- Summing amplifier
- Differential amplifier
- Differentiator
- Integrator
- Logic gates
- AND and OR logic
- Fibre optics

- LVDT principles
- Controlling capacitive sensors
- Relaxation oscillator
- Motor controller
- Feedback control system

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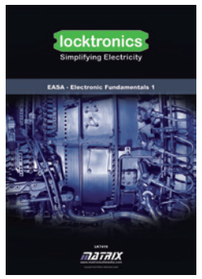
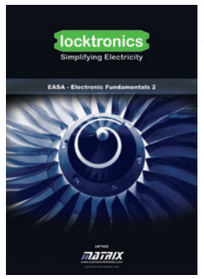
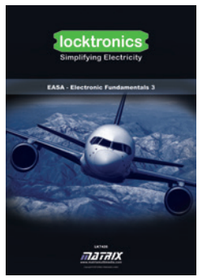
EASA Electrical and Electronic Fundamentals (modules 3 and 4) LK9672

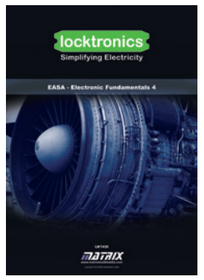
This comprehensive solution is designed to fulfil the learning requirements of the European Safety Agency (EASA) module 3 - electrical fundamentals - for aircraft maintenance engineers. The solution contains all the Locktronics parts needed as well as 4 separate workbooks covering each of the sub-modules in the EASA specification.

ANSI version also available **LK9672A**









LEARNING OBJECTIVES & EXPERIMENTS:

This kit includes all of the learning objectives included in LK9282 plus the following:

- Series and parallel circuits
- Measuring voltage and current
- Cells and batteries
- Thermocouples
- Photocells
- Ohm's law

- Resistors in series and in parallel
- Series/parallel networks
- Voltage and current dividers
- Kirchoff's laws
- Power in DC circuits
- Power transfer

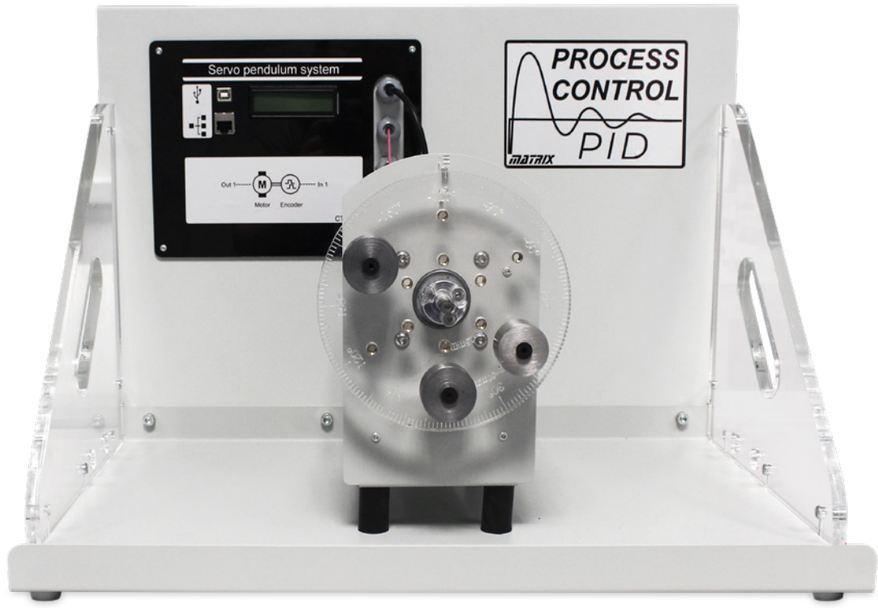
- Capacitors and electrostatics
- Inductors and inductance
- DC motors
- Generator principles
- Transformers and their construction

- Transformer losses
- AC measurements
- Inductance and capacitance
- LR and CR series AC circuits
- LCR series AC circuits
- LR and CR parallel AC circuits
- LCR parallel AC circuits
- Q factor and bandwidth
- Low pass and high pass filters
- Band pass and band stop filters

SCAN TO VISIT PRODUCT PAGE

Motor Control CT9513

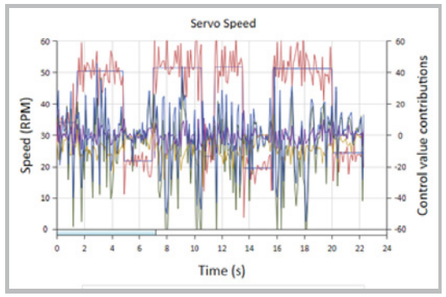
The system consists of a powerful DC motor mounted on a rugged frame. A disc with captive nuts is attached to the DC motor and students are able to screw in 100-gram weights to different parts of the disc to alter the characteristics of the system. A single weight at 0 degrees forms an inverting pendulum.



LEARNING OBJECTIVES & EXPERIMENTS:

- Understanding the drive
- Understanding the sensors
- On/Off control systems
- System time constant
- PI controller
- PID controller

- Zeigler Nichols algorithm
- Integral wind up
- Derivative filter
- Manual tuning
- Servo pendulum - angle control



SCAN TO VISIT PRODUCT PAGE

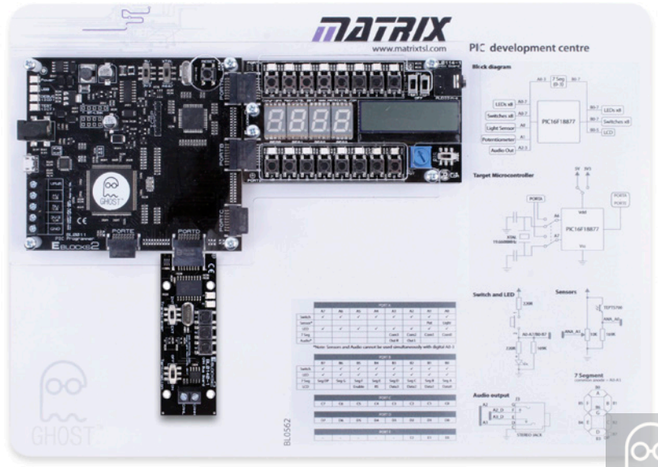
MODULE 5.0

DIGITAL TECHNIQUES/ ELECTRONICS INSTRUMENTATION

Module 5.0 covers multiple subjects, including computers and microprocessors, digital techniques and Electronic Flight Instrument Systems (EFIS). We have developed two sets of equipment which cover many of these key principles. These systems are controlled through our software package, Flowcode, which is a professional development environment that allows engineers to develop microcontroller based systems through graphical programming.

Digital Techniques in Aviation BL2976

This package is designed for students working towards EASA part 66 – module 5: Digital Techniques. The solution consists of a set of microcontroller based training hardware based on our E-blocks system including a PICmicro programmer board, general purpose input output board, motors training board and a CAN bus communications interface. Students firstly use our Flowcode software to develop simple programs, compile and send them to the microcontroller hardware. Then students look at pre-written programs to understand how more complex systems are developed. Lastly students use prewritten programs to interface the hardware to our Electronic Flight Information System trainer using CAN bus to understand how larger more complex aircraft systems are developed. By following this process students learn how digital microcontroller and microprocessor based systems and peripherals function in a modern, relevant and motivating environment. An 80 page manual is included. Requires Flowcode software. This is a student centered course that will take around 10 hours to complete.



Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Logic Analyzer

Requires Flowcode which must be ordered separately

LEARNING OBJECTIVES & EXPERIMENTS:

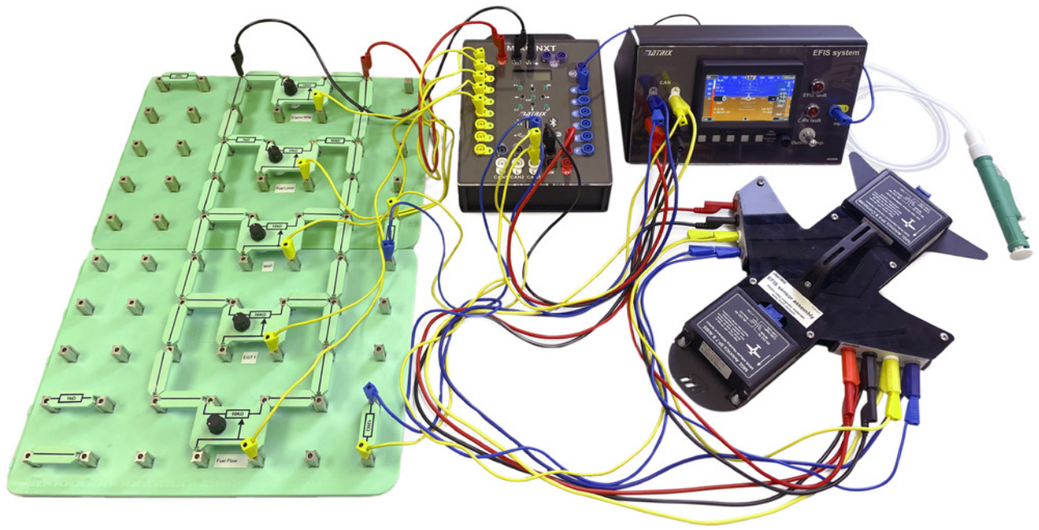
- Decimal, binary, hexadecimal
- Microcontroller chips and types
- Microcontroller technology: CPU, ROM, RAM, ALU, inputs, outputs, clock, internal peripherals
- Microcontroller circuits and systems
- Microcontroller programming:
- Flow chart programming techniques
- Inputs, Outputs, Delays, IF...THEN, While, Goto points, Calculations, Decisions, Subroutines
- Compilers, Assemblers, Linkers
- Variables, open loop control, closed loop control
- LED indicators, 7-segment LED displays
- Switches - push to make and slide
- Serially addressed LCD displays
- Potentiometers and sensors
- PWM control of motors, stepper motors, servo motors,
- Microcontroller communications and multiplexing
- Digital to Analogue conversion and Analogue to Digital conversion
- CAN bus for communications

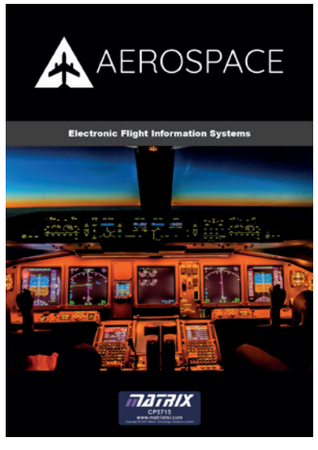
SCAN TO VISIT PRODUCT PAGE

EFIS Trainer

AV3737

The Matrix Electronic Flight Information System consists of an EFIS with LCD display, user controls, compass sensor, attitude sensor and a Locktronics board with additional potentiometers mimicking further sensors on an aircraft. The sensors and the EFIS are connected with CAN bus. Students use this system and PC based diagnostic software to understand how complex computer based flight systems are made from separate electronic modules linked by multiplexed signals on a serial data bus – in this case the CAN bus. Fault finding with multimeters and oscilloscopes is included. The system links to our microcontrollers training package so that students can understand system operation at a low level. A 50 page manual is included. This is a student centred course that will take around 5 hours to complete.

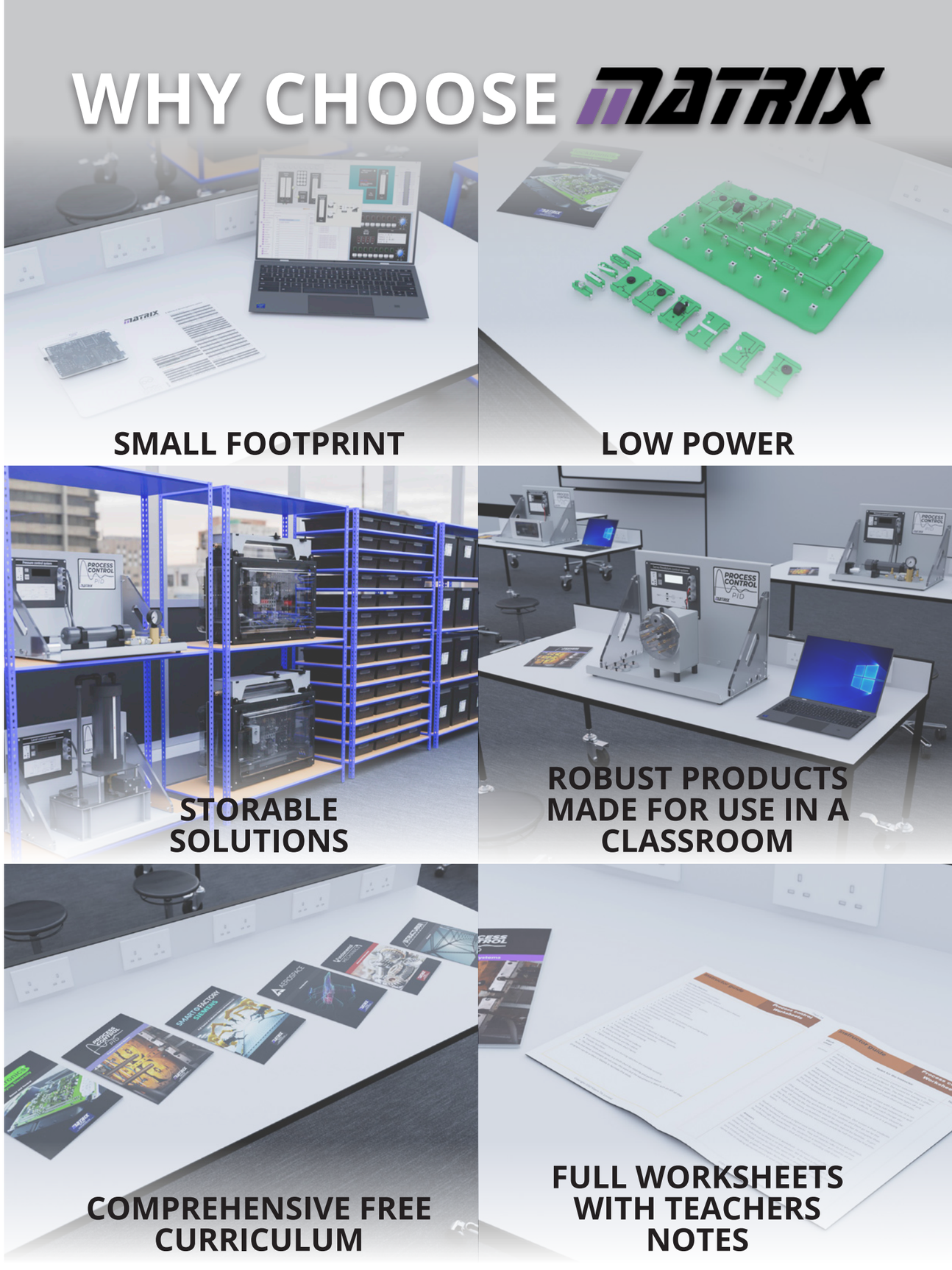




LEARNING OBJECTIVES & EXPERIMENTS:

- Hexadecimal, decimal and binary number systems
- Message multiplexing
- Interconnection of electronics modules in aircraft systems
- Sensors in aircraft
- CAN/ARINC 825 bus systems in aircraft
- CAN/ARINC 825 bus fault-finding with a multimeter
- CAN/ARINC 825 bus fault-finding with an oscilloscope
- Built-in test, monitoring and fault-finding
- Fly-by-wire systems
- CAN bus message structure and protocol
- Electronic Flight Information Systems
- PC-based diagnosis software tools
- Use of GPS

SCAN TO VISIT PRODUCT PAGE



FLOWCODE

www.flowcode.co.uk

Flowcode is a graphical programming Integrated Development Environment (IDE) that allows you to develop highly functional electrical, electronic and electromechanical systems for microcontroller based systems and for Windows PCs and tablets.

> "I used Flowcode for the students in a module called "Embedded Systems Engineering" (MSc and MEng module). Some students have never used microcontrollers before and they were able to use Flowcode easily for basic microcontroller based embedded system design on a ping pong game.
>
> The students moved on to use Flowcode for a project on Zigbee based wireless network system for environment monitoring. The project was very successful."
>
> *Hongying Meng,*
>
> *Brunel University, United Kingdom*

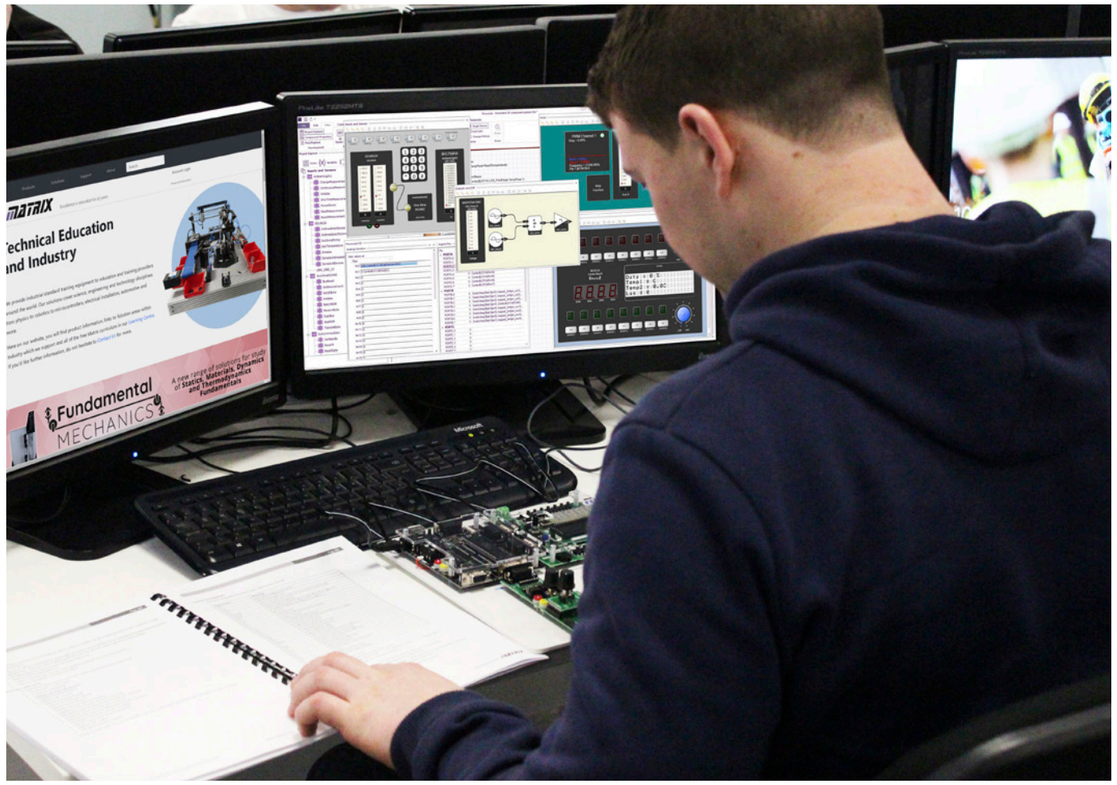
Why choose Flowcode:

- Academic licenses include all chip packs
- Free student licenses for home use
- Dedicated 2D component panel
- Free curriculum with over 120 hours of guided learning
- Plot variables on graph, scope and data recorder
- Open source components

MATRIX

FLOWCODE in Education

Educational institutions use Flowcode because it is accessible for all engineering students including electrical, mechanical, aerospace, and automotive. All engineers need to understand programming, sensors, actuators, feedback and control systems. Flowcode allows junior engineers to be successful system designers - whatever their major discipline.



Did you know? Student licences are available for all educational Flowcode sites. That means if your school, college or university are using Flowcode, then you can licence your students to use the software at home, free of charge.

FLOWCODE SUPPORTS MULTIPLE LANGUAGES

MATRIX

FLOWCODE APP DEVELOPER

4 PROGRAMMING METHODS

120 COMPONENTS

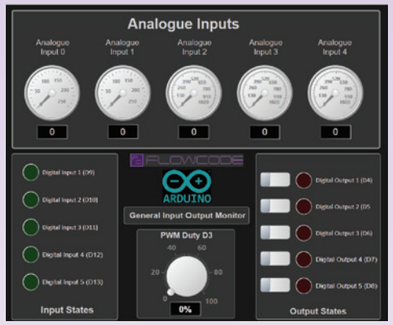
4 LEVELS OF REMOTE I/O SUPPORT

1500 COMPONENT SUBROUTINES

UNLIMITED DISTRIBUTION COPIES

Flowcode App Developer allows students to easily develop highly functional projects for Windows computers and tablets using low cost hardware interfaces.

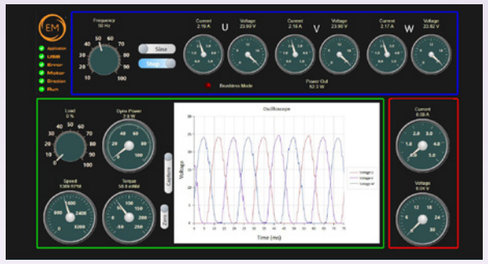
- Create great Windows Human Machine interfaces for control and data gathering using Rpi, Arduino, PIC, ESP
- Graphical programming: use flowcharts, state diagrams and data flow techniques
- Comprehensive library of dials, switches, indicators, graphs and other components



General input output interface for Arduino

Design

Design your electronic system on screen:



Control system with USB, LAN, Wi-fi and Bluetooth connection

- Choose the Input Output device(s) that has the characteristics your application needs from four types of device
- Choose from one of our own low cost hardware interfaces or use any third party hardware
- Add other instruments and systems that have Application Programming Interfaces you can work with like signal generators, environmental chambers etc
- Drag local (USB/Bluetooth) and remote (Wi-fi/LAN/Internet) hardware components onto the 2D panel
- Add components from the library to create a distributed electronic system
- Design a program using flow chart, Blocks, Pseudo-code, or state machine diagrams

Test

Test your design to make sure it functions like you want it to:

- Link your design to low cost local or remote hardware interfaces
- 'Play' the program or step through the program one command at a time to make sure it works
- Use the on-screen instruments to see the variables in your system
- Use the Data Recorder and Console to monitor your program and see how it is working
- Use the Graph plotter to document the performance of your system in real time

Process Control software built with App Developer

MATRIX

FLOWCODE EMBEDDED

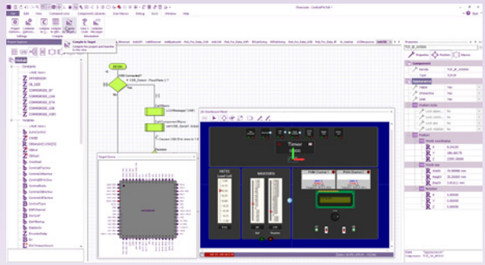
Flowcode Embedded helps students learn to develop complex embedded systems. It allows students to progress faster and go further than other programming languages.

- Create highly functional microcontroller projects using Rpi, Arduino, PIC, ESP, ARM and AVR processors
- Graphical programming: use flowcharts, state diagrams and data flow techniques
- Full simulation – electrical and mechanical
- Hugh library of parts and subroutines

Design

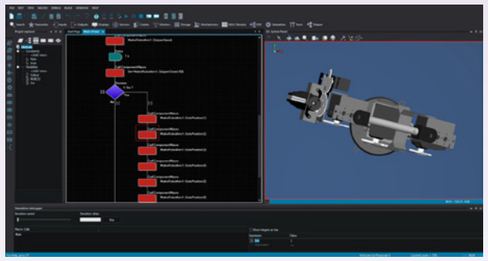
Design your electronic system on screen:

- Choose a microcontroller that has the characteristics your application needs.
- Develop a model of the electronic system using the 2D or 3D panels.
- Add components from the library or create your own. Link to a mechanical model exported from Solidworks.
- Design a program using flow chart, Blocks, Pseudo-code, C code or state machine diagrams.
- Develop a Human Machine Interface to provide a good visual test bed.



Flowcode design example

Simulate



Simulation with a robot arm

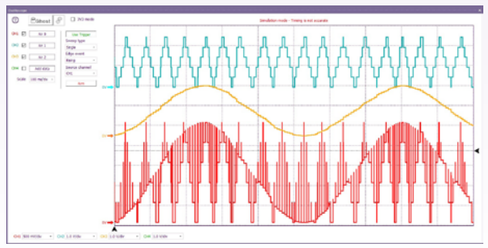
Simulate your design to see how it functions:

- Use on-board digital switches and analogue sliders to change real world parameters and see how your system copes.
- Use the Meters, Oscilloscope, Data Recorder, Console or Graph to verify your system's performance.
- Use test signal injectors to send streams of comms data in any protocol to see how your system responds.
- Link to Solidworks to see your 3D hardware model move on screen under control of your program.

Test

Test your design to make sure it functions like you want it to:

- Compile your design to hex for a microcontroller.
- Using Matrix In-Circuit-Debug hardware step through the program in the chip one icon at a time or let the program run.
- Use Matrix Ghost to view pin and variable status on the Oscilloscope.
- Use the Data Recorder and Console to decode comms serial buses and check message integrity.
- Verify your design's performance using Flowcode App developer via USB, Bluetooth or the internet.

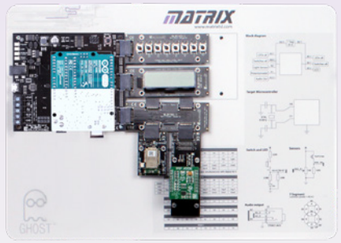


Flowcode scope for testing

MATRIX

FLOWCODE in Education

Advanced Digital Communications



Students can study a wide variety of modern digital communications systems including SPI, I2C, CAN bus, Bluetooth, USB, Internet communications, Zigbee, RDIF.

Software: Flowcode Embedded

Matrix hardware: E-blocks II solutions

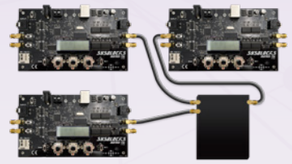
Windows Programming with Low Cost Hardware Targets

Flowcode App Developer allows students to build advanced human machine interfaces for Windows systems based on low cost hardware interfaces using PIC, Arduino, RPi and ESP32 target hardware. With a wide range of on-screen switches, dials, indicators, graphs and other controls this allows control and data gathering using USB, Bluetooth, Wi-Fi and LAN. Compatible with Matrix's MIAC controller, E-blocks, ECIO and many third party hardware boards.

Software: Flowcode App Developer

Third party hardware: Arduino Uno, PIC ECIO, ESP32, RPi, with appropriate free API. A huge variety of third party hardware with an API supplied.

Communications



COMING SOON

Sysblocks and Flowcode allow a number of communications systems to be studied. Data flow graphical programming allows students to construct communications systems on screen, simulate their performance using internal oscilloscope and then download them to a fast microcontroller. Students can easily construct modulator/demodulator and encoder decoder systems including AM, FM, PM, QAM, SSB, ASK, APSK, CPM, FSK, MFSK, OOK, PPM, PSK, QAM, ASFDMA and spread spectrum techniques.

Software: Flowcode 10

Matrix Hardware: Sysblocks

Music Technology and Music Engineering

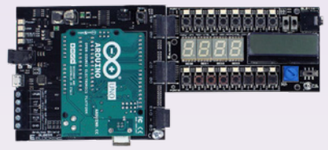
COMING SOON

Flowcode is the perfect tool for teaching how modern audio technology systems manipulate audio in a digital format to create audio effects, condition delays in stadiums, and manage music in a variety of situations. Flowcode also includes components for MIDI, DMX and other control standards.

Software: Flowcode 10

Matrix Hardware: Sysblocks

Embedded System Programming



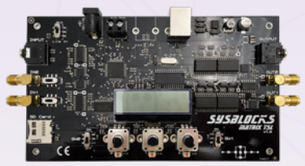
Flowcode Embedded can be used to teach graphical and C code programming for more than 1500 microcontrollers from the PIC, AVR, Arduino, RPI, ESP32 and ARM families. With full simulation, in circuit debug, large component libraries and accompanying courses this is the easiest way to teach embedded programming. Compatible with Matrix's own E-blocks boards (with integrated oscilloscope and logic analyser) as well as many third party hardware boards.

Software: Flowcode Embedded

Third party hardware: More than 1500 targets from Arduino, AVR, PIC, dsPIC, PIC32, ARM, ESP32, RPi

Matrix hardware: ECIO, E-blocks II

Digital Signal Processing



COMING SOON

A Sysblock is a powerful Digital Signal Processing capable microcontroller fitted with external fast A/D and D/A blocks that facilitates a number of investigations in signal processing. Flowcode Embedded now includes an array of DSP components that allow signal processing systems to easily be constructed on screen and compiled to the Sysblock. Flowcode and Sysblocks provides the ideal environment for studying DSP systems.

Software: Flowcode 10

Matrix Hardware: Sysblocks

Robotics

Flowcode is the perfect accompaniment for Robotics courses. Flowcode interfaces with Solidworks to allow students to design electromechanical systems and simulate them electrically and mechanically in Flowcodes's 3D interface. Flowcode can also be used in an embedded and PC based context to control robotic systems locally and remotely.

Software: Flowcode Embedded

Third party hardware: Third party robotic systems based on Arduino, PIC etc.

Matrix hardware: Formula Allcode, Matrix Robot Arm

Automotive and Industrial Engineering

MIAC NXT is a rugged controller interface for industrial and automotive applications. MIAC NXT is based on a powerful dsPIC microcontroller and is directly programmable from Flowcode Embedded. An API is available which allows direct communication with Flowcode App Developer to allow students to create feature rich PC-based apps.Software: Flowcode App Developer

Matrix hardware: MIAC NXT

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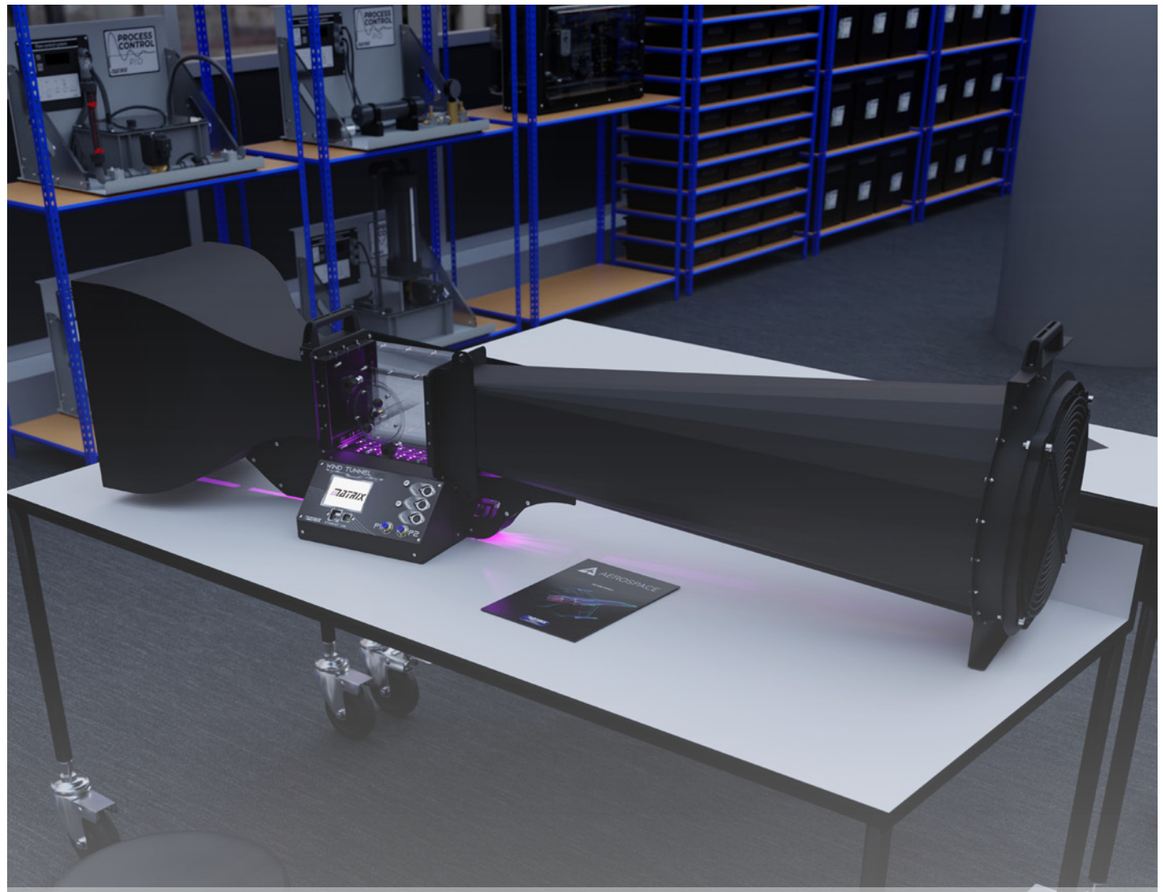


MODULE 8.0
BASIC AERODYNAMICS

Module 8.0 primarily sees the inclusion of one of our flagship aerospace products, with the Wind Tunnel 125, which is designed to deliver many of the key requirements for aerodynamics study across multiple disciplines.

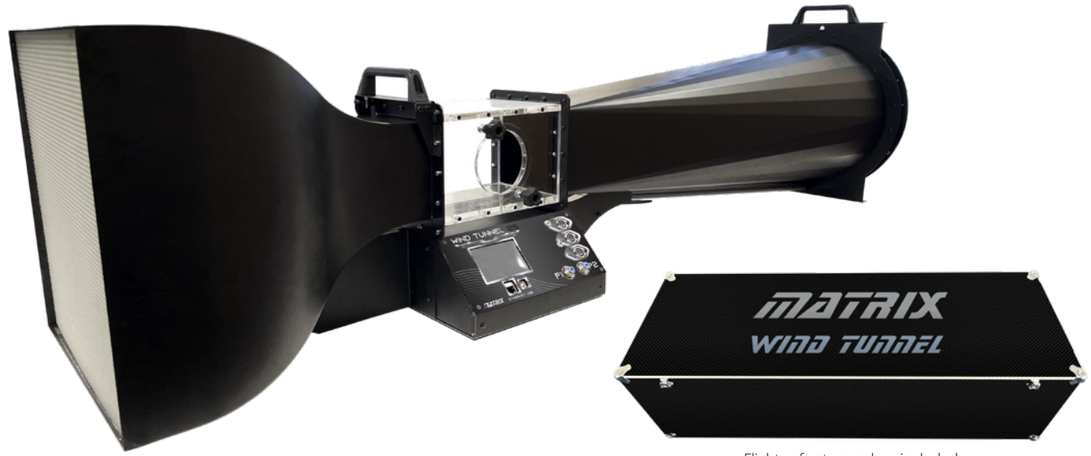
Wind Tunnel 125 AV5289

This compact open-circuit sub-sonic wind tunnel is designed for benchtop use. The wind tunnel is designed for teaching aerodynamic principles and exploration of fluid flow. Suitable for college to undergraduate teaching, it features a computer controlled fan, data acquisition and multiple experimental setups, controlled by a touch screen interface. The wind tunnel has a 125mm transparent test section and 25m/s wind speed.

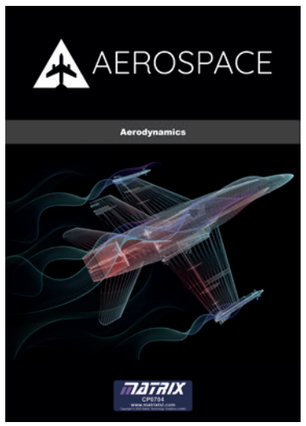
The wind tunnel has a honeycomb structure built into the contraction nozzle (ratio 9.2:1) which ensures uniform flow through the test section. The clear test section allows for visibility and clear understand of the experimental behaviour. The air exits through a variable speed controlled fan, with a finger guard covering the back.

Built-in data acquisition allows users to have direct output of pressure readings from pitot static tube and pressure tappings. It also allows for real time lift and drag force components to be logged. Different drag shapes are provided along with multiple NACA profile aerofoils. Simple thread attachment allows students to design their own test pieces for analysis.

A smoke generator can be used to create streamline smoke trails over the test objects for visualisation of flow patterns.



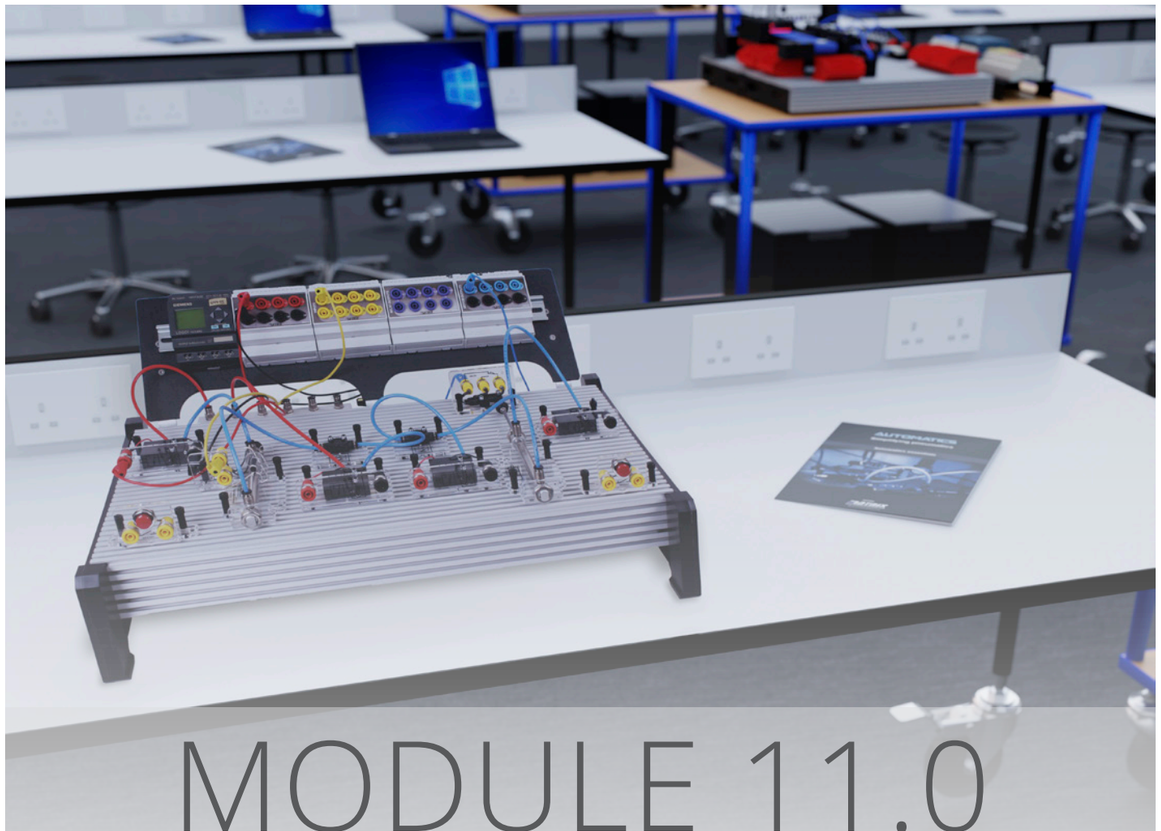
Flight safe storage box included



LEARNING OBJECTIVES & EXPERIMENTS:

- Bernoulli's equation
- Air flow over aerofoils
- Air flows around blunt and streamlined shapes
- Pressure distribution around a cylinder and aerofoil.
- Lift and drag forces for blunt and streamlined shapes
- Flow visualisation
- Manometers

SCAN TO VISIT PRODUCT PAGE



MODULE 11.0

AEROPLANE AERODYNAMICS, STRUCTURES AND SYSTEMS

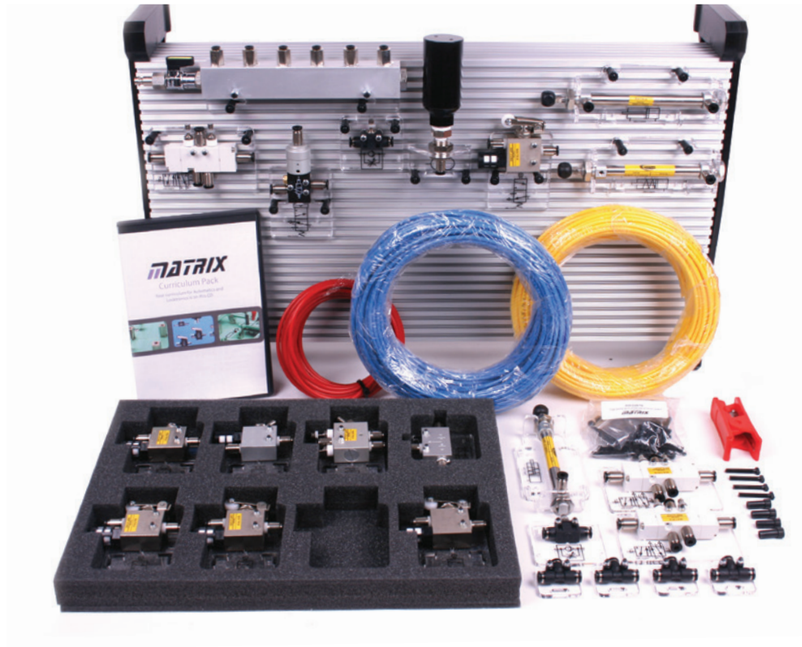
Pneumatic, vacuums, electrical power and hydraulics are a key part of learning in module 11.0 of the EASA part 66. Here, we present the Automatics range, which gives students a safe learning platform upon which to construct pneumatic circuits. Adding electro pneumatics parts to these circuits covers a number of additional learning objectives set out in the syllabus.

Automatics Essentials Solution AU9020

This kit provides a complete introduction to pneumatic circuit design and construction. The curriculum pack includes a comprehensive set of worksheets that allow students to progress from first principles through to circuits of moderate complexity; including reciprocating circuits and generating sequences of movements.

The solution is intended for students in their early teens and older who are learning technology and engineering subjects. Tasks are designed to be suitable for pairs of students sharing a single kit.

Everything you will need to teach the course is included in the solution pack, with the exception of an air compressor.



Requires Compressor **AU1050 (US and EU versions also available)**

LEARNING OBJECTIVES & EXPERIMENTS:

- Understanding the different varieties of valves and where each is appropriate in a system
- Understanding the basic types of cylinder, controlling speed and the factors that influence power output
- Combining valves to produce logic functions
- Semi-automatic and automatic reciprocation
- Creating sequences of movements
- Using reservoirs to create time delays
- Air bleed and pilot operated circuits
- Component symbols and circuit diagrams
- Staying safe when using air at high pressure

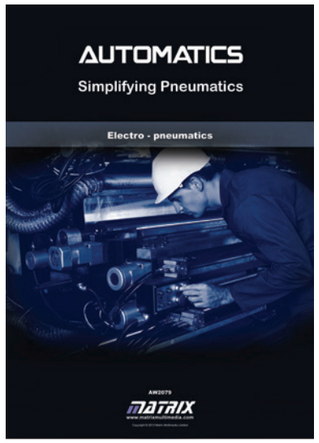
SCAN TO VISIT PRODUCT PAGE

Electro-pneumatics add-on kit AU9015

This kit supplements the Automatics essentials solution by adding a selection of electrically operated valves and a range of sensors. By following the curriculum, students will learn how to use these new components to create systems in which pneumatics and electrical circuits are combined into complete systems.

The electrical components are connected together quickly and reliably using 4mm connectors, for which all of the necessary leads and accessories are provided. Electrical components are robustly mounted to the Automatics platform using the same 'tee' bolt system used for the pneumatic parts and are printed with standard circuit symbols.

Working two to a kit, students follow the detailed worksheets to gain a comprehensive understanding of electro-pneumatics. By the end of the course, students will be able to create reciprocating and sequential circuits, and will have an understanding of how these are used to solve real world engineering problems.



LEARNING OBJECTIVES & EXPERIMENTS:

- Understand the operation of electrically controlled pneumatic valves
- Use of electrical switching to control circuit operation
- Using microswitches to sense cylinder position
- Sensing position without physical contact using reed switches
- Expressing electrical circuits using ladder diagrams
- Electrically operated reciprocal circuits
- Sequential control circuits
- Analysing real world problems and formulating solutions

SCAN TO VISIT PRODUCT PAGE

Notes

Notes

AEROSPACE
TRAINING RANGE

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