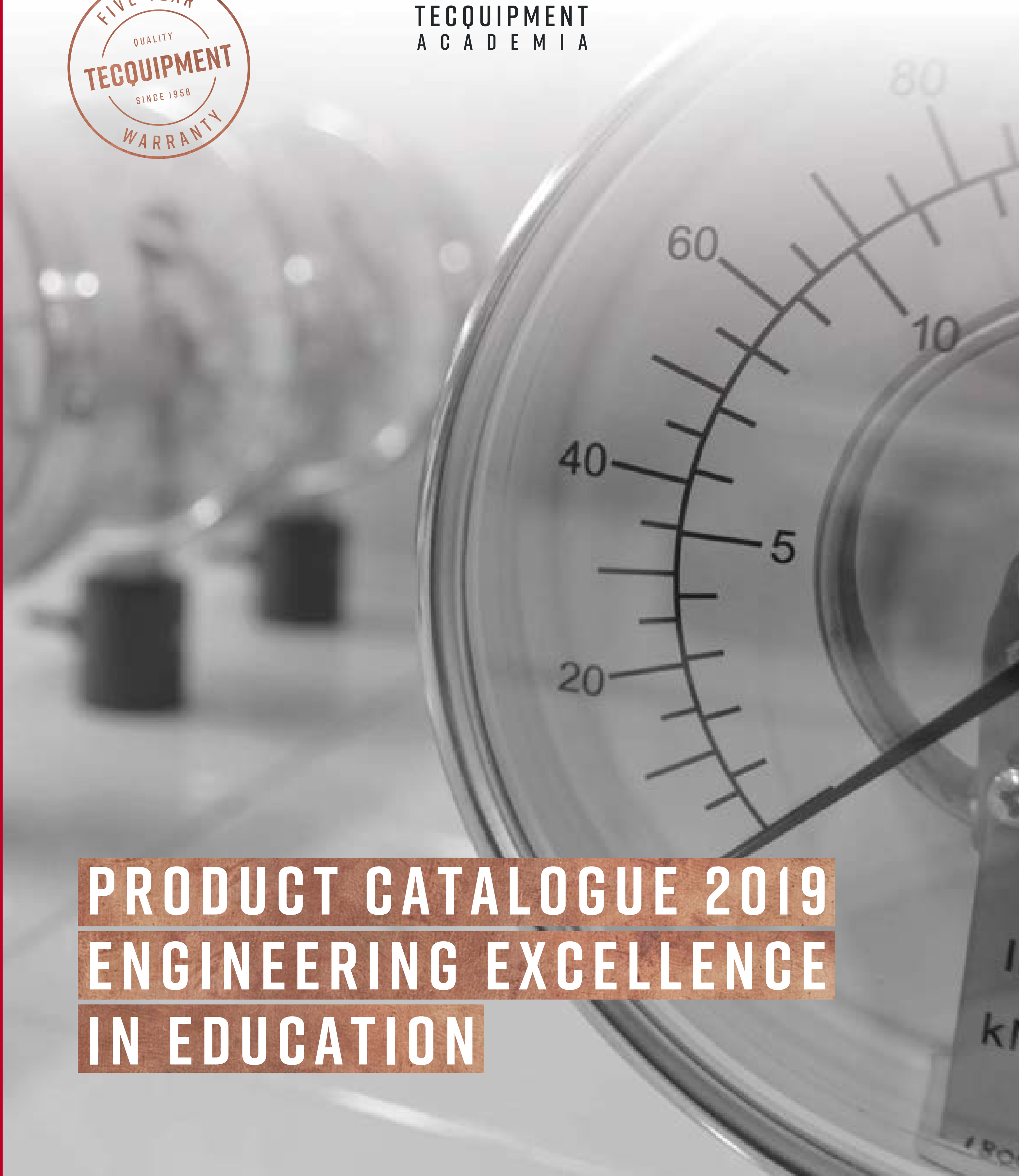
TECQUIPMENT
ACADEMIA

FIVE YEAR
QUALITY
TECQUIPMENT
SINCE 1958
WARRANTY



PRODUCT CATALOGUE 2019
ENGINEERING EXCELLENCE IN EDUCATION

INTERMITTENT SUPERSONIC WIND TUNNEL (AF300)

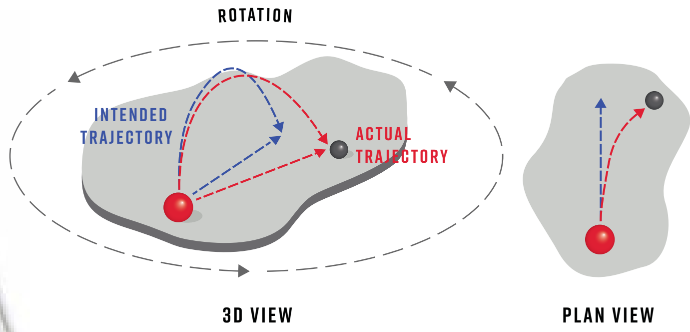
CONTENTS

NEW PRODUCTS IN THIS EDITION

For 2019, TecQuipment has focused on the development of the Fluid Mechanics range and Theory of Machines range.

NEW TO THEORY OF MACHINES

The **CORIOLIS FORCE** (TM1017) is a desk-top, stand-alone apparatus that complements the Theory of Machines 'motion' products for teaching students about the Coriolis force and understanding fictitious, or inertial forces. This equipment turns theory into reality, enabling students within a laboratory set-up to see, in real-life, the effect of the Coriolis force acting on a jet of water within a rotating container. Suitable for teaching modules in disciplines including civil engineering, meteorology and aerospace engineering – **SEE PAGE 228**.

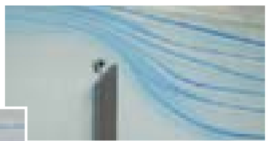


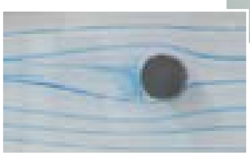
THE ACTUAL TRAJECTORY OF AN OBJECT APPEARS TO CURVE AWAY FROM THE INTENDED TRAJECTORY WHEN VIEWED FROM WITHIN THE ROTATING REFERENCE FRAME

NEW TO FLUID MECHANICS

The Fluid Mechanics range features two new compact entry-level products:

The **SERIES AND PARALLEL PUMPS** (H52) bench-top test set is the new entry-level apparatus for understanding single and dual pumps within the Fluid Mechanics range. The simplicity means that this can be used for illustrating the basics of centrifugal pump performance, applicable for many generic engineering foundation courses, requiring little direction for carrying out experiments. The compact size also makes this a great option where budget and space are limited – **SEE PAGE 131**.





DYE FLOW AROUND THE MODELS

The **FLOW VISUALISATION** apparatus (FC15) is a compact entry-level product for visualising flow patterns around weirs and other objects in an open channel. This is perfect for introducing students to the concept of flow by capturing their interest using a high-impact, visual sensory experience. While this is part of the Fluid Mechanics range, the application is relevant to many common areas of engineering, such as civil, built environment, aerospace and hydrology – **SEE PAGE 92**.

CRAFTSMANSHIP

Attention to detail, expert craftsmanship and a philosophy that our products should be built to last for decade after decade are key to the TecQuipment culture. These goals are achieved through the employment of a highly skilled workforce, and a culture that breeds individual passion and pride in their work. This, along with stringent quality control practices, careful selection of materials, and specialist in-house equipment, ensures that each product is brought to you with hand-crafted care.

Before any products leave the factory, to be shipped across the world, they are thoroughly tested by specialist electrical and mechanical test teams to ensure that they perform according to the specifications.

The TecQuipment doors are always open to visitors who can learn first-hand how committed the TecQuipment workforce is to designing and making equipment that they know will withstand the rigours of years and years of use by generations of students pushing it to its limits.

In the company's 61st year, TecQuipment continues to grow, embracing a culture of continual improvement, resourcefulness and lateral thinking. The product range expands year on year to offer a greater inclusive range of equipment that provides more accurate results and better experiment visualisation, at the price and scale that meets the requirements of the worldwide market.

PRODUCTS AND INDUSTRY

TECQUIPMENT RANGE	SUBJECT AREA	INDUSTRY															
		AEROSPACE	AGRICULTURE	AUTOMOTIVE	CHEMICAL/PHARMA	CIVIL ENGINEERING	CONSTRUCTION	DEFENCE	FOOD AND DRINK	MARINE	METALS	MINING	OIL AND GAS	POWER	RAIL	RENEWABLES	UTILITIES
AERODYNAMICS	Subsonic Wind Tunnels	✓		✓		✓	✓	✓						✓		✓	✓
	Supersonic Wind Tunnels	✓		✓				✓					✓		✓		
	Special Purpose Wind Tunnels	✓		✓	✓	✓	✓	✓					✓		✓		
CONTROL ENGINEERING		✓		✓	✓			✓	✓	✓			✓		✓		
PROCESS CONTROL					✓				✓				✓	✓			✓
ELECTRICAL POWER					✓	✓		✓	✓	✓			✓	✓	✓	✓	✓
ENGINEERING SCIENCE	Forces and Moments	✓				✓	✓			✓							
	Materials Testing	✓		✓		✓	✓								✓	✓	
	Vibration, Friction, Energy			✓						✓					✓		
	Simple Machines	✓		✓		✓	✓						✓		✓		
	Mechanisms	✓		✓			✓			✓					✓		
FLUID MECHANICS	Flow and Pressure	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
	Friction	✓	✓	✓	✓	✓	✓		✓	✓			✓				✓
	Open Channel		✓			✓				✓				✓		✓	✓
	Hydrostatics	✓	✓		✓	✓	✓	✓	✓	✓		✓		✓			✓
	Hydrology	✓	✓			✓	✓					✓					✓
	Fluid Power	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓	✓
MATERIALS TESTING AND PROPERTIES	Basic Properties	✓		✓		✓	✓	✓	✓		✓	✓	✓		✓	✓	
	Strain Gauging	✓		✓	✓	✓	✓				✓	✓	✓	✓		✓	
	Destructive Testing	✓		✓		✓	✓	✓			✓	✓	✓		✓		
STATICS FUNDAMENTALS						✓	✓							✓			
STRUCTURES	Beams	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓		
	Failure	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓
	Arches, Bridges, Trusses	✓	✓		✓	✓	✓		✓			✓		✓	✓	✓	✓
THEORY OF MACHINES	Friction	✓	✓	✓		✓	✓				✓	✓		✓	✓	✓	
	Motion	✓		✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	
	Vibration	✓		✓		✓				✓	✓	✓	✓	✓	✓	✓	✓
THERMODYNAMICS	Fundamentals	✓			✓	✓	✓	✓	✓		✓	✓	✓			✓	
	Heat Transfer/Exchange	✓		✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
	Steam					✓			✓		✓		✓	✓	✓		✓
	Compressors	✓	✓		✓	✓	✓	✓		✓		✓	✓				
ENGINES	Internal Combustion Engines	✓		✓				✓		✓			✓	✓			
	Gas Turbines	✓			✓			✓		✓			✓	✓	✓		✓
ENVIRONMENTAL CONTROL		✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	✓		✓
SOLAR ENERGY						✓	✓							✓		✓	

ENGINEERING SCIENCE

> I am very pleased to find the highly innovative and professional approach of TecQuipment Ltd in designing and manufacturing a variety of equipment for engineering and technical education at all levels. Such equipment is very useful to develop conceptual skills in students.
>
> DR ING V P SINGH
> SHRI VAISHANV INSTITUTE OF TECHNOLOGY AND SCIENCE, INDORE, INDIA

ENGINEERING SCIENCE

The Engineering Science range is a modular system of experimental kits that addresses the fundamental principles of mechanical engineering, including:

- FORCES AND MOMENTS
- MATERIALS TESTING
- VIBRATION, FRICTION AND ENERGY
- SIMPLE MACHINES
- MECHANISMS

The high quality, robust kits are suitable for teaching STEM principles at beginner level, while remaining relevant for familiarisation for post-graduate students. All the hardware required to do experiments related to a particular topic are contained within a kit. These are presented in a storage tray with a purpose-made insert and checklist to ensure all of the parts are returned at the end of the laboratory session.

Kits can be purchased in any combination, from multiple kits for a whole class to perform the same experiment, or a selection of individual kits for demonstrating a variety of different experiments. TecQuipment also sells a purpose-built storage trolley for keeping the kits tidy while protecting them from damage when not in use.

Ideal for curricula based on educating students in four specific disciplines – science, technology, engineering and mathematics – in colleges and schools. The ES range, with its hands-on approach and detailed notes on experiments, provides the perfect link between theory and real-world applications.

TecQuipment's Engineering Science range is the foundation of STEM education.

COMPREHENSIVE EXPERIMENT KITS

- Each kit offers multiple experiments – with over 60 experiments for the 18 kits, it is outstanding value for money
- All the kits are safe and simple to use – ideal for minimal supervision at many levels of education

LONG-LASTING WORK PANEL

- Rugged, compact and easy to use – the Engineering Science work panel comes with over 1000 pages of worksheets, notes and lecturer material in PDF format

CONVENIENT STORAGE

- Kits are housed in tough, stackable trays
- A purpose-built mobile storage unit offers the flexibility to expand as required

FLEXIBLE ORDERING

- Start with one panel and one experiment, a package or buy the whole range – TecQuipment's Engineering Science range can be completely tailored to your needs and budget

ENGINEERING SCIENCE FULL SET

ESF

A mobile trolley with a complete set of TecQuipment's Engineering Science kits and three work panels.

- A mobile and compact trolley holding a full set of TecQuipment's Engineering Science kits (ES2 to ES19) and three work panels (ES1) for over 60 experiments in fundamental engineering science topics
- All the parts needed in one mobile frame – one person can move a full set of kits from one room to another
- Includes a Spares Kit (ESX) to replace common parts that could become lost from experiments during use
- Spare empty trays to store additional material such as coursework, worksheets or guidance notes
- Strong, lockable wheels on the trolley allow easy movement but also hold the trolley stable when needed – making it an ideal demonstration table

This full set allows at least three sets of students to work with any three of the Engineering Science experiments at the same time, while storing the other kits tidily and efficiently. Alternatively, lecturers or teachers may set up one experiment as a demonstration on the mobile trolley while two groups of students do experiments at their desks.

PACKAGES

As well as the full set, the following packages are also available which offer great value for money:

FORCES AND MOMENTS KIT PACKAGE ESB1

- Forces Kit (ES2)
- Moments Kit (ES3)
- Work Panel (x2)

MATERIALS TESTING KIT PACKAGE ESB2

- Deflection of Beams and Cantilevers Kit (ES4)
- Torsion of Circular Sections Kit (ES5)
- Tensile Tester Kit (ES6)
- Spring Tester Kit (ES19)
- Work Panel (x4)

SIMPLE MACHINES KIT PACKAGE ESB3

- Pulley Kit (ES10)
- Drive Systems Kit (ES11)
- Gear Trains Kit (ES13)
- Centrifugal Force Kit (ES16)
- Work Panel (x4)

MECHANISMS KIT PACKAGE ESB4

- Cam, Crank and Toggle Kit (ES12)
- Simple Mechanisms Kit (ES14)
- Bar Linkages Kit (ES15)
- Additional Mechanisms Kit (ES18)
- Work Panel (x4)

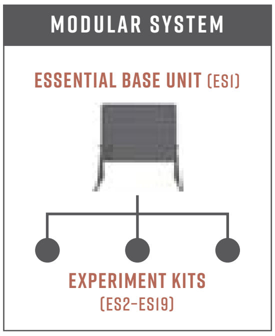
VIBRATION, FRICTION AND ENERGY KIT PACKAGE ESB5

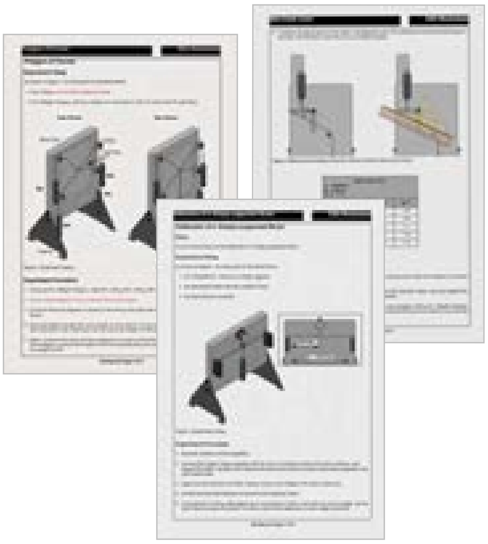
- Simple Harmonic Motion Kit (ES7)
- Friction and Inclined Plane Kit (ES8)
- Potential and Kinetic Energy Kit (ES9)
- Rotational Friction Kit (ES17)
- Work Panel (x4)

WORK PANEL

ES1

Multiposition work panel for use with TecQuipment's Engineering Science kits.





OVER 1000 PAGES OF TEACHING MATERIAL FOR ALL THE EXPERIMENTS IN THE RANGE

- Perfect size for both experiments and simple classroom demonstrations
- Supplied with digital copy of all teaching material needed for the full Engineering Science range
- Stable and multipositional – can be used in many different ways to suit the experiments or demonstrations
- Solid, thick perforated metal plate for long life and choice of fixing positions for the experiments
- Simple thumbscrews for safe, quick and easy assembly

For use with TecQuipment's Engineering Science kits, the work panel fits on any standard desk or bench top. Students, teachers or lecturers fit the parts of the kit to the Work Panel (ES1) to study or demonstrate an engineering science topic.

AVAILABLE EXPERIMENT KITS:

FORCES KIT

ES2

Demonstrates how to find the centre of gravity of shapes and the relationship between angles and coplanar forces.

LEARNING OUTCOMES:

- Centres of gravity
- Force triangles
- Force polygons and Bow's notation
- Linked polygons (non-concurrent forces)

SPECIAL OFFER

FORCES AND MOMENTS BUNDLE (ESB1)

This basic experiment bundle includes:

- Forces Kit (ES2)
- Moments Kit (ES3)
- Two Engineering Science Work Panels (ES1)

This kit includes a set of different plastic shapes for experiments in centres of gravity of two-dimensional objects. It also includes pulleys, weights and a magnetic protractor for experiments in concurrent and non-concurrent coplanar forces and angles.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

ALTERNATIVE PRODUCTS:

- Equilibrium of Forces (STF4) 183

MOMENTS KIT

ES3

Demonstrates the relationship between distances and forces in rigid beams and levers.

LEARNING OUTCOMES:

- Principle of moments
- Beam balances
- 1st, 2nd and 3rd order levers
- Bell crank lever
- Beam reactions

This kit includes a rigid beam for experiments in the principle of moments, extending to levers and beams. It demonstrates the three main lever types (first, second and third order) and includes an 'L' shaped plate for experiments in bell crank levers. A pulley allows extra experiments with moments caused by oblique forces.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

ALTERNATIVE PRODUCTS:

- Equilibrium of a Beam (STF5) 183

DIGITAL DATASHEETS

Visit individual product pages on the TecQuipment website to view and download the digital datasheets.

TECQUIPMENT.COM

DEFLECTION OF BEAMS AND CANTILEVERS KIT

ES4

Demonstrates the deflection of beams of different materials and dimensions, held on different supports.

LEARNING OUTCOMES:

- Beam length and deflection
- Beam material and deflection (Young's modulus)
- Beam 'I' value and deflection
- Beam supports (cantilever, propped cantilever, fixed beam and simply supported) and deflection

HERE TO HELP YOU

A team of specialist customer care personnel is available to answer a range of questions relating to technical details, spare parts and maintenance.

CUSTOMER.CARE@TECQUIPMENT.COM

This kit includes different beams and fixing blocks. The fixing blocks work as clamps or knife-edge supports. They hold the beams in different ways, such as a cantilever, simply supported, fixed (encastre) and a propped cantilever.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

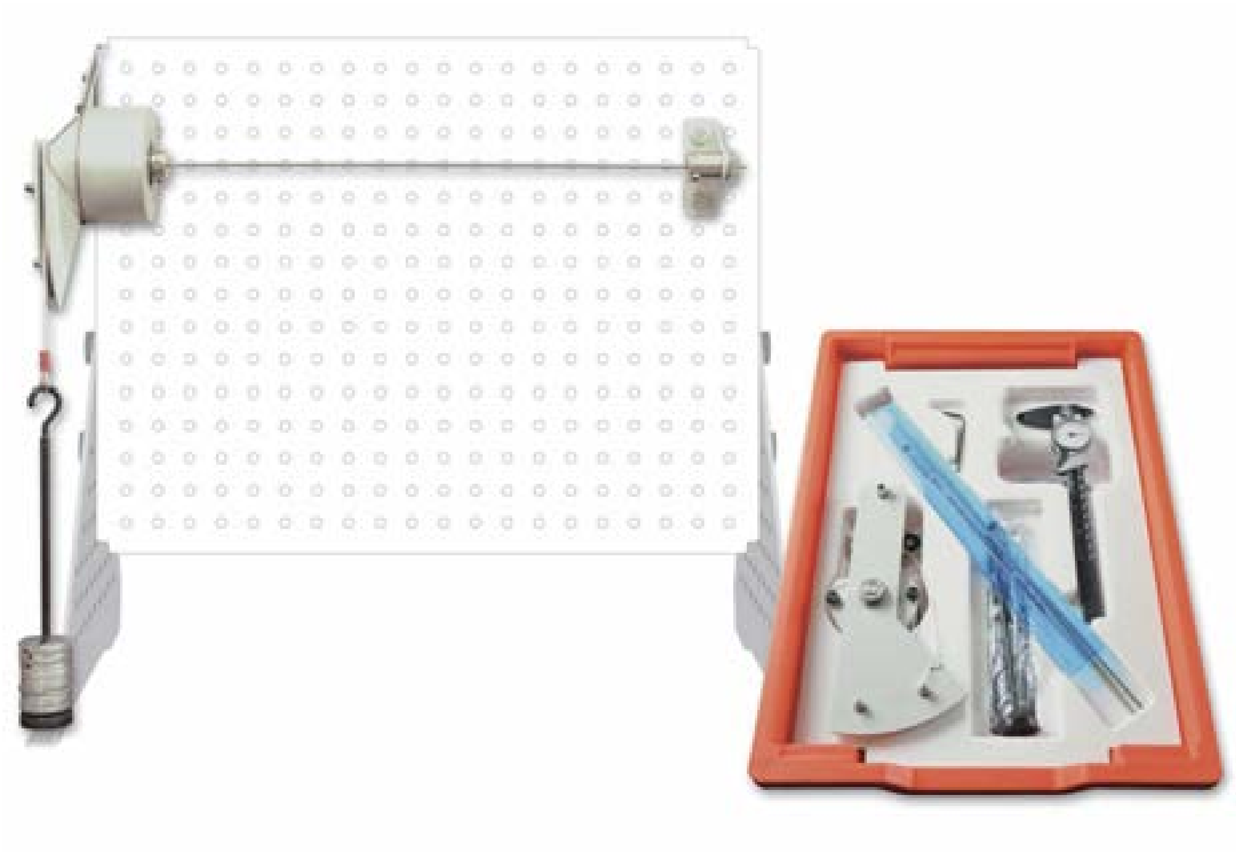
ALTERNATIVE PRODUCTS:

- Stiffness – Bending and Torsion (TE16) 152
- Beam and Leaf Spring (SM1000g) 165
- Beam Apparatus (SM1004) 175
- Deflection of Beams and Cantilevers (STR4) 202
- Continuous and Indeterminate Beams (STR13) 204

TORSION OF CIRCULAR SECTIONS KIT

ES5

Demonstrates the torsion in circular section specimens of different materials and lengths.



LEARNING OUTCOMES:

- Specimen length and angle of twist
- Specimen material and angle of twist (modulus of rigidity)
- Specimen 'J' value and angle of twist

This kit includes different circular section specimens and adjustable chucks for experiments in torsion. Students fix the specimens in the chucks and apply weights to a lever arm. The arm applies a moment (torque) to one end of the specimen. A scale on the arm shows the angle of twist.

ESSENTIAL BASE UNIT:

• Work Panel (ES1)	8

ALTERNATIVE PRODUCTS:

• Torsion Testing Machine – 30 Nm (SM1001)	158
• Torsion of Circular Sections (STR6)	211
• Torsion Testing Components (TE16b)	152

TENSILE TESTER KIT

ES6

Demonstrates the principles of tensile tests on specimens of different materials.

LEARNING OUTCOMES:

- Tensile tests (to destruction) of different materials
- Finding the tensile strength of a material
- Material behaviour in the elastic and plastic region
- Creating a force and extension chart

SPECIAL OFFER

MATERIALS TESTING BUNDLE (ESB2)

This experiment bundle includes:

- Deflection of Beams Kit (ES4)
- Torsion of Circular Sections Kit (ES5)
- Tensile Tester Kit (ES6)
- Spring Tester Kit (ES19)
- Four Engineering Science Work Panels (ES1)

This kit includes a cased tensile tester with specimens of different materials for students to stretch specimens to destruction, while measuring the extension and force.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

RECOMMENDED ANCILLARIES:

- Tensile Test Specimens (MTT) 28

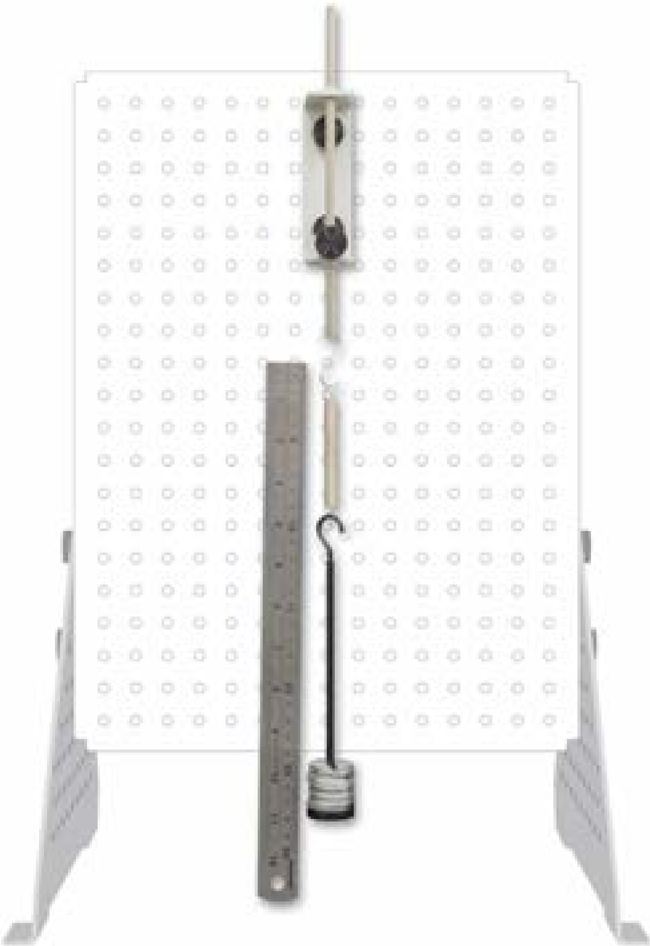
ALTERNATIVE PRODUCTS:

- Universal Testing Machine (SM1000) 163
- Bench-top Tensile Testing Machine (SM1002) 161
- Materials Laboratory with Data Capture (MF40 MkII) 166

SPRING TESTER KIT

ES19

Demonstrates the characteristics of coiled springs and how to test them.



LEARNING OUTCOMES:

- Hooke's law and compression spring tests
- Hooke's law and extension spring tests
- Parallel and series spring tests

This kit includes different coiled springs for experiments in spring testing. These include extension springs, compression springs, parallel springs and springs that can connect in series.

Students test the springs to prove Hooke's law and find their spring rate, comparing it with given manufacturers' values. They also test springs in parallel and series to see how this affects the overall spring rate.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

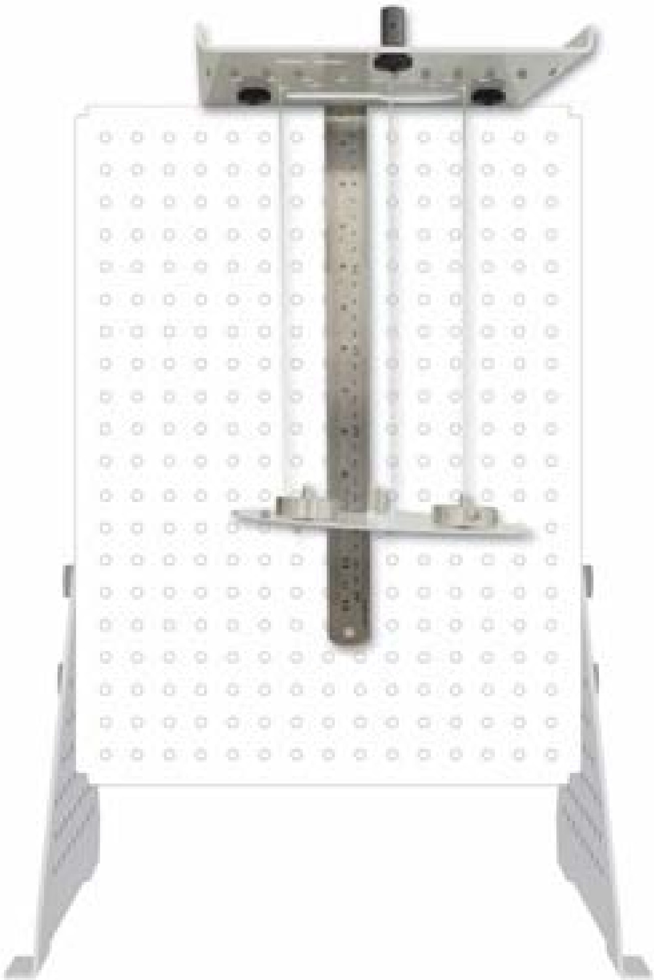
ALTERNATIVE PRODUCTS:

- Hooke's Law and Spring Rate (SM110) 151
- Coil Spring (SM1000f) 165

SIMPLE HARMONIC MOTION KIT

ES7

Demonstrates simple harmonic motion (oscillation) in springs and pendulums, and its usefulness.



LEARNING OUTCOMES:

- Simple harmonic motion of simple, bifilar and trifilar pendulums of different lengths and masses
- Simple harmonic motion of a spring with different masses, and a simple spring rate test
- Simple harmonic motion of a compound pendulum
- Simple harmonic motion and gravity using a Kater's pendulum

This kit includes different pendulums and a spring to show students the principles and uses of simple harmonic motion. Students test different pendulums and a spring to see how different factors, such as mass or pendulum length, affect simple harmonic motion and the period of oscillation.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

ALTERNATIVE PRODUCTS:

- Simple and Compound Pendulums (TM161) 231
- Filar Pendulums (TM162) 232

FRICTION AND INCLINED PLANE KIT

ES8

Demonstrates the frictional and other forces on bodies and between different surfaces on a flat or inclined plane.

LEARNING OUTCOMES:

- Forces on an inclined plane
- Rolling and sliding friction on different surfaces
- Kinetic and static sliding friction between different surfaces
- Surface angle and friction between different surfaces

This kit includes parts for experiments in friction and forces on a flat or inclined plane. The plane has an inclinometer and adjustment to allow the student to set the plane to any angle between zero and 90 degrees. The parts include different friction surfaces, a roller set, a rolling car or sled with adjustable mass, and a simple roller.

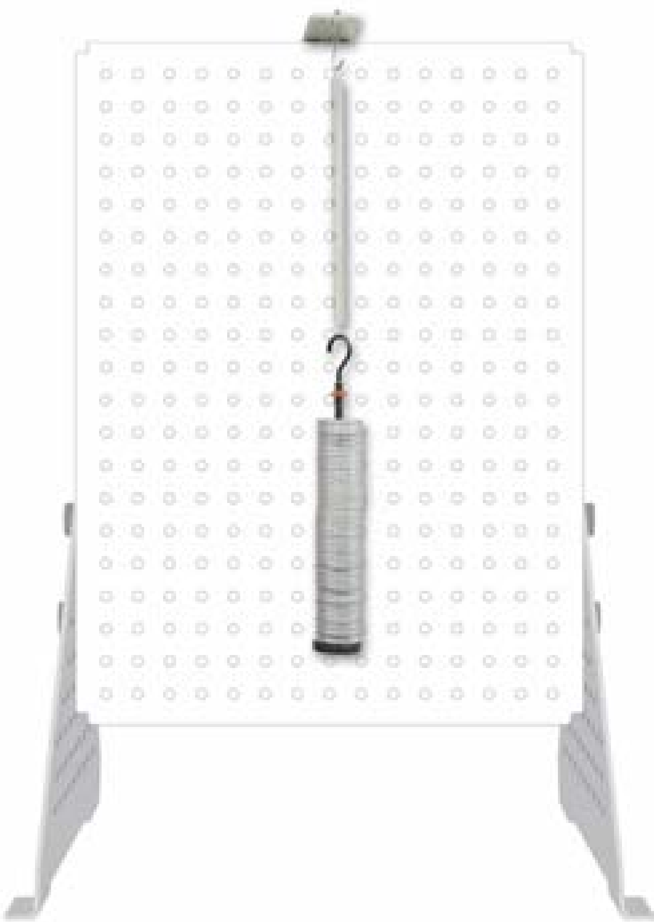
ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

POTENTIAL AND KINETIC ENERGY KIT

ES9

Demonstrates the difference between potential and kinetic energy and how it can change from one to the other.



LEARNING OUTCOMES:

- Kinetic and potential energy in a pendulum
- Elastic potential energy in a spring
- Kinetic energy in a flywheel

This kit includes a pendulum, a spring and a flywheel for experiments in potential and kinetic energy. Students test each part to discover the difference between potential and kinetic energy and the transfer of energy from one form to another.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

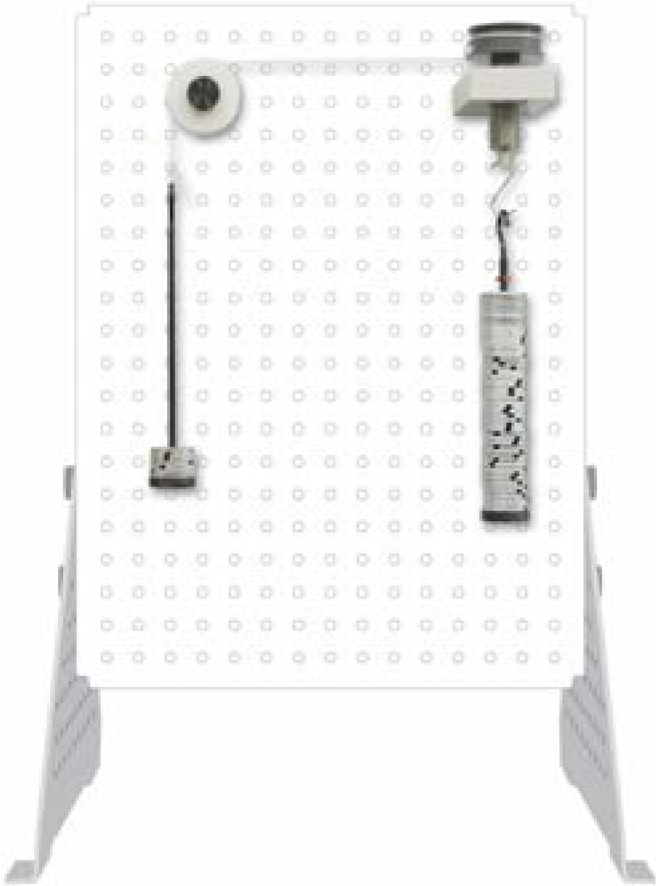
ALTERNATIVE PRODUCTS:

- Geared Systems Test Stand (TM1018a) 222

ROTATIONAL FRICTION KIT

ES17

Demonstrates how rotational friction affects the efficiency of popular machine elements.



LEARNING OUTCOMES:

- Efficiency of a screw jack
- Efficiency of a wedge
- Efficiency of different bearings

This kit includes a screw jack (or 'jackscrew'), a wedge and different bearings. It helps students understand how rotational friction affects the efficiency of popular machine elements and bearing materials. It shows why engineers choose some materials and devices above others for any given application.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

SPECIAL OFFER

VIBRATION, FRICTION AND ENERGY KIT BUNDLE (ESB5)

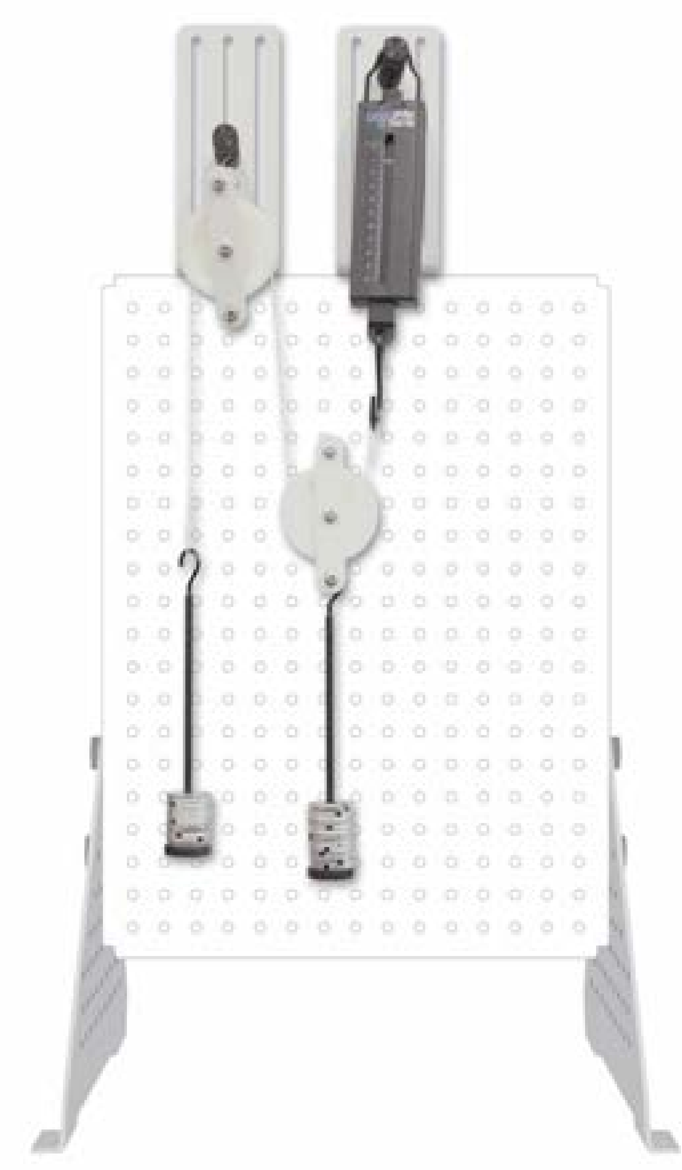
This experiment bundle includes:

- Simple Harmonic Motion Kit (ES7)
- Friction and Inclined Plane Kit (ES8)
- Potential and Kinetic Energy Kit (ES9)
- Rotational Friction Kit (ES17)
- Four Engineering Science Work Panels (ES1)

PULLEY KIT

ES10

Demonstrates the mechanical advantage of different combinations of pulleys and a simple wheel and axle.



LEARNING OUTCOMES:

- Simple pulleys – fixed, movable and compound
- The wheel and axle
- The Weston differential pulley

This kit includes a wheel and axle with single, double and triple wheel or 'sheave' pulleys for experiments in mechanical advantage. Students test fixed, movable and compound pulleys attached to load and effort weights to test their mechanical advantage.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

DRIVE SYSTEMS KIT

ES11

Demonstrates the advantages and disadvantages of three popular drive systems: belt, chain and a universal coupling.

SIMPLE MACHINES

ENGINEERING SCIENCE

LEARNING OUTCOMES:

- Power transfer, efficiency and direction in a belt drive
- Power transfer and efficiency in a chain drive
- Input and output relationships of a universal coupling
- Friction and angle of lap on a pulley

SPECIAL OFFER

SIMPLE MACHINES KIT BUNDLE (ESB3)

This experiment bundle includes:

- Pulley Kit (ES10)
- Drive Systems Kit (ES11)
- Gear Trains Kit (ES13)
- Centrifugal Force Kit (ES16)
- Four Engineering Science Work Panels (ES1)

This kit includes three different drive systems to show their relative advantages and disadvantages.

Students test a universal coupling, a belt drive and a chain drive to see how they work and how they differ in the way they transfer motion (power).

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

ALTERNATIVE PRODUCTS:

- Geared Systems (TM1018) 222

GEAR TRAINS KIT

ES13

Demonstrates the characteristics of the most popular gear sets.

LEARNING OUTCOMES:

- Characteristics of spur gears, including single and compound gear trains and the 'idler' gear
- Characteristics of a bevel gear
- Characteristics of a worm drive

This kit includes a selection of different gears for experiments to find their unique characteristics.

The gears include spur gears, a bevel gear and a worm drive. The spur gears have two sets of teeth on the same shaft, allowing extra experiments in compound gear trains. Students test each set of gears to see how it works and note the differences in characteristics (such as efficiency, gear ratio and mechanical advantage) of each set.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

ALTERNATIVE PRODUCTS:

- Geared Systems (TM1018) 222

SOCIAL MEDIA

Find out all the latest up-to-the-minute news, promotions, stories from users and videos etc.

Plus, embrace the opportunity to interact with other academics, students and get fresh ideas.

CENTRIFUGAL FORCE KIT

ES16

Demonstrates the relationship between centrifugal force, radius and velocity of rotating masses.

LEARNING OUTCOMES:

- Relationship between centrifugal force, radius and velocity of different rotating masses.

This kit includes a manually rotated frame with a low-friction cantilever linkage. The frame has mounting positions for adjustable masses and a spring that applies a fixed frictional force value to a rotating drum. The range of mounting positions and masses allows many variations of the experiment to help students understand the relationships between the variables of speed, mass and radial position.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

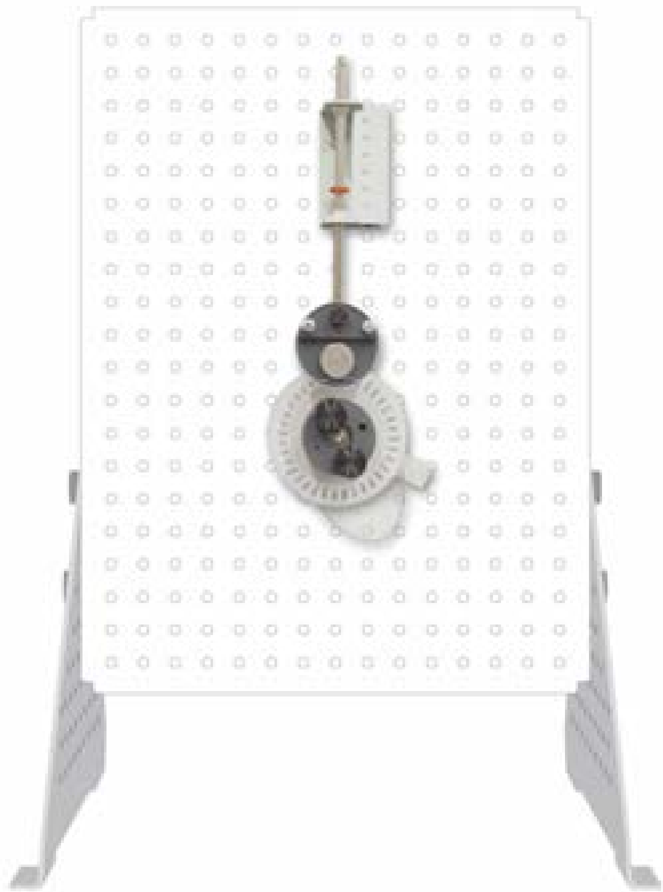
ALTERNATIVE PRODUCTS:

- Centrifugal Force (TM1005) 227

CAM, CRANK AND TOGGLE KIT

ES12

Demonstrates the characteristics of a mechanical toggle, crank motion and the most popular shaped cams.



LEARNING OUTCOMES:

- Displacement and angle characteristics of pear, heart, round and spiral cams
- Characteristics of a mechanical toggle
- Turning moments and forces during crank motion

This kit includes a crank and slider to show the relative forces during crank motion. It also includes four popular cam shapes to show their different characteristics. Another set of parts in the kit shows the characteristics of a mechanical toggle.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

ALTERNATIVE PRODUCTS:

- Cam Analysis Machine (TM1021) 219

SIMPLE MECHANISMS KIT

ES14

Demonstrates how three popular mechanisms convert motion.

LEARNING OUTCOMES:

- Conversion of motion using the 'Scotch yoke' (or 'slotted link')
- Conversion of motion using the quick return mechanism
- Conversion of motion using the crank and slider

This kit includes three popular mechanisms for experiments in conversion of motion, from linear to rotary, or rotary to linear. These include the Scotch yoke (sometimes called 'donkey crosshead' or 'slotted link'), the crank and slider, and the quick return mechanism. Students test each mechanism to see how it works and note the differences in the way that each mechanism converts the motion.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

SPECIAL OFFER

MECHANISMS KIT BUNDLE (ESB4)

This experiment kit bundle includes:

- Cam, Crank and Toggle Kit (ES12)
- Simple Mechanisms Kit (ES14)
- Bar Linkages Kit (ES15)
- Additional Mechanisms Kit (ES18)
- Four Engineering Science Work Panels (ES1)

BAR LINKAGES KIT

ES15

For students to assemble and understand different bar linkage mechanisms.

LEARNING OUTCOMES:

- Four bar linkages – crank rocker, double rocker, draglink and parallelogram
- Straight line linkages – Watt's straight line, Chebyshev, Peaucellier-Lipkin, Hart's inversor, Robert's and Hoeken's
- Pantograph
- Ackermann steering

This kit includes a selection of over 20 perforated bars of different lengths and pivots or 'joints' to allow students to create an unlimited choice of linkages.

Students assemble the bars and joints in any arrangement and note how the linkage converts movement from one form to another (for example: rotary motion to linear motion). Bar linkages are one of the most basic mechanisms used in mechanical engineering.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

PRODUCT DEVELOPMENT

The information contained in this publication has been carefully prepared and is correct at the time of printing. TecQuipment is, however, committed to a programme of continuous improvement; hence we reserve the right to alter the design and product specification without prior notice to ensure it continues to meet customer needs.

For the latest information on all our products please visit our website at: TECQUIPMENT.COM

ADDITIONAL MECHANISMS KIT

ES18

Demonstrates how two popular mechanisms convert motion.

LEARNING OUTCOMES:

- Conversion of motion using the Geneva mechanism
- Conversion of motion using a ratchet

This kit includes two popular mechanisms for experiments in conversion of motion from one form to another. These include the Geneva mechanism (sometimes called the Maltese cross mechanism or crank and star), and a ratchet mechanism. Students test each mechanism to see how it works and note the differences in the way that each mechanism converts the motion.

ESSENTIAL BASE UNIT:

- Work Panel (ES1) 8

QUALITY CONTROL WITH IN-HOUSE PRODUCTION

To maintain high quality and keep lead times to a minimum, products are designed and manufactured all under one roof in the TecQuipment headquarters based in the UK.

STORAGE EQUIPMENT

EST / ETL

Storage equipment for use with TecQuipment's Engineering Science range.

- A set of five spare trays and lids (ETL) – useful for safely storing ancillaries or printed material such as lecturer guides or worksheets
- A compact mobile frame (EST) that stores up to 24 trays safely and tidily, while allowing one person to move all 24 trays from one room to another

For use with the Engineering Science kits, TecQuipment offers these supporting products as a useful resource for lecturers or teachers:

STORAGE UNIT EST

A mobile trolley for use with the Engineering Science kits. This trolley allows lecturers or teachers to safely and tidily store up to 24 trays in one mobile unit.

TRAYS AND LIDS ETL

A set of five trays and lids. Identical to those used for the kits, so they fit and stack in the same way.

QUICK DELIVERY ON STOCK PRODUCTS

TecQuipment holds stocks of the most popular products, ready for speedy shipment across the world.

Contact us to find out what is currently in stock.

SALES@TECQUIPMENT.COM

SPARES AND CONSUMABLES

ESX / SW1 / WT / WTL / MTT

Spares and consumables for use with TecQuipment's Engineering Science range.

SPARE PARTS KIT (ESX)

- Useful to replace any parts that become lost from the experiment kits during use, or to increase the variation of experiments
- Additional tensile test specimens (MTT) for the Tensile Tester Kit (ES6)
- Additional weight sets (WT and WTL) and stopwatch (SW1) – useful spares for both the Engineering Science range and other TecQuipment products
- A tray of spares (ESX) containing the most common parts of the Engineering Science kits

TecQuipment offers these spares and consumables mainly for the Engineering Science range. However, the stopwatch and weight sets also work as spares for other TecQuipment product ranges.

SPARE PARTS KIT ESX

This kit includes spares of the most common parts used in the other Engineering Science kits, including fixings, weights, hooks and cord.

STOPWATCH SW1

An easy-to-use, accurate, hand-held digital stopwatch. Replaces any lost from the kits or allows more students to share experiments.

WEIGHT SETS WT AND WTL

Slotted masses that fit onto TecQuipment's weight hangers. They will work as general-purpose weights and spares for those in several other TecQuipment products, such as the Structures range.

WT – A set of 10 g masses and weight hangers

WTL – A set of 1 g masses

TENSILE TEST SPECIMENS MTT

Specimens made from a choice of four different materials for use with the Engineering Science Tensile Tester (ES6).

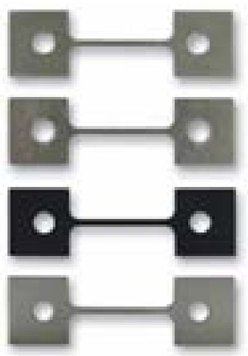
MTTA – Aluminium

MTTD – Duralumin

MTTP – PVC

MTTS – Mild Steel

NOTE: TecQuipment supplies all specimens individually, but a minimum order charge applies.



AERODYNAMICS

> We recently purchased a wind tunnel for the training of our aeronautical engineering students from TecQuipment. The product was easy to set-up, straight forward to operate and I am confident will continue to be used for many years to come. The service and training that TecQuipment provides makes them a pleasure to work with.
>
> **SEAN HAINSWORTH**
> AERONAUTICAL ENGINEERING LECTURER, MILTON KEYNES COLLEGE

AERODYNAMICS

The aerodynamics range is used for teaching a vast range of aerodynamic principles – from fundamentals through to advanced theories – with products to suit every space, budget and complexity requirement. The wind tunnels span a variety of sizes and experimentation capabilities, from bench-top models for learning the basics, to versions requiring large laboratories for a more detailed understanding of aerodynamics.

PRINCIPLES OF AERODYNAMICS

TecQuipment's subsonic wind tunnels teach students the basics of lift, drag and pitching moments, plus high-level topics such as boundary layer and pressure distribution around models. Students can also perform wake investigations.

ADVANCED THEORY OF AERODYNAMICS

TecQuipment's supersonic wind tunnels are for the more advanced teaching of aerodynamics engineering, with experiments that start with nozzle pressure distribution, on to analysis of Mach numbers, and the measurement and visualisation of pressure and shock waves using Schlieren apparatus.

AUTOMATIC DATA ACQUISITION VDAS®

A variety of the products in this range work with TecQuipment's unique Versatile Data Acquisition System (VDAS®) – SEE PAGE 299.

KEY FEATURES AND BENEFITS:

MADE FOR TEACHING: Realistic results yet small enough for laboratories.

FLEXIBILITY: Packages of equipment can be chosen to suit budgets and needs.

EASY SET-UP: It takes only minutes to change and set up an experiment.

HANDS-ON: Laboratory-scale parts allow easy fitting and adjustments, for a more practical understanding.

MODULAR FLUID POWER RANGE

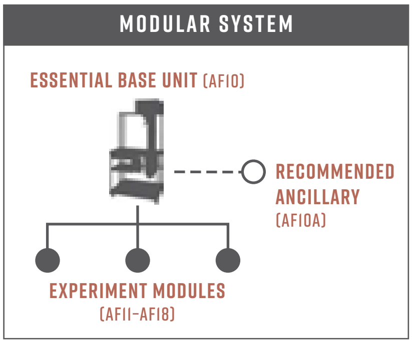
The Modular Fluid Power range includes products that allow demonstrations and studies of the performance of different types of 'real world' air machines (fans and compressors)
– SEE PAGES 134–148.

CENTRIFUGAL FAN MODULE (MFP106)

MODULAR AIR FLOW BENCH

AF10

A mobile bench providing the base unit for a wide range of air flow experiment modules.



SHOWN FITTED WITH ONE OF THE AVAILABLE EXPERIMENT MODULES (AF12) AND MULTI-TUBE MANOMETER (AF10A)

FEATURES:		BENEFITS:
Supports and supplies a controllable air flow to its optional experiment modules	→	Modular design saves space and reduces costs
Eight different optional experiment modules	→	Covers all aspects of a basic aerodynamics curriculum
Compact, mobile and easy to install	→	Simplifies laboratory layout
Easy set-up – just minutes to remove and fit experiment modules	→	Maximises experiment time and requires minimal supervision

The AF10 is a small-scale wind tunnel with an electric fan and adjustable air flow control. It is the essential base unit for eight different experiment modules that demonstrate key principles and phenomena of air flow.

CONTINUED ON NEXT PAGE

AVAILABLE EXPERIMENT MODULES:

RECOMMENDED ANCILLARIES:

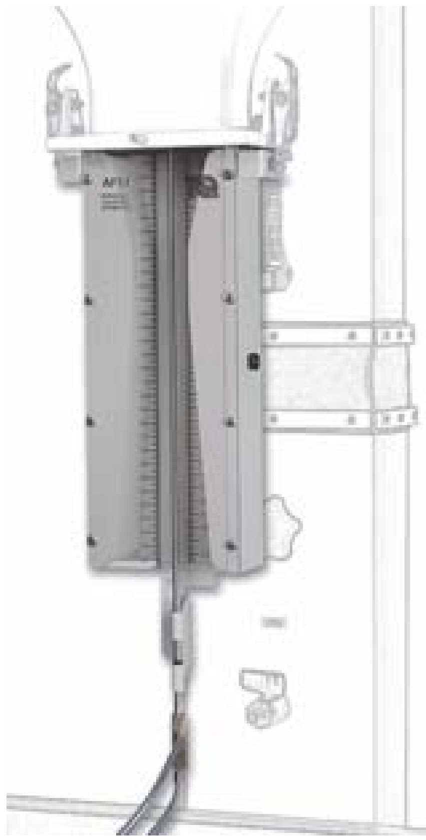
ALTERNATIVE PRODUCTS:

BERNOULLI'S EQUATION

AF11

Allows students to measure the pressure distribution in a convergent-divergent duct.

- One of a series of eight experiment modules that fit to the Modular Air Flow Bench (AF10)
- Quickly and simply illustrates Bernoulli's equation for air, and its limitations due to boundary layer effects
- Quick-release couplings for rapid and reliable pressure connection to the AF10a Manometer
- Transparent front to the duct so that the profile of the test nozzle and the position of the Pitot static tube can be seen clearly



LEARNING OUTCOMES:

- Confirmation of Bernoulli's equation
- The use of a Pitot static tube and water manometer

This experiment module illustrates Bernoulli's equation as applied to a convergent-divergent duct. A Pitot static tube measures both the total pressure and the static pressure independently. The tube traverses along the axis of the duct and connects to the AF10a manometer (ancillary) via flexible tubes fitted with quick-release couplings.

ESSENTIAL BASE UNIT:

ESSENTIAL ANCILLARIES:

ALTERNATIVE PRODUCTS:

DRAG FORCE

AF12

Allows students to investigate the direct and indirect measurement of drag on various shapes.

- One of a series of eight experiment modules that fit to the Modular Air Flow Bench (AF10)
- Compares drag for a cylinder calculated from a measured pressure distribution, and a wake traverse against that measured directly for a cylinder
- Allows comparisons of drag force between a cylinder, flat plate and aerofoil
- The test duct has transparent sides with clearly printed scales – allowing students to see the experiment and accurately position the models and the Pitot tube

This simple yet comprehensive experiment module consists of a duct with transparent front and rear. The front has scales printed on it to position the various parts during the experiments. A Pitot tube and simple mass balance are attached to the outside of the duct for wake traverse and direct drag measurements respectively.

LEARNING OUTCOMES:

- Determination of the drag coefficient by measurement of the pressure distribution around the cylinder
- Determination of the drag coefficient by wake traverse
- Determination of the drag coefficient around the cylinder by direct measurement and comparison to results obtained by pressure distribution and wake traverse
- Direct measurement and comparison of drag coefficient between a cylinder, flat plate and aerofoil

ESSENTIAL BASE UNIT:

- Modular Air Flow Bench (AF10) 31

ESSENTIAL ANCILLARIES:

- Multi-tube Manometer (AF10a) 38

ALTERNATIVE PRODUCTS:

- Cylinder Model (AF1300a) 43
- NACA 0012 Aerofoil with Tappings (AF1300b) 43
- Flat Plate Drag Model (AF1300e) 43
- Three-dimensional Drag Models (AF1300j) 43
- S1210 Aerofoil (AF1300l) 43

DOCUMENTS INCLUDED – EVERYTHING YOU NEED

A comprehensive pack of documents is supplied with all experiments, including:

- **USER MANUAL:** How to use the product, along with instructions on experiment set-up and supporting enginering principles for guided learning.
- **PACKING CONTENTS LIST:** All the parts that make up the complete product.
- **TEST CERTIFICATE:** Your peace of mind that the product has been thoroughly tested before dispatch.

ROUND TURBULENT JET

AF13

Allows students to investigate a jet of air as it emerges from the end of a tube.

- One of a series of eight experiment modules that fit to the Modular Air Flow Bench (AF10)
- Allows a number of tests on the velocity of a submerged jet emerging from the end of a tube
- The tube has a carefully designed inlet for best results
- Quick-release coupling fitted to the Pitot tube to allow rapid and reliable connection to the AF10a Manometer

LEARNING OUTCOMES:

- Decay of the centre-line velocity
- Velocity profile at various distances along the jet and the development of the spread of the jet
- Analysis of the velocity profiles to demonstrate how the mass flux in the jet increases, the kinetic energy flux decreases and the momentum flux remains constant along the jet length

This module consists of a tube with a specially designed rounded entry. The tube is mounted on a stiff plate with the rounded entry on one side and the exit on the other.

ESSENTIAL BASE UNIT:

- Modular Air Flow Bench (AF10) 31

ESSENTIAL ANCILLARIES:

- Multi-tube Manometer (AF10a) 38

BOUNDARY LAYER

AF14

Allows students to investigate the boundary layer on a flat plate.

- One of a series of eight experiment modules that fit to the Modular Air Flow Bench (AF10)
- Allows a number of tests on laminar and turbulent boundary layers, with rough and smooth surfaces with different pressure gradients
- Boundary layer velocity profile is measured with a Pitot tube with a fine micrometer adjustment for best results
- Test section has a transparent front – students can see the experiment and the position of the Pitot tube clearly

LEARNING OUTCOMES:

- Measurement of the velocity profile in laminar and turbulent boundary layers
- Measurement of the velocity profile in the boundary layer formed over both rough and smooth plates
- Measurement of the velocity profile in the boundary layer at various distances from the leading edge of the plate
- Effect of the pressure gradient on the boundary layer velocity profile

This module consists of a duct in which there is situated a flat plate. The flat plate is rough on one side and smooth on the other, providing different surface conditions for the formation of a boundary layer.

ESSENTIAL BASE UNIT:

- Modular Air Flow Bench (AF10) 31

ESSENTIAL ANCILLARIES:

- Multi-tube Manometer (AF10a) 38

ALTERNATIVE PRODUCTS:

- Flat Plate Drag Model (AF1300e) 43

FLOW AROUND A BEND

AF15

Allows students to measure the pressure distribution in a smooth rectangular bend.

- One of a series of eight experiment modules that fit to the Modular Air Flow Bench (AF10)
- Shows the pressure distribution in a smooth rectangular bend as an example of internal flow problems
- Quick-release couplings for rapid and reliable pressure measurement connection to the AF10a Manometer
- Highly visual plot of the pressure profile on the manometer

LEARNING OUTCOMES:

- Pressure distribution along the curved inner and outer walls
- Radial pressure distribution and comparison with that predicted assuming free vortex velocity distribution
- Calculation of loss coefficient (K)

This module consists of a smooth rectangular bend with ten static tapping points on both the inner and outer curved walls, plus a further nine along the radius.

ESSENTIAL BASE UNIT:

- Modular Air Flow Bench (AF10) 31

ESSENTIAL ANCILLARIES:

- Multi-tube Manometer (AF10a) 38

COANDĂ EFFECT AND JET FLOW

AF16

Allows students to investigate the Coandă effect and a fluidic flip-flop.

- One of a series of eight experiment modules that fit to the Modular Air Flow Bench (AF10)
- Shows an example of how the phenomena of fluid mechanics can be exploited to perform a useful task – a fluidic flip-flop
- Transparent fronted test duct with clearly printed scales allows the experiment to be clearly seen and components accurately positioned
- Effectively demonstrates the Coandă effect

LEARNING OUTCOMES:

- Demonstration of the Coandă effect
- Demonstration of the fluidic flip-flop

This module consists of an aerodynamically shaped nozzle from which a jet of air emerges. This flows against a wall to which it attaches.

ESSENTIAL BASE UNIT:

- Modular Air Flow Bench (AF10) 31

FLOW VISUALISATION

AF17

Allows students to “see” the air flows around various shapes by using smoke filaments.

- One of a series of eight experiment modules that fit to the Modular Air Flow Bench (AF10)
- Includes a set of differently shaped two-dimensional models
- Transparent fronted test duct, with clearly printed angular scale, allows the models to be clearly seen and accurately positioned
- Comes complete with ducting to allow the smoke to be easily and safely drawn away by the Modular Air Flow Bench

This module consists of a specially shaped duct which has a large working section with transparent window. The inlet of the duct is attached to the Air Flow Bench plenum chamber using quick-release clamps; the outlet is located into the bench exhaust.

LEARNING OUTCOMES:

- Demonstration of the flow patterns round a cylinder, flat plate, aerofoil and a sharp-edged orifice/slit

ESSENTIAL BASE UNIT:

- Modular Air Flow Bench (AF10) 31

ALTERNATIVE PRODUCTS:

- Flow Visualisation Wind Tunnel (AF80) 55

TRAINING AVAILABLE ON-SITE OR AT TECQUIPMENT HEADQUARTERS

Comprehensive equipment training is available from TecQuipment’s team of specialist engineers.

Topics include:

- Operation
- Safety
- Maintenance
- Introductory experimentation

TAPPED AEROFOIL

AF18

Allows students to investigate the pressure distribution around a two-dimensional aerofoil.

- One of a series of eight experiment modules that fit to the Modular Air Flow Bench (AF10)
- Provides both a visual and analytical experience for students as the manometer readings clearly show both the pattern and magnitude of the pressure distribution
- Serves as a useful companion experiment to the Drag Force Apparatus (AF12)
- Transparent front and rear to the test duct with a printed scale allows the experiment to be clearly seen and allows the aerofoil angle to be accurately set

LEARNING OUTCOMES:

- The visualisation and measurement of the pressure distribution around an aerofoil section
- Lift characteristics and stall angle of an aerofoil

ESSENTIAL BASE UNIT:

- Modular Air Flow Bench (AF10) 31

ESSENTIAL ANCILLARIES:

- Multi-tube Manometer (AF10a) 38

ALTERNATIVE PRODUCTS:

- NACA 0012 Aerofoil with Tappings (AF1300b) 43

This module consists of a duct with transparent front and rear, between which is mounted a symmetrical aerofoil with a NACA profile. The aerofoil has 12 tapping points at various chordwise positions on its surface, allowing the pressure to be measured at that point. The tapping points are permanently connected to a manifold mounted on the duct showing the tapping position and number for easy reference.

MULTI-TUBE MANOMETER

AF10A

A multi-tube inclinable manometer for use with the Modular Air Flow Bench.

- Uses water for safety and simplicity
- Inclinable for increased sensitivity
- Adjustable height datum and levelling feet
- Includes non-toxic coloured dye to see water levels clearly

ANCILLARY FOR:

- Modular Air Flow Bench (AF10) 31
- Bernoulli's Equation (AF11) 32
- Drag Force (AF12) 33
- Round Turbulent Jet (AF13) 34
- Boundary Layer (AF14) 35
- Flow Around a Bend (AF15) 36
- Tapped Aerofoil (AF18) 38

The multi-tube manometer is an ancillary to the AF10 base module and its experiment modules. It fits on or near to the AF10 and connects to pressure tappings on the optional experiment modules. Some experiment modules may only have two or three pressure tappings but others use up to 12 tappings. This makes the multi-tube manometer essential to see all the pressures at the same time.

BENCH-TOP SUBSONIC WIND TUNNEL

AF1125

An ultra-compact, open-circuit bench-top subsonic wind tunnel that offers a complete system ready for aerodynamic experimentation – suitable for college use, undergraduate study and research projects.

LIFT AND DRAG BALANCE (INCLUDED)

- Selection of models included for studies of drag and pressure profiles
- Efficient and compact where laboratory space is at a premium
- Two-component balance with digital display for lift and drag measurement
- Compact, open-circuit suction design
- Transparent working section for a full view of the test area
- Electronic controller for variable air velocity

Air enters the tunnel through an aerodynamically designed effuser (inlet cone) and honeycomb flow straightener that accelerate the air linearly. It then enters the working section and passes through a grille before moving through a diffuser and then to a variable-speed fan. The grille protects the fan from damage by loose objects. The air leaves the fan, passes up through a silencer unit and then back out to atmosphere.

EXPERIMENT MODELS INCLUDED:

- Drag models
- Cylinder with pressure tapping
- NACA0020 aerofoil

LEARNING OUTCOMES:

A wide variety of subsonic aerodynamics experiments, including:

- Flow past bluff and streamlined bodies
- Pressure distribution around a cylinder
- Lift and drag forces

RECOMMENDED ANCILLARIES:

- Smoke Generator (AFA11) 51

ALTERNATIVE PRODUCTS:

- Modular Air Flow Bench (AF10) 31
- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1450S) 47
- Subsonic Wind Tunnel (AF1600S) 49
- Flight Demonstration Wind Tunnel (AF41) 53
- Flow Visualisation Wind Tunnel (AF80) 55
- Supersonic Wind Tunnel – Intermittent (AF300) 59
- Supersonic Wind Tunnel – Continuous (AF302) 61

MILTON KEYNES COLLEGE TAKES OFF WITH AF1300 WIND TUNNEL

The electronic and aeronautical test facility at Milton Keynes College in the UK recently purchased an AF1300 Subsonic Wind Tunnel for teaching Level 3 Aeronautical Engineering BTEC Diploma students, which is used on a regular basis as part of the course.

ADDRESSING THE AERONAUTICAL ENGINEERING SKILLS SHORTAGE

In response to the world skills shortage of aeronautical engineers, in 2016 Milton Keynes College began a dedicated Aeronautical Engineering BTEC. This course, headed up by Sean Hainsworth, former RAF aerospace engineer, first began as a trial. Following the course's success, Milton Keynes College had a full cohort of 40 applicants starting in September 2018.

WIND TUNNEL IN THE SYLLABUS

Students are required to complete projects that involve the design, manufacture and test of aerofoils throughout the year. As part of the course, students have a project to design and build three types of aerofoil, testing with three angles in the wind tunnel (0 degrees, 5 degrees and the critical 15-degree stall angle) and then applying three different equations (lift, drag and wind speed).

PEARSON BTEC LEVEL 3 DIPLOMA IN AERONAUTICAL ENGINEERING

The AF1300 Subsonic Wind Tunnel is used as a standard piece of equipment in specialist aeronautical engineering facilities across the globe. For the Pearson BTEC Level 3 Diploma in Aeronautical Engineering, the equipment is utilised for the following units:

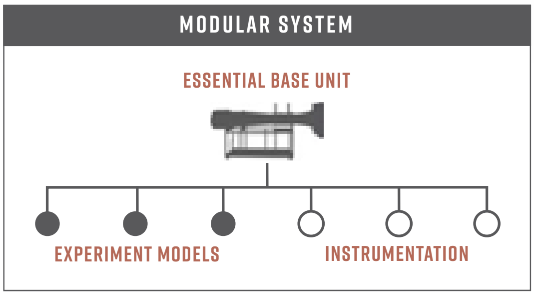
- Unit 5: Mechanical Principles and Applications
- Unit 48: Theory of Flight
- Unit 68: Principles and Applications of Aircraft Mechanical Science

SUBSONIC WIND TUNNEL 300 MM

VDAS® AF1300

A compact, free-standing open-circuit suction subsonic wind tunnel with a working section of 300 mm by 300 mm and 600 mm long, allowing students to perform advanced study such as analysing boundary layers, performing flow visualisation and observing velocity in the wake, offering extensive teaching and research functionality.

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE



- Safe, compact, open-circuit suction wind tunnel – a cost effective solution when compared to full-sale wind tunnels
- Additional models and instruments available to extend the range of experiments
- Wind tunnel controls mount on a separate, free-standing instrument frame for ease of use
- Also available as a starter set (see opposite)

"We recently purchased a wind tunnel for the training of our aeronautical engineering students from TecQuipment. The product was easy to set-up, straightforward to operate and I am confident will continue to be used for many years to come. The service and training that TecQuipment provides makes them a pleasure to work with."

SEAN HAINSWORTH
MILTON KEYNES COLLEGE

MODEL CAR IN THE SUBSONIC WIND TUNNEL

CONTINUED ON NEXT PAGE

LEARNING OUTCOMES:

TecQuipment can also supply optional models and instruments to extend experiments, giving:

- Flow past bluff and streamlined bodies with pressure and velocity observations in the wake
- Investigations into boundary layer development
- Influence of aspect ratio on aerofoil performance
- Performance of an aerofoil with flap, influence of flap angle on lift, drag and stall
- Pressure distribution around a cylinder under sub and super-critical flow conditions
- Study of characteristics of models involving basic measurement of lift and drag forces
- Study of the characteristics of three-dimensional aerofoils involving measurement of lift, drag and pitching moment
- Study of the pressure distribution around an aerofoil model to derive the lift and comparison with direct measurements of lift
- Flow visualisation

Air enters the tunnel through an aerodynamically designed effuser (cone) that accelerates the air linearly. It then enters the working section and passes through a grille before moving through a diffuser and then to a variable-speed axial fan. The grille protects the fan from damage by loose objects. The air leaves the fan, passes through a silencer unit and then back out to the atmosphere.

AVAILABLE EXPERIMENT MODELS:

STARTER SET AF1300S

Included with the wind tunnel in this starter set are:

- Basic Lift and Drag Balance (AF1300z)
- Set of Three-dimensional Drag Models (AF1300j)

RECOMMENDED INSTRUMENTATION:

ALTERNATIVE PRODUCTS:

SUBSONIC WIND TUNNEL (AF1300) EXPERIMENT MODELS

- Simple and quick to set-up and use
- Some models include pressure tappings for pressure distribution experiments
- All models work with the other optional instruments for the AF1300 Subsonic Wind Tunnel

CYLINDER MODEL WITH PRESSURE TAPPING AF1300A

A cylinder model with a single pressure tapping point. The model spans the full width of the working section of the wind tunnel.

NACA 0012 AEROFOIL MODEL WITH TAPPINGS AF1300B

The aerofoil has 20 static pressure tappings along its chord on the upper and lower surfaces. They each connect to tubes that pass through the aerofoil and then out to clear, numbered, flexible tubes.

150 MM CHORD NACA2412 AEROFOIL WITH VARIABLE FLAP AF1300C

An unsymmetrical section (cambered) aerofoil with adjustable flap. The adjustable flap allows students to study the effects of control surfaces such as flaps, ailerons, elevator or rudder.

150 MM CHORD NACA0012 AEROFOILS AF1300D

A set of two aerofoils. One aerofoil has a span that extends the full width of the working section of the wind tunnel. This model has the characteristics of a two-dimensional aerofoil. The other aerofoil has a span that extends for half of the working section of the wind tunnel. This model has the characteristics of a three-dimensional aerofoil.

100 MM DIAMETER FLAT PLATE AF1300E

This model shows the flow around a bluff body mounted normal to the air flow direction, and the drag force exerted on it.

FLAT PLATE BOUNDARY LAYER MODEL AF1300F

Demonstrates boundary layer development and separation. The model is a flat plate that spans the full width of the wind tunnel working section. It has aerodynamically shaped blocks mounted across the plate at different distances from the leading edge.

AIRCRAFT MODEL – LOW WING AF1300G
AIRCRAFT MODEL – HIGH WING AF1300H

Model aircraft with NACA profile wings. One has a low wing position (bottom of the fuselage), the other has a high wing position (above the fuselage).

THREE-DIMENSIONAL DRAG MODELS AF1300J

A set of five different shaped models with identical frontal area to allow students to compare the different coefficient of drag for each shape. Includes a dummy stem for tests to cancel out the drag due to each model's support arm.

S1210 AEROFOIL AF1300L

An unsymmetrical aerofoil that spans the full width of the working section of the wind tunnel, for two-dimensional experiments.

CONTINUED ON NEXT PAGE

SUBSONIC WIND TUNNEL (AF1300) INSTRUMENTS

BASIC LIFT AND DRAG BALANCE VDAS® AF1300Z

Measures lift and drag forces on models mounted in the AF1300 Subsonic Wind Tunnel.

- A two-component balance to measure the lift and drag forces on models mounted in the AF1300 Subsonic Wind Tunnel
- Transmits the force on the model directly to a strain-gauged load cell with digital display

The balance mechanism enables test models with a rigid support arm to be mounted and held securely in position in the working section of the wind tunnel. The arm transmits the force on the test model directly to a strain gauged load cell. The load cell is connected to a readout unit with a digital display, which is powered by a desktop power supply (included).

SHOWN FITTED WITH THE PROTRACTOR FROM THE AF1300 WIND TUNNEL

ANCILLARY FOR:

- Subsonic Wind Tunnel (AF1300) 41
- Cylinder Model with Pressure tapping (AF1300a) 43
- 150 mm Chord NACA0012 Aerofoils (AF1300d) 43
- 100 mm Diameter Flat Plate (AF1300e) 43
- Three-dimensional Drag Models (AF1300j) 43
- S1210 Aerofoil (AF1300l) 43

ALTERNATIVE PRODUCTS:

- Three-Component Balance (AF1300t) 45

DIFFERENTIAL PRESSURE TRANSDUCER VDAS® AFA5

Digital differential pressure measurement and display unit for use with the AF1300 Subsonic Wind Tunnel.

- Measures and displays differential pressures from models, Pitot static tubes and other devices
- Quicker, easier and more versatile than using liquid manometers
- Measures differential pressures or pressure with respect to atmosphere

The Differential Pressure Transducer and readout measures and displays pressures in Pitot static tubes and other pressure-sensing devices fitted to the AF1300 Subsonic Wind Tunnel, with respect to the atmosphere or differential pressures.

ANCILLARY FOR:

- Subsonic Wind Tunnel (AF1300) 41
- Cylinder Model (AF1300a) 43
- NACA 0012 Aerofoil Model with Tappings (AF1300b) 43
- 150 mm Chord NACA2412 Aerofoil with Variable Flap (AF1300c) 43
- Set of 2 NACA 0012 Aerofoils (AF1300d) 43
- Flat Plate Drag Model (AF1300e) 43
- Boundary Layer Model (AF1300f) 43
- Aircraft Model-Low Wing (AF1300g) 43
- Aircraft Model-High Wing (AF1300h) 43
- Three Dimensional Drag Models (AF1300j) 43
- S1210 Aerofoil (AF1300l) 43

ALTERNATIVE PRODUCTS:

- Multi-Tube Manometer (AFA1) 51
- 32-Way Pressure Display Unit (AFA6) 52

THREE-COMPONENT BALANCE VDAS® AF1300T

Measures lift, drag and pitching moment of models in the AF1300 Subsonic Wind Tunnel.

- Provides a convenient support system for models to measure the lift, drag and pitching moment
- Digital display shows lift, drag and pitching moment directly
- Fully adjustable for varying the angle of incidence to the direction of air flow

The Three-Component Balance provides an easy-to-use support system for wind tunnel models. It measures lift, drag and pitching moment exerted on the model.

RECOMMENDED ANCILLARIES:

- Balance Angle Feedback Unit (AFA4) 45

ANCILLARY FOR:

- Subsonic Wind Tunnel (AF1300) 41
- Cylinder Model with Pressure Tapping (AF1300a) 43
- 150 mm Chord NACA0012 Aerofoils (AF1300b) 43
- 150 mm Chord NACA2412 Aerofoil with Variable Flap (AF1300c) 42
- 100 mm Diameter Flat Plate (AF1300e) 43
- Aircraft Model - Low Wing (AF1300g) 43
- Aircraft Model - High Wing (AF1300h) 43
- Three-dimensional Drag Models (AF1300j) 43

ALTERNATIVE PRODUCTS:

- Basic Lift and Drag Balance (AF1300z) 44

SMOKE GENERATOR AFA10

Allows the observation of air flow in subsonic wind tunnels and other air flow situations.

A smoke generator and probe that allows students to see air flow in subsonic wind tunnels and other low flow rate air flow products.

ANCILLARY FOR:

- Subsonic Wind Tunnel (AF1300) 41
- Flight Demonstration Wind Tunnel (AF41) 53

ALTERNATIVE PRODUCTS:

- Flow Visualisation (AF17) 37
- Flow Visualisation Wind Tunnel (AF80) 55

BALANCE ANGLE FEEDBACK UNIT VDAS® AFA4

Measures the angle positions of models mounted on the Three-Component Blance (AF1300T) and feeds the information directly to the Versatile Data Acquisitin System (VDAS®)

The Balance Angle Feedback Unit is an ancillary for use with TecQuipment's Three-Component Balance and VDAS® together to measure and record the angluar position of models mounted on the balance in TecQupment's subsonic wind tunnels.

ANCILLARY FOR:

- Three-Component Balance (AF1300t) 45

CONTINUED ON NEXT PAGE

MINIMUM INSTRUMENTS REQUIRED

MINIMUM INSTRUMENTATION REQUIRED IF NOT USING VDAS®

This table shows the minimum additional instrumentation required if choosing not to use TecQuipment's VDAS®.

NOTE: When using AF1300 without VDAS® all data recording must be done manually.

	Basic Lift and Drag Balance (AF1300z) **OR** Three-Component Balance (AF1300t)	Three-Component Balance (AF1300t)	Multi-tube Manometer (AFA1)
Cylinder Model (AF1300a)	✓		
Set of Two NACA 0012 Aerofoils (AF1300d)	✓		
Flat Plate Drag Model (AF1300e)	✓		
Three-dimensional Drag Models (AF1300j)	✓		
S1210 Aerofoil (AF1300l)	✓		
NACA 0012 Aerofoil with Tappings (AF1300b)			✓
Boundary Layer Model (AF1300f)			✓
NACA 2412 Aerofoil with Flap (AF1300c)		✓	
Aircraft Model - Low Wing (AF1300g)		✓	
Aircraft Model - High Wing (AF1300h)		✓	

It is possible to complete all AF1300 experiments without using VDAS®. However, there is a minimum additional instrumentation requirement for some experiments.

All TecQuipment electronic instruments, e.g. the 32-Way Pressure Display Unit (AFA6), have visual displays from which data can be transcribed.

Other instruments, e.g. the Multi-tube Manometer (AFA1), are read manually and the data transcribed.

NOTE: The AF1300 is supplied with a standard Pitot tube, a Pitot static tube and a manometer (built into the control panel). Some or all of these instruments will be required, in addition to the optional instruments listed here, to complete the experiments.

SMOKE TRAIL AROUND THE LOW WING AIRCRAFT MODEL

MINIMUM INSTRUMENTATION REQUIRED IF USING VDAS®

This table shows the additional instrumentation required if using VDAS®, making the most of its data collecting abilities.

NOTE: When using VDAS® with the AF1300, data recording is quickly and accurately achieved directly onto a suitable computer.

The data can then be downloaded into a suitable software package for further evaluation and presentation if required.

	Differential Pressure Transducer (AFA5)	**EITHER** Basic Lift and Drag Balance (AF1300z) **OR** Three-Component Balance (AF1300t) **WITH** Balance Angle Feedback Unit (AFA4)	Pitot Static Traverse (AFA7)	32-Way pressure Display Unit (AFA6)	Three-Component Balance (AF1300t) **WITH** Balance Angle Feedback Unit (AFA4)
Cylinder Model (AF1300a)	2	✓	✓		
Set of Two NACA 0012 Aerofoils (AF1300d)	2	✓	✓		
Flat Plate Drag Model (AF1300e)	2	✓	✓		
Three-dimensional Drag Models (AF1300j)	2	✓	✓		
S1210 Aerofoil (AF1300l)	2	✓	✓		
NACA 0012 Aerofoil with Tappings (AF1300b)	2		✓	✓	
Boundary Layer Model (AF1300f)	✓			✓	
NACA 2412 Aerofoil with Flap (AF1300c)	2		✓		✓
Aircraft Model - Low Wing (AF1300g)	✓		✓		✓
Aircraft Model - High Wing (AF1300h)	✓		✓		✓

SUBSONIC WIND TUNNEL 450 MM

VDAS® AF1450S

A sizable open-circuit suction subsonic wind tunnel with a working section of 450 mm by 450 mm and 1000 mm length. It provides a cost-effective balance between being able to carry out advanced aerodynamics study, while being less bulky than the AF1600.

- Cost-effective solution when compared to full-scale wind tunnels or airborne laboratories
- Operates at meaningful Reynolds numbers
- Safe, open-circuit suction design
- Package includes an aerofoil with tappings, a three-component balance, angle feedback, dual differential pressure display, a 32-way pressure display unit, 2 x Pitot static traverse, protractor, model holder and data acquisition (VDAS-F)
- Controls and instrumentation conveniently mount on a separate, free-standing frame

Air passes into the wind tunnel through a honeycomb flow straightener and a grille. It then passes into an aerodynamically designed effuser (cone) that accelerates the air in a linear manner before it moves through the working section. Finally, it passes through a diffuser, then into the variable speed axial fan. The grille protects the fan from damage by loose objects. The air leaves the fan, passes through a silencer unit and then back out to atmosphere.

LEARNING OUTCOMES:

A wide variety of subsonic aerodynamics experiments (some need ancillaries), including:

- Flow past bluff and streamlined bodies with pressure and velocity observations in the wake
- Investigations into boundary layer development
- Influence of aspect ratio on aerofoil performance
- Performance of an aerofoil with flap, influence of flap angle on lift, drag and stall
- Pressure distribution around a cylinder under sub and super-critical flow conditions
- Study of characteristics of models involving basic measurement of lift and drag forces
- Study of the characteristics of three-dimensional aerofoils involving measurements of lift, drag and pitching moment
- Study of the pressure distribution around an aerofoil model to derive the lift, and comparison with direct measurements of lift
- Drag force on a bluff body normal to air flow
- Flow visualisation

CONTINUED ON NEXT PAGE

INCLUDED WITH THE WIND TUNNEL:

THREE-COMPONENT BALANCE AF1450T

The Three-Component Balance measures lift, drag and pitching moment exerted on the model. Includes a balance angle feedback unit which measures the angular position of models mounted on the balance in the wind tunnel and feeds the information directly to VDAS®.

SHOWN FITTED WITH THE BALANCE ANGLE FEEDBACK UNIT (INCLUDED)

NACA 0012 AEROFOIL WITH TAPPINGS AF1450B

A 150 mm chord 450 mm span NACA0012 aerofoil with pressure tappings.

DUAL DIFFERENTIAL PRESSURE DISPLAY DPG

Measures and displays pressures in Pitot static tubes and other pressure-sensing devices fitted to the wind tunnel, with respect to the atmosphere or differential pressures.

RECOMMENDED ANCILLARIES:

- Multi-Tube manometer (AFA1) 51
- Smoke Generator (AFA11) 51

AVAILABLE EXPERIMENT MODELS:

- Cylinder Model with Tapping (AF1450a)
- NACA 2412 Aerofoil with Flap (AF1450c)
- Set of 2 NACA 0012 Aerofoils (AF1450d)
- Flat Plate Drag Model (AF1450e)
- Boundary Layer (AF1450f)
- Aircraft Model – Low Wing (AF1450g)
- Aircraft Model – High Wing (AF1450h)
- Three-Dimensional Drag Models (AF1450j)
- Two Vehicle Drag Models (AF1450k)
- S1210 Aerofoil Model (AF1450l)

32-WAY PRESSURE DISPLAY UNIT AFA6

Measures and displays up to 32 different pressures from models, Pitot static tubes and other measuring instruments fitted to the wind tunnel – **SEE PAGE 51.**

PITOT STATIC TRAVERSE x2 AFA7

Two traversing Pitot static tubes with electronic position measurement for use with TecQuipment's Subsonic Wind Tunnels – **SEE PAGE 51**.

PROTRACTOR

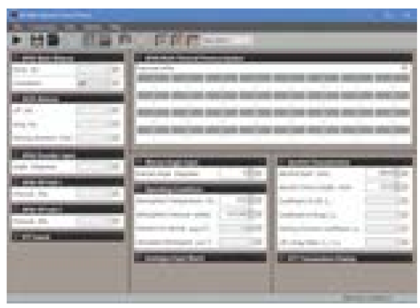
For assisting with setting up models and rotating them during experiments.

MODEL HOLDER

To hold models when the three-component balance is not used. Also for use with the user's own models.

VERSATILE DATA ACQUISITION SYSTEM VDAS-F

A frame-mounting versatile data acquisition system (VDAS®) to allow computer-based data capture – **SEE PAGE 299**.



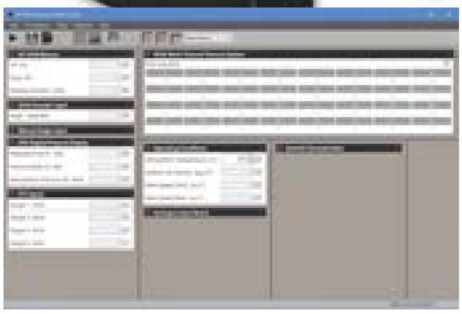
ALTERNATIVE PRODUCTS:

- Bench-Top Wind Tunnel (AF1125) 39
- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1600S) 49
- Modular Air Flow Bench (AF10) 31
- Flight Demonstration Wind Tunnel (AF41) 53
- Flow Visualisation Wind Tunnel (AF80) 55
- Supersonic Wind Tunnel – Intermittent (AF300) 59
- Supersonic Wind Tunnel – Continuous (AF302) 61

SUBSONIC WIND TUNNEL 600 MM

VDAS® AF1600S

TecQuipment's largest open-circuit subsonic wind tunnel, with a working section of 600 mm by 600 mm and 1250 mm long, is for the study of advanced aerodynamics theory and research. With the larger size comes greater visualisation and more accurate results, operating at meaningful Reynolds numbers.



SCREENSHOT OF THE VDAS® SOFTWARE

- A cost effective solution when compared to full-scale wind tunnels or airborne laboratories
- Operates at meaningful Reynolds numbers
- Safe, open-circuit suction design
- Package includes three-component balance, angle feedback unit, dual differential pressure display, 32-way pressure display unit, Pitot static traverse, X/Y Pitot static traverse, protractor, model holder and data acquisition (VDAS-F)
- High levels of safety

Air passes into the AF1600 through a honeycomb flow straightener and a grille. It then passes into an aerodynamically designed effuser (cone) that accelerates the air in a linear manner, before it moves through the working section. Finally, it passes through a diffuser, then into the variable-speed axial fan. The grille protects the fan from damage by loose objects. The air leaves the fan, passes through a silencer unit and then back out to atmosphere.

LEARNING OUTCOMES:

AF1600S is designed to be flexible and utilised for a variety of possible experiments designed by our customers. Typical examples include:

- Flow past bluff and streamlined bodies with pressure and velocity observations in the wake
- Investigations into boundary layer development
- Influence of aspect ratio on aerofoil performance
- Pressure distribution around a cylinder under sub and super-critical flow conditions
- Study of characteristics of models involving basic measurement of lift and drag forces
- Study of the characteristics of three-dimensional aerofoils involving measurements of lift, drag and pitching moment
- Study of the pressure distribution around an aerofoil model to derive the lift, and comparison with direct measurements of lift
- Drag force on a bluff body normal to an air flow
- Flow visualisation

CONTINUED ON NEXT PAGE

SUBSONIC WIND TUNNEL (AF1600S) CONTINUED FROM PREVIOUS PAGE

INCLUDED WITH THE WIND TUNNEL:

THREE-COMPONENT BALANCE AF1600T

The Three-Component Balance measures lift, drag and pitching moment exerted on the model. It includes a balance angle feedback unit which measures the angular position of models mounted on the balance in the wind tunnel and feeds the information directly to VDAS®.

SHOWN FITTED WITH THE BALANCE ANGLE FEEDBACK UNIT (INCLUDED)

DUAL DIFFERENTIAL PRESSURE DISPLAY DP6

Measures and displays pressures with respect to the atmosphere or differential pressures.

32-WAY PRESSURE DISPLAY UNIT AFA6

Measures and displays up to 32 different pressures from models, Pitot static tubes and other measuring instruments fitted to the wind tunnel – SEE PAGE 52.

PITOT STATIC TRAVERSE AFA7

A traversing Pitot static tube with electronic position measurement – SEE PAGE 50.

PITOT STATIC X/Y TRAVERSE AF1600XY

A traversing Pitot static tube with electronic position measurements for both the x and y planes.

PROTRACTOR

For assisting with setting up models and rotating them during experiments.

MODEL HOLDER

To hold models when the three-component balance is not used. Also for use with the user's own models.

VERSATILE DATA ACQUISITION SYSTEM VDAS-F

A frame mounting versatile data acquisition system (VDAS®) to allow computer-based data capture – SEE PAGE 299.

RECOMMENDED ANCILLARIES:

- Multi-tube Manometer (AFA1) 51
- Smoke Generator (AFA11) 51

AVAILABLE EXPERIMENT MODELS:

- Cylinder Model (AF1600a)
- NACA 0012 Aerofoil with Tappings (AF1600b)
- NACA 2412 Aerofoil with Flap (AF1600c)
- Set of two NACA 0012 Aerofoils (AF1600d)
- Aircraft Model – Low Wing (AF1600g)
- Aircraft Model – High Wing (AF1600h)
- Three-Dimensional Drag Models (AF1600j)

ALTERNATIVE PRODUCTS:

- Bench-Top Wind Tunnel (AF1125) 39
- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1450S) 47
- Modular Air Flow Bench (AF10) 31
- Flight Demonstration Wind Tunnel (AF41) 53
- Flow Visualisation Wind Tunnel (AF80) 55
- Supersonic Wind Tunnel – Intermittent (AF300) 59
- Supersonic Wind Tunnel – Continuous (AF302) 61

MULTI-TUBE MANOMETER

AFA1

A tilting 36-tube manometer for use with the AF1300, AF1450 and AF1600 Subsonic Wind Tunnels, other TecQuipment products, or as a general purpose instrument.

- Uses water as manometer fluid with colouring for ease of visibility
- Easy-to-read scale common to each manometer tube
- Preset incline levels for consistency and accuracy – up to five times magnification
- Pressure reading level preset by adjustable fluid reservoir – includes fine-adjustment hand-wheel

For safety and convenience, the manometer uses water as the manometer fluid. This is via an adjustable reservoir with fine-adjust hand-wheel held at the side of the equipment. Water colouring is included to aid visibility.

ANCILLARY FOR:

- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1450S) 47
- Subsonic Wind Tunnel (AF1600S) 49
- NACA 0012 Aerofoil Model with Tappings (AF1300b) 43
- NACA 0012 Aerofoil Model with Tappings (AF1450b) 43
- Flat Plate Boundary Layer Model (AF1300f) 43
- Flat Plate Boundary Layer Model (AF1450f) 43

ALTERNATIVE PRODUCTS:

- Different Pressure Transducer (AFA5) 44
- Dual Differential Pressure Display (DP6) 48
- 32-Way Pressure Display Unit (AFA6) 52

SMOKE GENERATOR

AFA11

A smoke generator and probe which allows the observation of air flow in subsonic wind tunnels and other airflow situations.

A control unit that pumps oil to the tip of a probe. A low-voltage electrical coil at the probe tip heats the oil to produce a fine smoke trail. The smoke moves into the air stream smoothly and steadily. Students can adjust the controls of the control unit to change the smoke strength to suit the air flow conditions.

ANCILLARY FOR:

- Subsonic Wind Tunnel (AF1125) 39
- Subsonic Wind Tunnel (AF1450S) 47
- Subsonic Wind Tunnel (AF1600S) 49

32-WAY PRESSURE DISPLAY UNIT

VDAS® AFA6

A 32-way pressure measurement and display unit for use with TecQuipment's Subsonic Wind Tunnels (AF1300, AF1450, AF1600).

- Measures and displays up to 32 differential pressures from models, Pitot static tubes and other devices
- Quicker, easier and more versatile than using liquid manometers
- Measures pressures with respect to atmosphere
- Fully compatible with TecQuipment's Versatile Data Acquisition System (VDAS®) to enable accurate real-time data capture, monitoring and display on a computer

The unit mounts onto the control and instrumentation frame of the wind tunnel. Connection to each of the 32 calibrated pressure transducers is via quick-release pressure inputs mounted on the front panel of the unit. This allows easy and quick connection between the unit and an experiment mounted in the wind tunnel. All pressures are measured with respect to atmosphere.

ANCILLARY FOR:

- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1450S) 47
- Subsonic Wind Tunnel (AF1600S) 49
- NACA 0012 Aerofoil Model with Tappings (AF1300b) 43
- NACA 0012 Aerofoil Model with Tappings (AF1450b) 43
- Flat Plate Boundary Layer Model (AF1300f) 43
- Flat Plate Boundary Layer Model (AF1450f) 43

ALTERNATIVE PRODUCTS:

- Multi-tube Manometer (AFA1) 51
- Dual Differential Pressure Transducer (DP6) 48
- Differential Pressure Transducer (AFA5) 44

PITOT STATIC TRAVERSE (DIGITAL)

VDAS® AFA7

A traversing Pitot static tube with electronic position measurement for use with TecQuipment's Subsonic Wind Tunnels (AF1300 / AF1450S / AF1600).

- Mounts either upstream or downstream of a test model to measure pressures across the wake of a model
- Accurate digital display of position
- Zero facility allows the starting point of an experiment to be set in any position

A Pitot static tube, its vertical position within the working section is displayed on a digital indicator that can be set to zero in any position. The signals from the indicator can be read directly or output to VDAS® for accurate, reliable data capture.

ANCILLARY FOR:

- Subsonic Wind Tunnels (AF1300, AF1450, AF1600) 41 / 47 / 49
- Cylinder Model with Tappings (AF1300a, AF1450a) 43 / 48
- NACA 0012 Aerofoil With Tappings (AF1300b, AF1450b) 43 / 48
- NACA 2412 Aerofoil With Variable Flap (AF1300c, AF1450c) 43 / 48
- NACA 0012 Aerofoils (AF1300d, AF1450d) 43 / 48
- Flat Plate Drag Model (AF1300e, AF1450e) 43 / 48
- Aircraft Model – Low Wing (AF1300g, AF1450g) 43 / 48
- Aircraft Model – High Wing (AF1300h, AF1450h) 43 / 48
- Three-dimensional Drag Models (AF1300j, AF1450j) 43 / 48
- S1210 Aerofoil Model (AF1300l, AF1450l) 43 / 48

FLIGHT DEMONSTRATION WIND TUNNEL

AF41

A model aircraft suspended in an open-circuit wind tunnel. Includes realistic flight controls to teach a variety of principles of aircraft flight.

- Simulates take-off, level flight, cruise and landing
- Demonstrations include aerofoil lift, stall, longitudinal stability and transient motion
- Includes electronic display of air speed, attitude, altitude, pressure and lift
- Tufts on the wing clearly demonstrate the phenomenon of separation and stall
- Adjustable centre of gravity of the model

CONTINUED ON NEXT PAGE

LEARNING OUTCOMES:

A variety of practical demonstrations, 'hands-on' flight simulations, and student investigations into the behaviour of fixed-wing aircraft and wing performance, including:

- Practical investigation of longitudinal stability and control of the aircraft to demonstrate behaviour during take-off, level flight and landing
- Determination of the effect of speed on attitude for level flight and stall
- Measurement of the lift curve for the wing up to and beyond stall
- Students can adjust the centre of gravity of the model to alter its trim. They can then plot trim curves and determine the neutral point

WITH TWO-PEN CHART RECORDER (AF41A, AVAILABLE SEPARATELY):

- Demonstration of phugoid motion in terms of altitude
- Short-period oscillation due to sudden disturbance can be shown by the change of incidence

WITH SMOKE GENERATOR (AFA10, AVAILABLE SEPARATELY):

- Visualisation of flow patterns past the aircraft's aerofoil and tail plane

For classroom demonstrations and student investigations into the behaviour of fixed-wing aircraft and wing performance during take-off, flight and landing.

The apparatus is an open-circuit wind tunnel with a model aircraft suspended in the working section. The model is supported by linkages that allow it to move vertically and to pitch about the quarter chord point independently.

RECOMMENDED ANCILLARIES:

- Two-Pen Chart Recorder (AF41a) 54
- Smoke Generator (AFA10) 45

ALTERNATIVE PRODUCTS:

- Modular Air Flow Bench (AF10) 31
- Bench-Top Subsonic Wind Tunnel (AF1125) 39
- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1450S) 47
- Subsonic Wind Tunnel (AF1600S) 49
- Flow Visualisation Wind Tunnel (AF80) 55

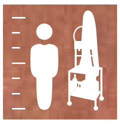
FLOW VISUALISATION WIND TUNNEL

AF80

A vertical suction-type wind tunnel that uses smoke trails to demonstrate air flow around differently shaped models, for understanding boundary layers, separation and rotational flow.

- High-quality, vertical wind tunnel that helps students understand air flow around different shaped objects
- Ideal for small group experiments or classroom demonstrations
- Includes smoke generator and lighting to demonstrate flow clearly
- Variable air speed
- Includes a set of models with additional model set available separately

PHOTOGRAPH OF THE SMOKE TRAILS AROUND A HEMISPHERE



LEARNING OUTCOMES:

When used with the optional models, the visualisation and demonstration of:

- Boundary layers
- Separation
- Rotational flow

A variable-speed fan mounted on top of the wind tunnel produces the air flow through the working section. Air flow is vertically upwards.

RECOMMENDED ANCILLARIES:

- Additional Model Set (AF80b), including:
  - Bend
  - Cascade corner
  - Plain corner
  - Heat exchanger tube bank

ALTERNATIVE PRODUCTS:

- Flow Visualisation (AF17) 37
- Bench-Top Subsonic Wind Tunnel (AF1125) 39
- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1450S) 47
- Subsonic Wind Tunnel (AF1600S) 49
- Flight Demonstration Wind Tunnel (AF41) 53

AEROSPACE EQUIPMENT FOR SOLIHULL COLLEGE

Solihull College and University Centre recently introduced an Aerospace Engineering and Maintenance degree. A new facility was created, which required a substantial investment in specialist aeronautical educational equipment to teach everything from the basic theory of flight, looking at drag and lift equations, through to more advanced topics that look at boundary layers, pressure distribution and wake investigations. This was part of a £2.5 million spend on the aviation and aeronautical facilities at the Woodlands Campus of Solihull College and University Centre.

"After inviting companies to bid for the new equipment, we selected TecQuipment based on the premium specifications, competitive price, and reputation for quality of service supported by the excellent pre-sales experience," commented Paul Matthews, Senior Lecturer and Coordinator at Solihull College.

TURBOJET TRAINER USES KEROSENE TO REPLICATE THE BEHAVIOUR OF A SINGLE-SHAFT GAS TURBINE

TEACHING FUNDAMENTALS OF A JET ENGINE

For teaching students how single-shaft gas turbines on aircraft work, the college purchased a Turbo Jet Trainer (GT100). Powered by kerosene, students can accurately replicate the behaviour of a single-shaft gas turbine that would be used in aircraft. The self-contained design allows students to learn the following:

- Effect on thrust generation by variation in rotational speed and propelling nozzle area
- Isentropic, polytropic and mechanical efficiencies of compressor, combustion chamber and turbine
- Pressure ratios of turbine, compressor and non-dimensional characteristics
- Combustion chamber pressure losses and combustion efficiencies
- Specific fuel consumption, thermal efficiency, air standard cycle, work ratio and heat balance

THEORY OF FLIGHT

In addition to the BSc degree course, Solihull College also offers an HNC in aircraft maintenance, and an HND. Salman Javed, Aerospace Lecturer at Solihull College, explained: "Rather than the BEng version of an aerospace engineering degree that focuses on the design of aircraft, the BSc is designed to be more-hands on. This focus means that practical experiments play a greater role in the learning process."

The aerodynamics laboratory has an array of different pieces of apparatus for teaching all of these courses.

AERODYNAMICS PRINCIPLES

For teaching the foundations of aerodynamics, Solihull College purchased a Subsonic Wind Tunnel (AF1300). This sits in the middle of an extensive range of wind tunnels available from TecQuipment. It is compact enough to be moved around on wheels, and yet has the functionality to allow students to perform experiments to understand the following:

- Investigations into boundary layer development
- Influence of angle of attack on aerofoil performance
- Flow past bluff and streamlined bodies with pressure and velocity observations in the wake
- Performance of an aerofoil with flap, influence of flap angle on lift, drag and stall
- Pressure distribution around a cylinder under sub and super-critical flow conditions
- Study of characteristics of models involving basic measurement of lift and drag forces
- Study of the characteristics of three-dimensional aerofoils involving measurement of lift, drag and pitching moment
- Study of the pressure distribution around an aerofoil model to derive the lift and comparison with direct measurements of lift
- Flow visualisation

ADVANCED AERODYNAMIC THEORY WITH SUPERSONIC STUDIES

For a more advanced understanding, the College added an Intermittent Supersonic Wind Tunnel (AF300) to their laboratory. At the easier end of advanced theory, students can learn about nozzle pressure distribution, analyse Mach numbers and then use the Schleiren apparatus to measure and visualise pressure and shock waves on a model.

TecQuipment offers two supersonic wind tunnel options: the intermittent and continuous supersonic wind tunnels. For budget, easy laboratory set-up and result accuracy reasons, Solihull College opted for the intermittent wind tunnel, which stores compressed air in tanks - in this case a line of three tanks, which induces a flow in the working section of the wind tunnel. This controlled air supply provides a more stable flow of air, with filters and air dryers for accurate results that can be captured in a 5-10 second window. Once the experiment has run, the air tanks will refill for 3-5 minutes and then be ready to run an experiment once more.

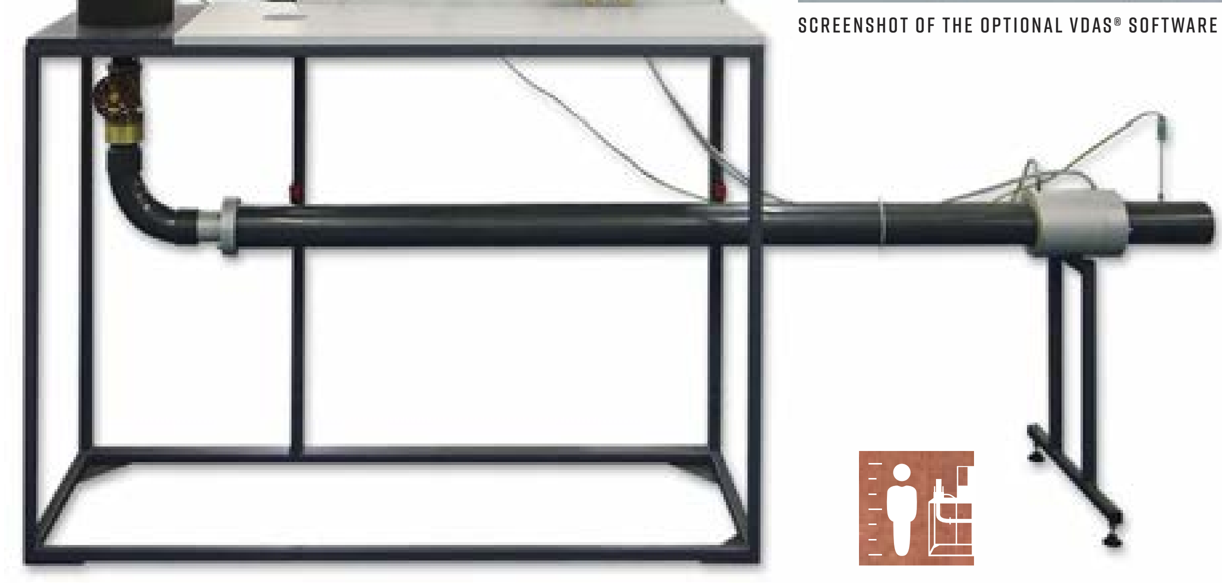
The Schlieren apparatus allows students to see density gradients as variations in intensity of illumination, see for themselves supersonic air flow around models, plus shockwaves and expansions. A series of mirrors and lenses allow the student to see the results as they happen, while a digital camera records them for later reference. The recording functionality is particularly useful when sharing the results with a group of students.

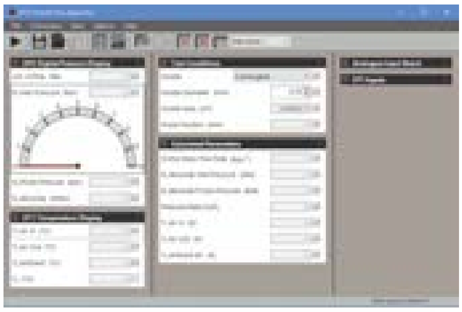
FIRING UP THE TURBOJET TRAINER

LAVAL NOZZLE FLOW APPARATUS

VDAS® AF27

Demonstrates the thermodynamics and fluid mechanics of the adiabatic expansion of air through subsonic and supersonic nozzles.





SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Connects to suitable laboratory compressed air supply or TecQuipment's optional Compressor (AF27a)
- Includes three interchangeable, profiled and polished brass nozzles: convergent, convergent-divergent and convergent-parallel
- Electronic instruments measure and display multiple pressures and temperatures at the same time, for ease of use and for connection to TecQuipment's VDAS®
- Works with TecQuipment's Versatile Data Acquisition System (VDAS®) for instant recording of multiple readings and automatic calculations

A nozzle is fitted to the chest. Compressed air passes through the pressure regulator and an isolating valve. It then enters the pressure chest and passes vertically down through the nozzle, then through a precision downstream valve. The air flow then settles as it passes along a horizontal pipe, through an orifice and out to atmosphere.

LEARNING OUTCOMES:

- The relationship between pressure ratio and flow for convergent and convergent/divergent Laval nozzles
- The pressure profile in convergent/divergent nozzles at various pressure ratios
- Investigation of expansion with friction in a parallel passage at high subsonic velocities
- Boundary layer growth under subsonic and supersonic conditions
- The phenomenon of choked flow corresponding to sonic velocity at a nozzle throat

ESSENTIAL ANCILLARIES:

- Compressor (AF27a)

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

ALTERNATIVE PRODUCTS:

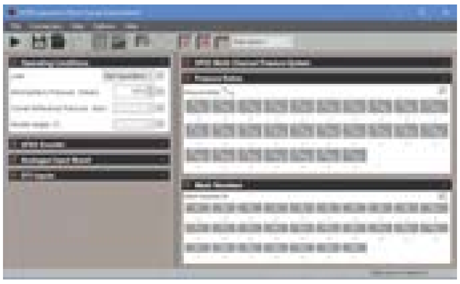
- Supersonic Wind Tunnel – Intermittent (AF300) 59
- Supersonic Wind Tunnel – Continuous (AF302) 61

INTERMITTENT SUPERSONIC WIND TUNNEL

VDAS® AF300

Investigates subsonic and supersonic air flow, including flow around two-dimensional models.

SHOWN WITH THE OPTIONAL SCHLIEREN APPARATUS (AF300A)



SCREENSHOT OF THE VDAS® SOFTWARE

- Laboratory-scale wind tunnel for subsonic and supersonic tests, nominally up to Mach 1.8
- Supplied with aerodynamic models for supersonic tests – includes model angle-feedback encoder
- Supplied with a set of different liners for controlled subsonic and supersonic air flow
- Induction flow for better air flow and accurate results

LEARNING OUTCOMES:

- Pressure distribution along a convergent/divergent (Laval) nozzle with subsonic and supersonic air flow
- Comparison of theoretical and actual pressure distributions
- Comparison of actual and theoretical area ratios of a nozzle at supersonic air velocities (Mach numbers)
- Pressures around a two-dimensional model in subsonic and supersonic flow conditions, at different angles of incidence
- Lift coefficients for aerodynamic models in supersonic flow
- Shock waves and expansion patterns around a two-dimensional model in supersonic flow conditions (when used with the optional Schlieren apparatus)

CONTINUED ON NEXT PAGE

A compressed air supply (AF300b, available separately) induces a flow in the working section of the wind tunnel. This gives a less turbulent and more stable flow for accurate results and comparison with theory. The essential compressed air supply includes filters and air dryers to give the dust-free and dry air source needed for good results.

ESSENTIAL ANCILLARIES:

- Air Compressor Receiver and Dryer (AF300b)
- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

RECOMMENDED ANCILLARIES:

- Schlieren Apparatus (AF300a) 60

ALTERNATIVE PRODUCTS:

- Bench-Top Subsonic Wind Tunnel (AF1125) 39
- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1450S) 47
- Subsonic Wind Tunnel (AF1600S) 49
- Laval Nozzle Flow Apparatus (AF27) 58
- Continuous Supersonic Wind Tunnel (AF302) 61

SCHLIEREN APPARATUS

AF300A

Allows students to visualise density gradients as variations in intensity of illumination, when connected to the AF300 Intermittent Supersonic Wind Tunnel.

- High-quality, laboratory-standard mirrors and lenses for clear images without distortion
- Shows supersonic air flow patterns around models
- Shows shockwaves and expansions
- Includes digital imaging equipment and TV monitor

IMAGE OF AIR FLOW PATTERN ROUND A 5° SINGLE WEDGE MODEL

The focused light from the light source (and condenser lens) passes through the optical slit and is reflected at 90 degrees to the first achromatic lens. The light passes through the working section of the wind tunnel, then through the second achromatic lens. A second mirror reflects the light at 90 degrees towards the Schlieren edge. The Schlieren edge enhances the light refracted image. The small lens focuses this image onto the imaging screen.

Achromatic lenses are chosen because of their ability to pass light without colour distortion, that would normally ruin the Schlieren image.

ANCILLARY FOR:

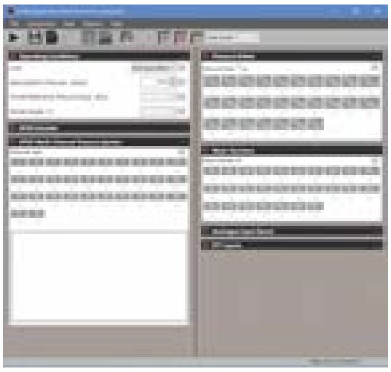
- Intermittent Supersonic Wind Tunnel (AF300) 59

CONTINUOUS SUPERSONIC WIND TUNNEL

VDAS® AF302

A suction-type, continuous-operation supersonic wind tunnel for investigations into subsonic and supersonic air flow around two-dimensional models.

VACUUM PUMP (SUPPLIED) NOT SHOWN ON IMAGE



SCREENSHOT OF THE VDAS® SOFTWARE

- A suction-type, continuous-operation supersonic wind tunnel for investigations into two-dimensional air flow around models for nominal airspeeds up to Mach 1.8
- Includes high-quality optical glass windows in the working section, suitable for use with an optional Schlieren system
- Includes a selection of models for two-dimensional flow experiments and an encoder for feedback of model angle
- Supplied with a multi-pressure display unit and calibrated pressure sensors to show pressures relative to atmosphere
- Includes a vacuum pump with remote control for ease of use

An instrument frame (supplied) holds a remote-control unit that controls a high-capacity vacuum pump (supplied). The pump creates low pressure downstream of the working section to draw air into the wind tunnel. A bypass duct, with a hand-operated valve, allows the operator to reduce the air flow through the working section, without disturbing the quality of the main air flow. This is useful for startup and shutdown and for subsonic tests.

The working section of the wind tunnel is a convergent-divergent nozzle with a removable top part ('liner'). The shape of the liner controls the maximum air velocity at the divergent part of the working section. Included are three different shaped liners.

CONTINUED ON NEXT PAGE

LEARNING OUTCOMES:

- Pressure distribution along a convergent/divergent (Laval) nozzle with subsonic and supersonic air flow
- Comparison of theoretical and actual pressure distributions
- Comparison of actual and theoretical area ratios of a nozzle at supersonic air velocities (Mach numbers)
- Pressures around a two-dimensional model in subsonic and supersonic flow conditions, at different angles of incidence
- Lift coefficients for aerodynamic models in supersonic flow
- Shock waves and expansion patterns around a two-dimensional model in supersonic flow conditions (when used with the optional Schlieren apparatus)

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

RECOMMENDED ANCILLARIES:

- Schlieren Apparatus AF302a 62

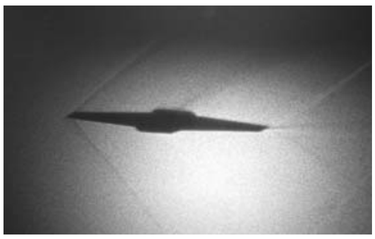
ALTERNATIVE PRODUCTS:

- Bench-Top Subsonic Wind Tunnel (AF1125) 39
- Subsonic Wind Tunnel (AF1300) 41
- Subsonic Wind Tunnel (AF1450S) 47
- Subsonic Wind Tunnel (AF1600S) 49
- Laval Nozzle Flow Apparatus (AF27) 58
- Intermittent Supersonic Wind Tunnel (AF300) 59

SCHLIEREN APPARATUS

AF302A

Allows students to visualise density gradients as variations in intensity of illumination, when used with the AF302 Continuous Supersonic Wind Tunnel



5 DEGREES MACH 1-8 AND 5 DEGREE WEDGE

- High-quality, laboratory-standard mirrors and lenses for clear images without distortion
- Shows supersonic air flow patterns around models
- Shows shockwaves and expansions
- Includes digital imaging equipment and TV monitor

The focused light from the light source (and condenser lens) passes through the optical slit and is reflected at 90 degrees to the first achromatic lens. The light passes through the working section of the wind tunnel, then through the second achromatic lens. A second mirror reflects the light at 90 degrees towards the Schlieren edge. The Schlieren edge enhances the light refracted image. The small lens focuses this image onto the imaging screen. Achromatic lenses are chosen because of their ability to pass light without colour distortion, that would normally ruin the Schlieren image.

ANCILLARY FOR:

- Continuous Supersonic Wind Tunnel (AF302) 61

CONTROL ENGINEERING

> Our students are comfortable while using products from TecQuipment in labs. Highly innovative products by TecQuipment Ltd for engineering education are ideal for engineering and technical education at all levels. Our students are regularly using this equipment for masters and doctoral research. The products are user-friendly and need minimum after-sales service.
>
> **PROFESSOR R D MISAL**
> DEFENCE INSTITUTE OF ADVANCED TECHNOLOGY, GIRINAGAR, PUNE, INDIA

CONTROL ENGINEERING

The Control Engineering range focuses on the teaching of specific control principles relating to static and dynamic systems, as well as naturally unstable, non-linear, multi-variable and oscillatory systems.

The majority of the range can be connected to TecQuipment's dedicated controllers with easy-to-use control software. The simple, low-voltage connections allow safe and quick experiment set-up.

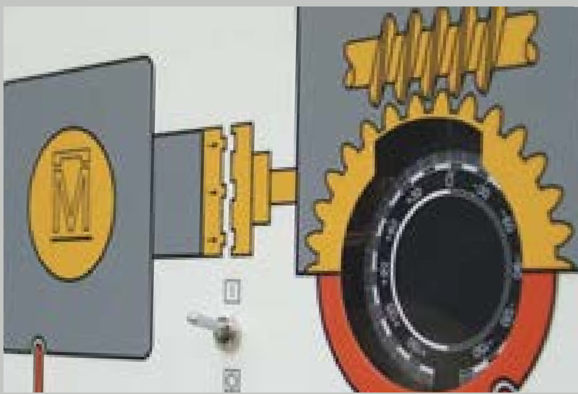
KEY FEATURES AND BENEFITS:

ACADEMIC AND INDUSTRIAL: Bench-top products for academic teaching and industrial products for vocational training.

CHOICE: Start with a single control scenario and build up, or choose a more complete product to suit the budget and needs.

SAFE AND EASY SET-UP: Simple, low-voltage connections allow safe and quick experiment set up.

HANDS-ON: Both the academic and industrial products allow easy connection and adjustments, for a more practical understanding.

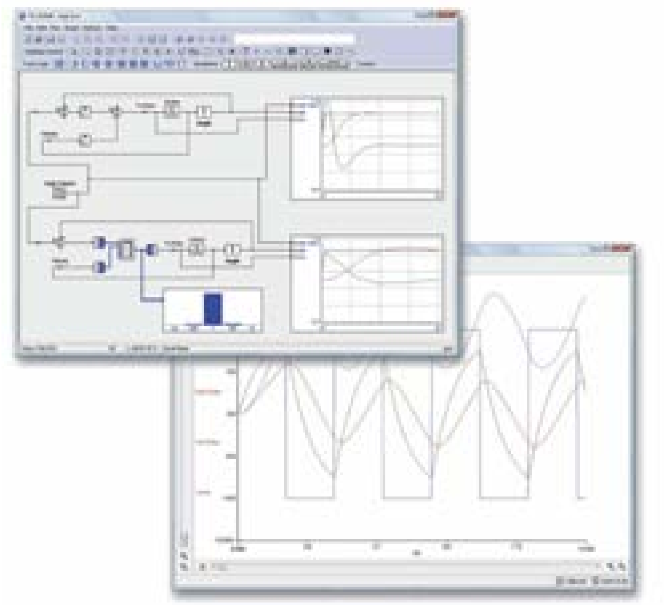


CONTROL SOFTWARE

CE2000

Icon-based software that simulates control systems and works with TecQuipment's Controller (CE120) or Digital Interface (CE122) to control and acquire data from TecQuipment's Control Engineering range.

- Software only – needs no extra circuit boards in the computer
- Includes a range of ready-made fuzzy logic and control blocks, such as proportional, integral and derivative blocks
- Collected data can be shown and printed as charts or exported for use in other programs
- Real-time display of variables by virtual meters, virtual chart recorders or virtual oscilloscopes
- Easy-to-create control circuits made by linking together drag-and-drop icons
- Users can create their own circuits and save them, or use the ready-made circuits supplied



LEARNING OUTCOMES:

SOFTWARE ONLY:

The user guide shows students how to use the software and how to build and test common control systems, such as:

- Design and implementation of three-term controllers
- Design of controllers and filters

SOFTWARE AND HARDWARE (WHEN USED WITH OTHER PRODUCTS FROM THE CE RANGE):

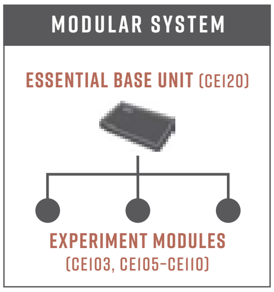
- Thermal control (CE103)
- Level control (CE105/CE105MV)
- Ball and beam control (CE106)
- Engine speed control (CE107)
- Coupled drives control (CE108)
- Ball and hoop control (CE109)
- Servo control (CE110)
- Flow, level, pressure and temperature control (CE117)

The CE2000 is a powerful control software package with many features. It is supplied as standard with TecQuipment's Controller (CE120), Digital Interface (CE122) and Process Trainer (CE117). The software allows students and experienced control engineers to develop and test a wide selection of controllers and filters.

CONTROLLER

CE120

A self-contained analogue and computer-based controller designed to support practical investigations into the basic and advanced principles of control engineering at all academic levels.



FEATURES:		BENEFITS:
Controls and monitors signals to and from selected Control Range experiment modules	→	Modular design saves space and reduces costs
Manual controls plus additional interface with analogue-to-digital and digital-to-analogue conversion	→	Allows 'hands-on' control arrangements, plus computer control and data acquisition, with no need to fit interface cards in the computer
Buffered, low-voltage connections	→	Safe, even for inexperienced students, with minimal supervision
Multiple summing junctions, proportional, integral and PID blocks	→	Allows many different control arrangements
Includes TecQuipment's CE2000 Control Software	→	Real-time control and data acquisition with more choice of control arrangements
Standard 10 VDC signals	→	May be used to control other suitable systems

LEARNING OUTCOMES:

When used with the experiment modules:

- Temperature (thermal) control
- Level control
- Engine speed control
- Servo control
- Coupled drive control
- Ball and beam control
- Ball and hoop control

This compact unit has analogue electronic circuits connected in blocks. These blocks mimic the important parts of industrial controllers. Clear diagrams on the front panel of the controller show the blocks, each of which has its own set of connection sockets. The user connects the blocks in any way that they need and then connects them to their chosen experiment module.

AVAILABLE EXPERIMENT MODULES:

- Thermal Control Process Apparatus (CE103) 68
- Coupled Tanks Apparatus (CE105/CE105MV) 69
- Ball and Beam Apparatus (CE106) 70
- Engine Speed Control Apparatus (CE107) 71
- Coupled Drives Apparatus (CE108) 73
- Ball and Hoop Apparatus (CE109) 74
- Servo Trainer (CE110) 75

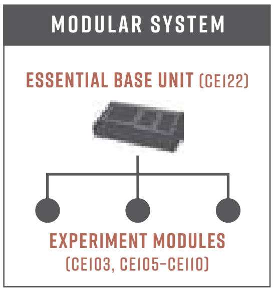
ANCILLARY FOR:

- Process Trainer (CE117) 81

DIGITAL INTERFACE

CE122

A self-contained, computer-based controller designed to support practical investigations, covering the basic and advanced principles of control engineering at all academic levels.



FEATURES:		BENEFITS:
Connects between a computer and selected Control Engineering range experiment modules for control and monitoring of signals	→	No need to fit interface cards in your computer
Buffered, low-voltage connections	→	Safe, even for inexperienced students, with minimal supervision
Fully digital with simple set-up	→	Needs no adjustments and saves time
Includes TecQuipment's CE2000 Control Software	→	Real-time control and data acquisition with hundreds of different control arrangements
Standard 10 VDC signals	→	May be used to control other suitable systems

The Digital Interface is an alternative to the CE120 Controller, when the user only needs the interface part of the CE120. It converts analogue inputs from other equipment into digital signals for a computer. It also converts the digital signals from a computer into analogue signals to control other equipment.

AVAILABLE EXPERIMENT MODULES:

HERE TO HELP YOU

A team of specialist customer care personnel is available to answer a range of questions relating to technical details, spare parts and maintenance.

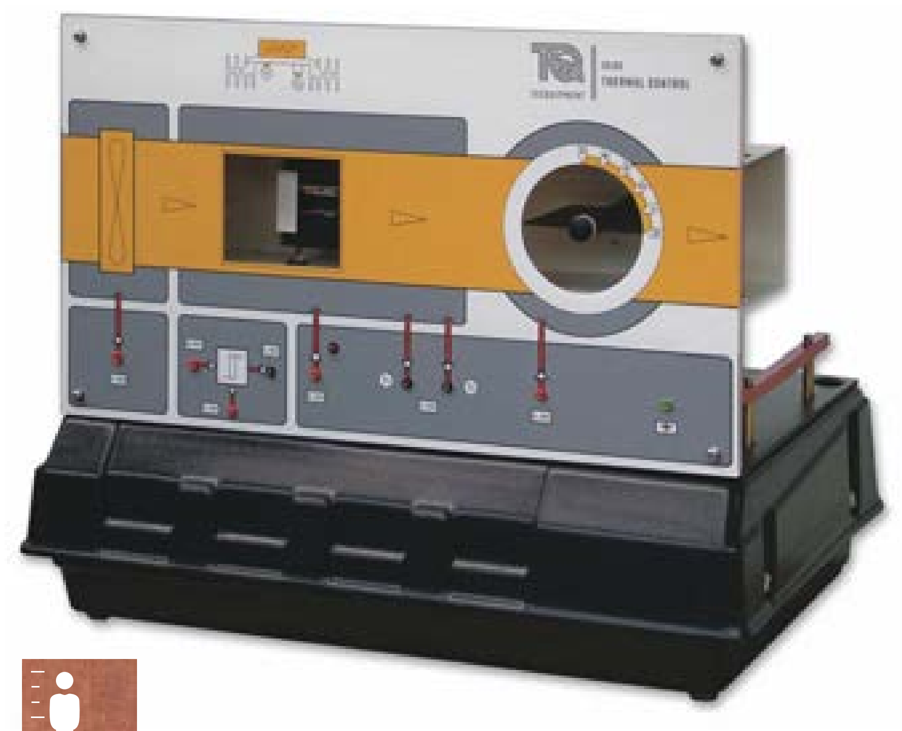
CUSTOMER.CARE@TECQUIPMENT.COM

THERMAL CONTROL PROCESS APPARATUS

CE103

A self-contained, bench-mounted temperature control apparatus that mimics common industrial processes, designed to allow students at all academic levels to investigate the basic and advanced principles of control.

- Electrically-heated and air-cooled model process that mimics a real industrial process
- Includes variable hysteresis for advanced process control experiments
- Temperature sensors with different thermal contact to the process give variations in thermal inertia and time constant
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controllers



LEARNING OUTCOMES:

- Heat transfer
- On/off control: experiment includes investigation of overshoot and undershoot, on and off time ratio, rates of heating and cooling, offset and hysteresis
- Proportional, proportional + integral, or proportional + integral + differential control
- Frequency response of model process
- Thermal inertia and variable-time constants
- Multi-variable control – up to three variables can be monitored and individually controlled

The apparatus has a variable-speed fan that forces air through a duct. In the duct is an electrically-heated process block. A balance of the heat gained from electrical heating and heat lost by convection and conduction gives a steady temperature at the block.

Two temperature sensors measure the temperature of the block. One sensor is in direct thermal contact with the block. The other sensor mounts on an insulating spacer to introduce thermal inertia and variable-time constants into the control loop. A servo-driven vane, mounted after the fan and the process block, creates a variable restriction downstream for more advanced experiments.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** — 66
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) — 67

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 65) with editable, pre-made control experiments for use with the CE103.

ALTERNATIVE PRODUCTS:

- Process Trainer (CE117) — 81
- Temperature Process Training System (TE3300/05) — 85
- Control and Instrumentation Study Station (TE37) — 87

COUPLED TANKS APPARATUS

CE105/CE105MV

A self-contained, bench-mounted apparatus to demonstrate basic and advanced principles of control of single and coupled tanks, including the study of static and dynamic systems.

- Option for second pump with second flow meter to allow multivariable (MV) operation (CE105MV)
- Level control of one and two tanks
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controllers
- Includes rotameter-type flow meter so students can see the flow rate
- Ideal for use with other control strategies such as fuzzy logic

LEARNING OUTCOMES:

- Calibration of transducer and actuator circuits
- System dynamics in process systems
- Design and operation of analogue controllers using proportional, proportional + integral, or proportional + integral + differential control
- Steady-state errors and closed-loop transient responses
- Ziegler/Nichols controllers tuning rules
- Multivariable control
- Step-change tuning
- State feedback
- Flow control

MULTIVARIABLE COUPLED TANKS APPARATUS (CE105MV)

Based on the CE105 but features a second pump and flow metre for more advanced experiments on the principles of multivariable control.

Each tank has a level sensor that gives output signals proportional to the water level in each tank. A scale on each tank allows students to check the level-sensor calibration. A variable-speed pump forces water into the left-hand tank. A valve connects this tank to a second tank, if needed, for two-tank experiments. A rotameter-type flow meter shows the flow rate. An electronic flow meter measures the flow rate.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 66
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 67

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 65) with editable, pre-made control experiments for use with the CE105/CE105MV.

ALTERNATIVE PRODUCTS:

- Process Trainer (CE117) 81
- Level Process Training System (TE3300/04) 84
- Control and Instrumentation Study Station (TE37) 87

BALL AND BEAM APPARATUS

CE106

A self-contained, bench-mounted apparatus to demonstrate basic and advanced principles of control in naturally unstable systems.

- Self-contained, compact and bench-mounted unit that mimics a real control problem in unstable systems, such as missile or rocket take-off
- Highly visual apparatus, with moving ball and front panel mimic diagram of the process – students can see what they are controlling
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controllers
- For basic and advanced experiments with angle, velocity and position control

LEARNING OUTCOMES:

- Measurement of system dynamics by transient and closed-loop methods
- Design of analogue phase-advance compensators
- Design of state reconstructors to obtain estimates of ball velocity and position

The apparatus has a steel ball which is free to roll on two parallel tensioned wires positioned on a beam that pivots at its centre. A servo motor controls the beam angle and sensors measure the beam angle and ball position. The basic control problem is to vary the beam angle to control the ball position. The system is a double integrator, so it is naturally unstable. It needs active feedback control using phase-advance methods.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 66
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 67

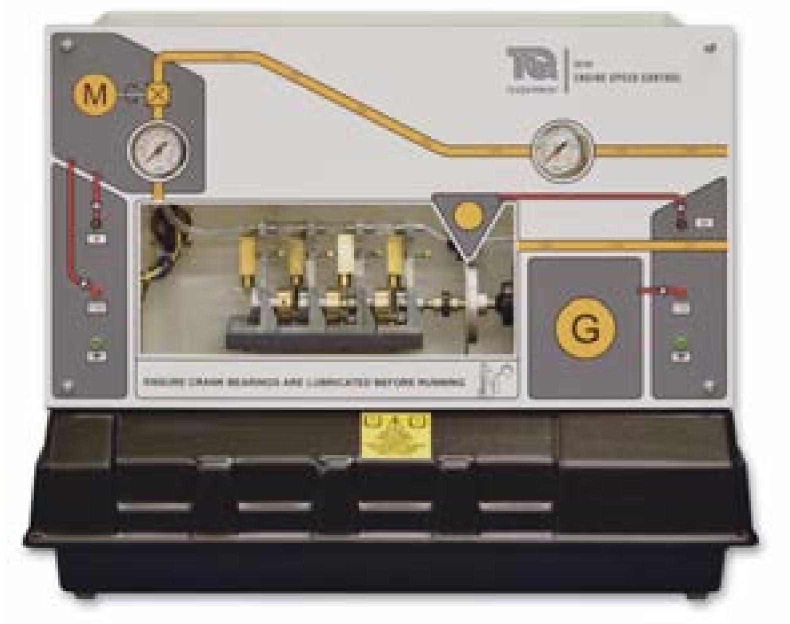
Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 65) with editable, pre-made control experiments for use with the CE106.

ENGINE SPEED CONTROL APPARATUS

CE107

A self-contained, bench-mounted apparatus to demonstrate basic and advanced principles of engine speed control, including non-linear systems and inner-loop feedback techniques.

- Small-scale, compressed air-powered piston engine to mimic a full-size engine with realistic results
- Demonstrates problems of speed control in non-linear systems
- Front panel includes mimic diagram of the process so students can clearly see what they are controlling
- For basic and advanced experiments with speed control and non-linearity compensation
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controller



LEARNING OUTCOMES:

- The use of dither signals in the compensation of system non-linearities
- The measurement of system dynamics from step response information
- Inner loop feedback compensation
- P+I controller design

A scale-model engine, driven by compressed air (not supplied) for safety. The basic purpose is to adjust a motorised valve to regulate the engine speed under load. A DC generator connects to the engine output and loads the engine.

The engine dynamics are similar to those of a typical ignition compression engine coupled to a dynamometer-controlled test bed. It is an ideal physical model to help engineering students at all academic levels to gain invaluable practical experience.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 66
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 67

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 65) with editable, pre-made control experiments for use with the CE107.

ESSENTIAL ANCILLARIES:

- Compressor (CE1B) 303

RECOMMENDED ANCILLARIES:

- Optical Tachometer (OT1) 303
- Stroboscope (ST1) 303


ALL PRODUCTS ARE MANUFACTURED IN-HOUSE BY A HIGHLY SKILLED WORKFORCE

COUPLED DRIVES APPARATUS

CE108

Compact, bench-mounted apparatus designed to allow students at all academic levels to investigate basic and advanced principles of control, including control of multi-variable systems.

- Coupled drives demonstrate the problems of speed and tension control
- Mimics many industrial and household applications with realistic results
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controllers
- Front panel includes a mimic diagram of the process so that students can see what they are controlling

LEARNING OUTCOMES:

- Independent control of speed and tension
- Simultaneous control of speed and tension
- Practical methods of controlling multi-variable electro-mechanical systems

The apparatus has two electric motors, coupled by a continuous flexible belt. The belt also passes over a swinging arm with a 'jockey wheel' that measures the belt speed and tension. A manual control allows the user to adjust the spring tension at the swinging arm.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 66
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 67

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 65) with editable, pre-made control experiments for use with the CE108.

RECOMMENDED ANCILLARIES:

- Optical Tachometer (OT1) 303

BALL AND HOOP APPARATUS

CE109

A self-contained, bench-mounted apparatus to demonstrate basic control of position or speed of a ball in a hoop, and more advanced studies of liquid slop.

- Demonstrates the problems of speed and position control of a mobile body or liquid in a container
- Mimics industrial, aeronautical, fluid transport and pumping system problems with realistic results
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controllers
- Front panel includes a mimic diagram of the process so that students can see what they are controlling

LEARNING OUTCOMES:

- The design and analysis of servo control systems for position and velocity control
- The analysis and modelling of liquid slop dynamics
- The use of 'pole zero' in the analysis of control systems

The apparatus has a steel ball that rolls inside a hoop. The hoop is free to rotate, but controlled by a servomotor. Transducers give outputs of the hoop and ball positions. When the hoop is under angular position control, the ball moves like a cylindrical pendulum. This allows students to use it as a model for the study of liquid slop dynamics.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** — 66
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) — 67

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 65) with editable, pre-made control experiments for use with the CE109.

RECOMMENDED ANCILLARIES:

- Optical Tachometer (OT1) — 303
- Oscilloscope (OS1) — 303

PRODUCT DEVELOPMENT

The information contained in this publication has been carefully prepared and is correct at the time of printing. TecQuipment is, however, committed to a programme of continuous improvement; hence we reserve the right to alter the design and product specification without prior notice to ensure it continues to meet customer needs.

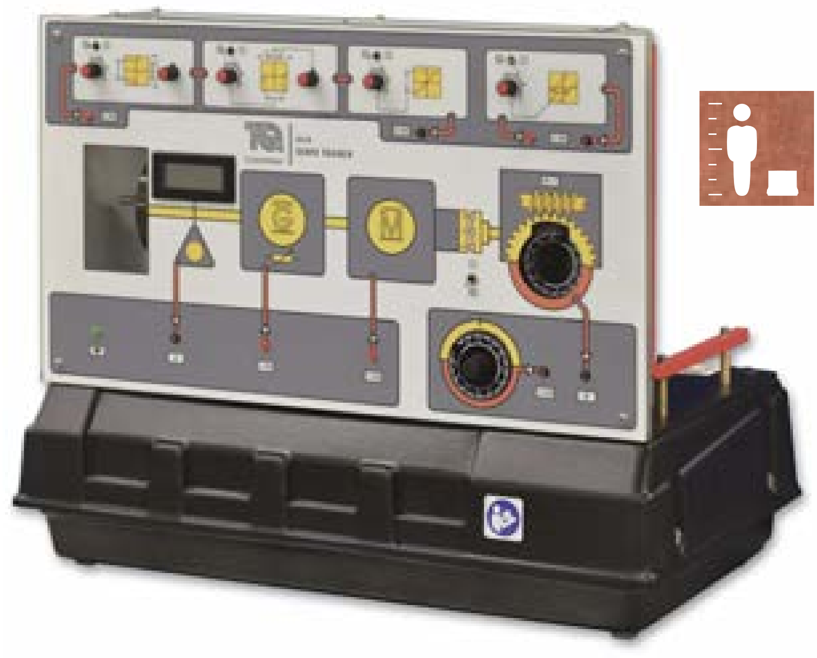
For the latest information on all our products please visit our website at: **TECQUIPMENT.COM**

SERVO TRAINER

CE110

A self-contained, bench-mounted DC servo apparatus to study basic control of speed of a servomotor, through to more advanced studies of non-linear effects of hysteresis, deadzone and saturation.

- Demonstrates the problems of speed and position control of a servomotor under different loads
- Mimics industrial, transport and aeronautical problems - with realistic results
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controllers
- Front panel includes a mimic diagram of the process so that students can see what they are controlling



LEARNING OUTCOMES:

- Basic tests and transducer calibration
- Response calculation and measurement
- Proportional and proportional plus integral control of servo-system speed
- Disturbance cancelling and feedforward control
- Angular position control: proportional control and velocity feedback
- Angular position control and the influence of non-linearities
- Non-linear system characteristics

The CE110 has a DC servomotor, a DC generator and a flywheel mounted on a common shaft. Analogue 0 to ±10 V control signals vary the servomotor shaft speed in either direction. An optical sensor measures the speed and shows it on a panel-mounted digital meter. The DC generator statically or dynamically loads the servomotor. An electric clutch connects or disconnects the shaft to a 30:1 reduction gearbox for position control studies. A manual control allows the user to set a position control setpoint.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 66
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 67

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 65) with editable, pre-made control experiments for use with the CE110.

SHARE YOUR INSTALL – LABORATORIES FROM AROUND THE WORLD

Academics and students from across the globe are proudly sharing their latest installation pictures on social media.

SHARE YOUR PICTURES

TEXAS STATE TECHNICAL COLLEGE

Following installation, Richard Filut and Kevin Staton from Texas State Technical College in Abilene familise themselves with their latest equipment – a transmission line simulator, a distribution trainer and a transformer trainer.

HCT AL AIN

Academics at the Higher Colleges of Technology in Al Ain, UAE undergo training on their latest intermittent supersonic wind tunnel and flight demonstration wind tunnel.

NEW YORK UNIVERSITY ABU DHABI

Training on the large AF1600 subsonic wind tunnel at New York University in Abu Dhabi, following installation.

UNIVERSITY OF VIGO

The University of Vigo in Spain takes derlivery of a large AF1600 wind tunnel.

PROCESS CONTROL ENGINEERING

> Just wanted to say what a great guy Dave Giddings (TecQuipment's ICT Manager) is. Thank you for sending him. I was very impressed with his work ethic and expertise. Also, he is very good interacting with the customer. You probably know all this already but I just wanted to say it!
>
> **CARY STOVER**
> BUCKEYE EDUCATIONAL SYSTEMS

PROCESS CONTROL ENGINEERING

MADE FOR ACADEMIC AND INDUSTRIAL TRAINING

The Process Control Engineering range extends from bench-top products, made for demonstrating control principles, to equipment using industrial parts for vocational training.

ACADEMIC AND INDUSTRIAL SOFTWARE

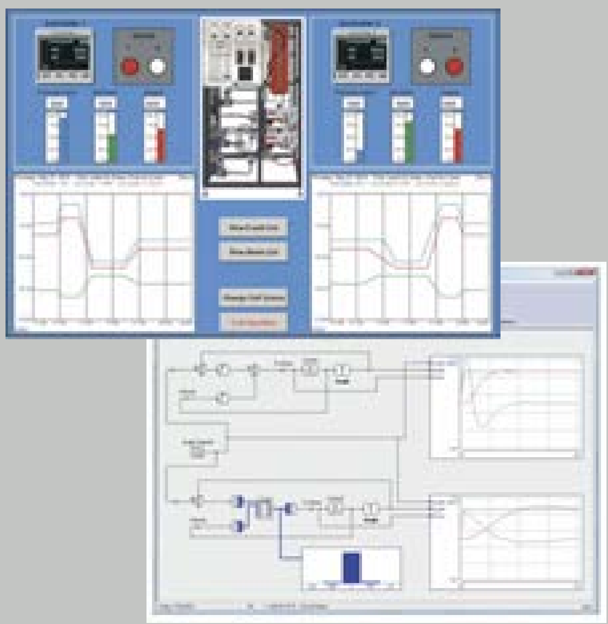
All our Process Control products work with software. Most of the academic products work with TecQuipment's own CE2000 control software. The more industrial products work with industrial process or PLC control software.

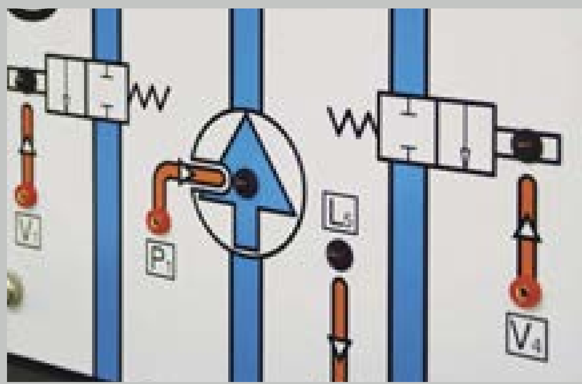
KEY FEATURES AND BENEFITS:

ACADEMIC AND INDUSTRIAL: Bench-top products for academic teaching and industrial products for vocational training.

HANDS ON: All the products allow easy connection and adjustments, for a more practical understanding of principles.

INDUSTRIAL COMPONENTS: Realistic student experience, with the use of industry-standard instrumentation.





CONNECTIVITY

The Process Training system (TE3300) can be used individually, to study control elements in isolation. They can also be connected to other units in the system, to introduce more complexity and wider experimentation capability.

PLC TRAINER

CE123

Uses an industry-standard PLC to control the PLC process using ladder logic programming running on a PC. For use with the PLC Process (CE111).

MODULAR SYSTEM

ESSENTIAL BASE UNIT (CE123)

EXPERIMENT MODULE (CE111)

- Includes PLC software to program the controller, and ready-made programs to match experiments given in the user guide
- Introduces ladder logic programming
- Works with TecQuipment's PLC Process (CE111) to show students how to control a common industrial process, but in safe conditions
- Uses an industry-standard controller to give students realistic industrial experience
- Includes manual override switches to introduce faults for fault-finding training

LEARNING OUTCOMES:

- Simple programming
- Ladder logic operations
- Timers, counters and monitoring
- Editing and adding comments in a PLC program
- Special ladder logic instructions

The PLC Trainer shows students how to use a programmable logic controller. It also works with TecQuipment's PLC Process (CE111) to help students study how to use programmable logic controllers to control a process.

AVAILABLE EXPERIMENT MODULES:

- PLC Process (CE111) 80

DOCUMENTS INCLUDED – EVERYTHING YOU NEED

A comprehensive pack of documents is supplied with all experiments, including:

- **USER MANUAL:** How to use the product, along with instructions on experiment set-up and supporting enginering principles for guided learning.
- **PACKING CONTENTS LIST:** All the parts that make up the complete product.
- **TEST CERTIFICATE:** Your peace of mind that the product has been thoroughly tested before dispatch.

PLC PROCESS

CE111

A self-contained, bench-mounted liquid flow and level process, providing a physical system to experience the programming of programmable logic controllers, for use with the PLC Trainer (CE123).

- Allows basic and advanced studies of programmable logic controllers (PLCs) in industrial applications
- Demonstrates control of liquid flow, volume and level in two tanks
- Includes a selection of fully controllable valves to give many different liquid level and flow control experiments, including batch processing
- Front panel includes mimic diagram of the process so students can clearly see what they are controlling

LEARNING OUTCOMES:

When used with the CE123:

- Basic programming of a PLC
- Basic level control
- Tank filling sequence
- Simulated batch processing (sequencing)
- Ladder logic programming
- Editing and adding comments in a PLC program

The open structure of the CE111 and CE123 allows the user to create additional experiments to suit their needs.

The apparatus has two transparent tanks, mounted one above the other. A variable-speed pump transfers water from the reservoir (in the base of the unit) into the upper tank. The water can drain down to the lower tank and then back into the reservoir. Solenoid valves may be individually opened or closed to control and redirect the movement of the water. The pump control is on or off , but a manual control allows the user to set the speed. A float switch in the reservoir monitors the level of water.

The object is to connect and program an external programmable logic controller to monitor and control the level and flow rate of water in a two-tank system.

ESSENTIAL BASE UNIT:

- PLC Trainer (CE123) 79

PROCESS TRAINER

CE117

A self-contained, bench-mounted, fully integrated teaching apparatus that mimics industrial process engineering, including a comprehensive range of experiments in flow, level, pressure and temperature, ranging from basic theories through to more advanced principles.

- Includes four basic process control methods in one compact unit
- Supplied with TecQuipment's CE2000 software for supervisory control of the process with data acquisition
- Mimics common industrial parts and processes with realistic results
- Ideal for classroom demonstrations and student experiments
- Includes experiments from basic control to advanced control methods, including ratio control, cascade control, interactive control and feedforward control

LEARNING OUTCOMES:

- Proportional, integral and derivative (PID) control
- Control of flow
- Control of level
- Control of pressure
- Control of temperature
- Ratio control
- Cascade control
- Multi-loop control
- Interacting control loops

Using water as the working fluid, the equipment allows safe, practical experiments on control of flow, liquid level, temperature and pressure. Students can study each of these separately or in combinations.

ALTERNATIVE PRODUCTS:

- Thermal Control Process Apparatus (CE103) 68
- Coupled Tanks Apparatus (CE105/CE105MV) 69
- Pressure Process Training System (TE3300/02) 82
- Flow Process Training System (TE3300/03) 83
- Level Process Training System (TE3300/04) 84
- Temperature Process Training System (TE3300/05) 85
- Control and Instrumentation Study Station (TE37) 87

PRESSURE PROCESS TRAINING SYSTEM

TE3300/02

A self-contained, mobile module using pressure as the control variable to illustrate the principles of single-loop control and the calibration and tuning of controllers, transmitters, converters and valves.

- Demonstrates automatic control of pressure in an accumulator using proportional, proportional plus integral, and proportional, integral plus derivative (PID) control
- Uses industry-standard parts making it ideal for industrial, vocational and academic training
- Demonstrates operation, calibration and tuning of controllers, transmitters, converters and valves
- Connects to the Flow Process Training System (TE3300/03) for cascade control
- Connects to the Computer Control System (TE3300/06) for distributed control

LEARNING OUTCOMES:

- Proportional, integral and derivative control
- Setting up and demonstrating automatic control
- The principles of loop control and the calibration and tuning of controllers, transmitters, converters and valves
- Cascade control of flow and pressure (when used with the TE3300/03 Flow Process Training System)
- Distributed control (when used with the TE3300/06 Computer Control System)

To carry out experiments, students fill the reservoir with clean water and prime the system. They then set the controller to regulate the flow of water using a pneumatic valve. This alters the pressure in the accumulator. A pressure transmitter measures the accumulator pressure and gives feedback to the controller. For a realistic experience, the equipment has industrial-standard instrumentation and parts.

The apparatus includes two gate valves. One valve controls the flow at the output (drain) and the other acts as a flow-bypass valve. A chart recorder shows and logs the changes of the process variable (level) and the controller output.

The self-contained unit can perform many experiments. By connecting this to other products in the TE3300 range further experiments are possible.

ESSENTIAL ANCILLARIES:

- Service Module (SM3300)

RECOMMENDED ANCILLARIES:

- Flow Process Training System (TE3300/03) 83
- Computer Control System (TE3300/06) 86

ANCILLARY FOR:

- Flow Process Training System (TE3300/03) 83

ALTERNATIVE PRODUCTS:

- Process Trainer (CE117) 81
- Control and Instrumentation Study Station (TE37) 87

FLOW PROCESS TRAINING SYSTEM

TE3300/03

A self-contained, mobile module for flow process control experiments to illustrate the principles of single-loop control and the calibration and tuning of controllers, transmitters, converters and valves.

- Demonstrates automatic control of flow using proportional, proportional plus integral, and proportional plus integral plus derivative (PID) control
- Uses industry-standard parts making it ideal for industrial, vocational and academic training
- Demonstrates operation, calibration and tuning of controllers, transmitters, converters and valves
- Connects to the Pressure Process (TE3300/02) and Level Process (TE3300/04) Training Systems for cascade control
- Connects to the Computer Control System (TE3300/06) for distributed control

To carry out experiments, students fill the reservoir with clean water and prime the system. They then set the controller to regulate the flow of the water using a pneumatic valve. The gap-type flow meter gives a visual indication of flow. The fixed orifice and pressure transmitter give feedback to the controller. For a realistic experience, the equipment has industrial-standard instrumentation and parts.

The apparatus includes two gate valves. One valve controls the flow at the output (drain) and the other acts as a flow-bypass valve. A chart recorder shows and logs the changes of the process variable (level) and the controller output.

The self-contained unit can perform many experiments. By connecting this to other products in the TE3300 range further experiments are possible.

ESSENTIAL ANCILLARIES:

- Service Module (SM3300)

RECOMMENDED ANCILLARIES:

- Pressure Process Training System (TE3300/02) 82
- Level Process Training System (TE3300/04) 84
- Computer Control System (TE3300/06) 86

ANCILLARY FOR:

- Pressure Process Training System (TE3300/02) 82
- Level Process Training System (TE3300/04) 84

ALTERNATIVE PRODUCTS:

- Process Trainer (CE117) 81
- Control and Instrumentation Study Station (TE37) 87

LEARNING OUTCOMES:

- Proportional, integral and derivative control
- Setting up and demonstrating automatic control
- The principles of loop control and the calibration and tuning of controllers, transmitters, converters and valves
- Calibration of an orifice flow meter with a differential pressure transmitter
- Quadratic flow laws and square root extraction
- Cascade control of pressure and flow, and level and flow (when used with the TE3300/02 and TE3300/04)
- Distributed control (when used with the TE3300/06 Computer Control System)

LEVEL PROCESS TRAINING SYSTEM

TE3300/04

A self-contained, mobile module for level process control experiments to illustrate the principles of single-loop control and the calibration and tuning of controllers, transmitters, converters and valves.

- Demonstrates automatic control of level using proportional, proportional plus integral, and proportional plus integral plus derivative (PID) control
- Uses industry-standard parts making it ideal for industrial, vocational and academic training
- Demonstrates operation, calibration and tuning of controllers, transmitters, converters and valves
- Connects to the Flow Process Training System (TE3300/03) for cascade control
- Connects to the Computer Control System (TE3300/06) for distributed control

To carry out experiments, students fill the reservoir with clean water and prime the system. They then set the controller to regulate the flow of water using a pneumatic valve. This alters the water level in the transparent vessel. The differential pressure transmitter connected to the vessel gives feedback to the controller. For a realistic experience, the equipment has industrial standard instrumentation and parts.

The apparatus includes two gate valves. One valve controls the flow at the output (drain) and the other acts as a flow-bypass valve. A chart recorder shows and logs the changes of the process variable (level) and the controller output.

The self-contained unit can perform many experiments. By connecting this to other products in the TE3300 range further experiments are possible.

ESSENTIAL ANCILLARIES:

- Service Module (SM3300)

RECOMMENDED ANCILLARIES:

- Flow Process Training System (TE3300/03) 83
- Computer Control System (TE3300/06) 86

ANCILLARY FOR:

- Flow Process Training System (TE3300/03) 83

ALTERNATIVE PRODUCTS:

- Coupled Tanks Apparatus (CE105/CE105MV) 69
- Process Trainer (CE117) 81
- Control and Instrumentation Study Station (TE37) 87

LEARNING OUTCOMES:

- Proportional, integral and derivative control
- Setting up and demonstrating automatic control
- The principles of loop control and the calibration and tuning of controllers, transmitters, converters and valves
- Wet and dry leg operation of a differential pressure transmitter
- Operation of a level-control system
- Cascade control of level and flow (when used with the TE3300/03 Flow Process Training System)
- Distributed control (when used with the TE3300/06 Computer Control System)

TEMPERATURE PROCESS TRAINING SYSTEM

TE3300/05

A self-contained mobile module for temperature process control experiments to illustrate the principles of single-loop control and the calibration and tuning of controllers, transmitters, converters and valves.

- Demonstrates automatic control of temperature using proportional, proportional plus integral, and proportional plus integral plus derivative (PID) control
- Uses industry-standard parts making it ideal for industrial, vocational and academic training
- Demonstrates operation, calibration and tuning of temperature transmitters and thermocouples
- Includes delay coil to mimic realistic time lag due to a process
- Connects to the Computer Control System (TE3300/06) for distributed control

LEARNING OUTCOMES:

- Proportional, integral and derivative control
- Setting up and demonstrating automatic control
- The principles of loop control and the calibration and tuning of temperature transmitters and thermocouples
- Operation of a temperature control system
- Distributed control (when used with the TE3300/06 Computer Control System)

To carry out experiments, students fill the reservoir with clean water and prime the system. They then set the controller to regulate the power to the in-line heater and control the temperature of the water at any of three places. The heat-exchanger removes the heat from the water, to give quicker experiments. The thermocouples (selected by a three-way switch) give feedback to the controller. For a realistic experience, the equipment has industrial-standard instrumentation and parts.

The apparatus includes one gate valve that works as a flow bypass. A chart recorder shows and logs the changes of the process variable (temperature) and the controller output.

RECOMMENDED ANCILLARIES:

- Computer Control System (TE3300/06) 86

ALTERNATIVE PRODUCTS:

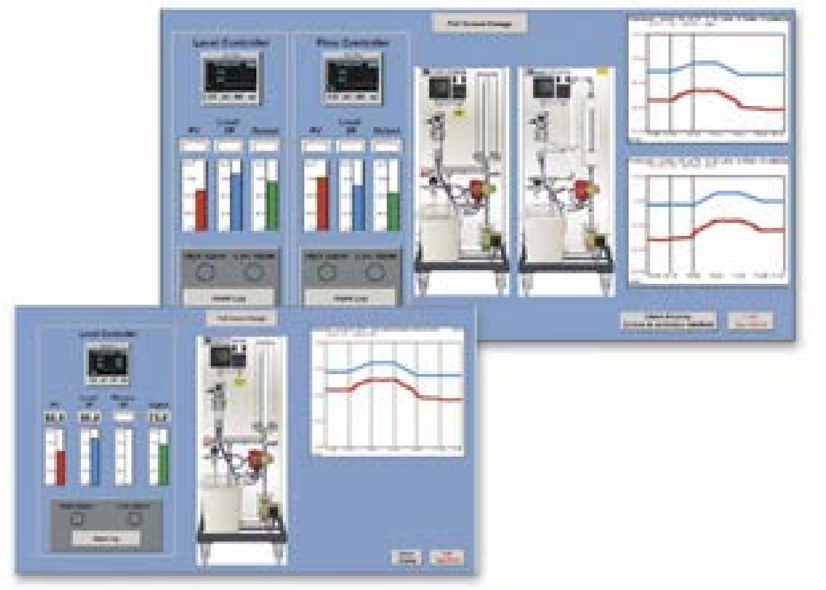
- Thermal Control Process Apparatus (CE103) 68
- Process Trainer (CE117) 81
- Control and Instrumentation Study Station (TE37) 87

COMPUTER CONTROL SYSTEM

TE3300/06

Connects to the TE3300 process control modules for remote control and monitoring of processes (distributed control).

- Industry-standard software
- Colourful, easy-to-use on-screen mimics of the processes
- Includes high-specification computer, large monitor, keyboard and mouse
- Real-time displays of variables



LEARNING OUTCOMES:

When used with the TE3300 process control modules, computer control and monitoring of:

- Pressure process (TE3300/02)
- Flow process (TE3300/03)
- Level control process (TE3300/04)
- Temperature process (TE3300/05)
- Cascaded flow and pressure (TE3300/02 and TE3300/03)
- Cascaded flow and level (TE3300/03 and TE3300/04)

The Computer Control System (TE3300/06) is a computer control package for use with modules from TecQuipment's TE3300 process control range. It allows remote control and data acquisition from the controller of each process. This system will also control and collect data from the controllers of TE3300 modules when connected in cascade.

ANCILLARY FOR:

One or more modules from the TE3300 process control range:

- Pressure Process Training System (TE3300/02) 82
- Flow Process Training System (TE3300/03) 83
- Level Process Training System (TE3300/04) 84
- Temperature Process Training System (TE3300/05) 85

CONTROL AND INSTRUMENTATION STUDY STATION

TE37

A laboratory-scale model of a typical industrial process plant providing the essential facilities to allow flow level temperature and pressure control. Demonstrates applications of advanced control systems using industry-standard instrumentation and controls for the training of plant technicians and process control engineers.

- Patch panel with leads for quick and simple connection between instruments, valves and controls
- Optional distributed computer control
- Gives academic and vocational study for process control engineers and plant technicians
- Includes hidden switches to create faults for fault-finding training
- Fully programmable controllers with local and remote set points, and fully programmable proportional, integral and derivative control

LEARNING OUTCOMES:

- Setting up process transmitters
- Level, pressure, flow and temperature control
- Cascade control
- Coupled and decoupled interactive control
- Ratio control
- Feedforward control
- Feedforward-feedback control
- Split range control
- Fault-finding

The Control and Instrumentation Study Station uses industry-standard parts to teach industrial process control. It is an excellent tool to help train plant technicians and process control engineers.

Hot and cold water supplies connect to the study station. Two valves (operated by compressed air) control the flow of the water supplies into a process vessel.

ESSENTIAL ANCILLARIES:

- Service Module (SM37) – This module connects to a suitable cold-water supply and provides hot and cold water at the correct flow and pressure for the study station. It includes an air compressor and storage vessel to supply compressed air to the study station valves.

RECOMMENDED ANCILLARIES:

- Distributed Control System (TE37DCS) 88

ALTERNATIVE PRODUCTS:

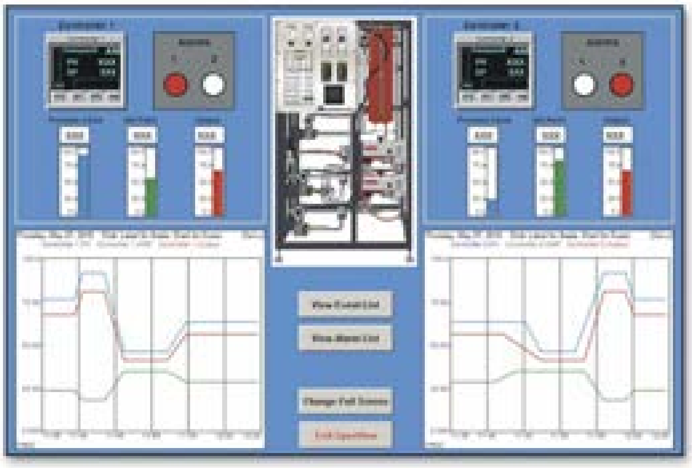
- Thermal Control Process Apparatus (CE103) 68
- Coupled Tanks Apparatus (CE105/CE105MV) 69
- Process Trainer (CE117) 81
- Pressure Process Training System (TE3300/02) 82
- Flow Process Training System (TE3300/03) 83
- Level Process Training System (TE3300/04) 84
- Temperature Process Training System (TE3300/05) 85

DISTRIBUTED CONTROL SYSTEM

TE37DCS

A computer control hardware and software package that connects to the Control and Instrumentation Study Station (TE37) for remote control and monitoring of processes.

- Industry-standard supervisory control and data acquisition (SCADA) software, with colourful, easy-to-use on-screen mimics of the processes
- Improves students' understanding of industrial process control
- Mimics and controls both controllers of the TE37
- Includes high-specification computer, large monitor, keyboard and mouse



The package includes a high-specification computer, with large screen monitor, keyboard and mouse. The computer includes connections for direct communication with the controllers on the study station.

The software logs all events and any controller alarm conditions. The data is shown in real-time (as a trend) or logged for later examination.

ANCILLARY FOR:

- Control and Instrumentation Study Station (TE37) 87

LEARNING OUTCOMES:

When used with the Control and Instrumentation Study Station (TE37), the remote control and monitoring of control processes including:

- Level
- Pressure
- Temperature
- Cascade control
- Coupled interactive control
- Decoupled interactive control
- Ratio control
- Feedforward control
- Feedforward-feedback control
- Split range control

TOP 5 REASONS TO VISIT TECQUIPMENT

1. Personal development
2. See real products in production
3. Get hands-on with equipment
4. Meet the teams
5. Combine with university visits

FLUID MECHANICS

> “We are extremely satisfied with the TecQuipment Fluids and Thermodynamics equipment: it is well presented, works well and the students are able to operate it easily. The best feature is that the user guides are of a very high quality, with excellent theory sections and experiment guides. The support from TecQuipment introducing the equipment and installing it has been excellent too.
>
> RICHARD ALBANY-WARD
> SCHOOL OF SCIENCE AND TECHNOLOGY, UNIVERSITY OF NORTHAMPTON

FLUID MECHANICS

The Fluid Mechanics range offers a wide scope of teaching equipment for the delivery of complete courses in fluid dynamics.

BASE UNIT AND MODULES FOR FLEXIBILITY

In many settings, the modular Digital Hydraulic Bench (H1F) acts as a base unit, allowing tutors to swap out individually mounted experiment modules on these self-contained benches, reducing laboratory set-up time, space requirements, the need to be near a water source and cost. Modules include experiments for exploring Bernoulli's theorem, the function and dynamics of weirs, pressure and flow measurement, pipe friction and energy loss, and much more.

UNDERSTANDING FLOW

The impressive flow and sediment channels, for demonstrating the mechanics of flow, also enable the practical teaching and demonstration of phenomena such as critical and sub critical flow, hydraulic jump, and dune formation. There are many ancillaries available for use with the flow channels, enabling them to be used as both teaching and research aids.

PITOT TUBE FOR THE FC80 FLUME

KEY FEATURES AND BENEFITS:

LONGEVITY: Long-lasting equipment to teach principles that do not go out of date.

WATER AND SPACE SAVING: Many experiments work with the self-contained, mobile hydraulic bench to save water and laboratory space.

LARGE CHOICE OF EXPERIMENTS: A huge range of experiments for a complete course in fluid mechanics, from simple flow and pressure measurements to advanced studies of vortices and open-channel flow.

MODULAR FLUID POWER RANGE

The Fluid Mechanics range includes a sub-section of Modular Fluid Power products **(PAGES 134-148)** to demonstrate real-world applications of fluid mechanics. They include pumps and turbines, which also provide a link to renewable energy.

AUTOMATIC DATA ACQUISITION VDAS®

Each product in this range works with TecQuipment's unique Versatile Data Acquisition System (VDAS®) – **SEE PAGE 299**.

SPILLWAY FOR THE FC300 FLUME

DIGITAL HYDRAULIC BENCH

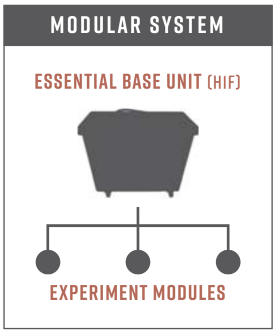
HIF

Provides a controlled recirculating water supply and accurate flowmeter for hydraulic and fluid mechanics experiments.

*UPGRADE YOUR OLDER GENERATION GRAVIMETRIC OR HYDRAULIC BENCH WITH A:

DIGITAL ELECTRONIC MEASURING KIT HIX

SEE PAGE 105



DIGITAL FLOW DISPLAY

FEATURES:	BENEFITS:
Supplies and measures water flow to over 15 different experiment modules	Saves space and reduces costs
Electronic flowmeter and digital display	Accurate measurements and quicker experiments
Self-contained with recirculating water circuit	Needs no external water supply, saves mains water
Fully mobile unit with a flat top to hold several experiment modules	Makes best use of laboratory space
Fibreglass construction	Strength, easier transport and long life

This product supplies a controlled flow of water to a wide variety of laboratory experiment modules (available separately). The body of the bench forms a reservoir or 'sump tank' with a submersible pump. Once filled, the bench needs no external water supply.

AVAILABLE EXPERIMENT MODULES:

BENCH-MOUNTED:

THE DIGITAL HYDRAULIC BENCH SHOWN WITH THE JET TRAJECTORY AND ORIFICE FLOW (H33) EXPERIMENT MODULE

FREE-STANDING:

*Currently available only in the UK

FLOW VISUALISATION NEW

FC15

A compact, entry-level piece of equipment for visualising flow patterns around weirs and other objects in an open channel. A range of models supplied in the package makes this an ideal product for introducing students to flow visualisation in fluid mechanics.

- Blank panel enhances visualisation by providing a plain backdrop
- Undershot inlet for demonstrating hydraulic jump
- Overshot outlet for regulating free surface height at low Reynolds numbers.

DYE FLOW AROUND ONE OF THE MODELS

LEARNING OUTCOMES:

- Visualisation of flow around objects in an open channel
- Study of flow around submerged sharp-crested weir
- Study of a broad-crested weir and the effects of changing the profile of the weir (by reversing the block in the channel)
- Visualisation of flow around a hydrofoil (symmetrical and asymmetrical)
- Visual demonstration of hydraulic jump

Consists of a robust stainless steel tank (to reduce turbulence) flowing into a 15 mm wide flow channel fabricated from transparent acrylic, together with various gates, weirs and blocks. The channel is fitted with dye injectors enabling the detail of flow patterns to be easily demonstrated and observed.

RECOMMENDED ANCILLARIES:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Hele-Shaw Apparatus (H9) 109

CALIBRATION OF A BOURDON PRESSURE GAUGE

H3A

Demonstrates how a Bourdon tube pressure gauge works and how to calibrate it.

- Demonstrates ‘dead weight’ calibration of a Bourdon gauge
- Bourdon gauge has transparent dial so students can see how it works
- Suitable for group demonstrations and student experiments
- Self-contained – needs no extra services

LEARNING OUTCOMES:

- Function, operation and calibration of a Bourdon tube pressure gauge

Many engineering applications use the Bourdon gauge. TecQuipment’s Calibration of a Pressure Gauge experiment allows students to study Bourdon tube theory. They see the working mechanism, calibrate the gauge and compare theoretical results to experimental results.

ALTERNATIVE PRODUCTS:

- Pressure Measurement Bench (H30) 96
- Hydrostatics and Properties of Fluids (H314) 121

DISCHARGE OVER A NOTCH

H6

For the study of weirs as flow regulation and measurement devices.

- Portable, corrosion-resistant glass-fibre channel for ease of use and long life
- Includes one rectangular and two V-shaped notches for basic experiments
- Two additional weirs included for more advanced experiments
- Adjustable depth gauge for precise measurement of water level
- Works with TecQuipment's Digital Hydraulic Bench for easy installation

SHOWN WITH THE DIGITAL HYDRAULIC BENCH (H1F) – AVAILABLE SEPARATELY

LEARNING OUTCOMES:

Comprehensive study of flow over weirs, including:

- Investigation of head against discharge
- Coefficient of discharge for notches
- Rectangular and different angled V-notches

The Discharge Over a Notch apparatus demonstrates clearly the use of weirs as simple flow regulators. It allows students to do tests on relationships between upstream water level and weir discharge for different shaped notches. They can then compare their results with theory.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Flow Channels 114–118

BERNOULLI'S THEOREM

H5

Allows students to study Bernoulli's theorem by measuring the complete static head distribution along a horizontal Venturi tube.

- Eleven pressure tappings along the tube
- Direct measurement of static heads
- Complete pressure distribution clearly visible
- Compact and simple to operate
- Works with TecQuipment's Digital Hydraulic Bench for easy installation

LEARNING OUTCOMES:

Comprehensive study of a Venturi meter and Bernoulli's theorem, including:

- Direct measurement of the static head distribution along a Venturi tube
- Comparison of experimental results with theoretical predictions
- Measurement of the meter coefficient of discharge at various flow rates

The Venturi tube in TecQuipment's Bernoulli's Theorem is typical of meters used throughout industry. However, it has many more pressure tappings, connecting to water manometers, which allow full study of the pressure distribution along the convergent-divergent passage.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Bernoulli's Equation (AF11) 32
- Flow Measurement Methods (H10) 95
- Flow Meter Calibration (H40) 97
- Fluid Friction Apparatus (H408) 102

FLOW MEASUREMENT METHODS

H10

Demonstrates typical methods of measuring the flow of an incompressible fluid and shows applications of Bernoulli's equation.

- Includes Venturi meter, orifice plate and rotameter
- Works with TecQuipment's Digital Hydraulic Bench for easy installation
- Direct measurement of head loss
- Three different flow meters which work with Bernoulli's equation
- Multi-tube manometer demonstrates pressure at various points

Students measure flow using a Venturi meter, an orifice plate meter and a rotameter. Students find and compare the head losses associated with each meter, as well as those arising in a rapid enlargement and a 90-degree elbow.

LEARNING OUTCOMES:

Study of Bernoulli's equation, flow measurement and losses, including:

- Application of the Bernoulli equation for incompressible fluids
- Direct comparison of flow measurement using a Venturi meter, orifice plate and rotameter
- Comparison of pressure drops across each flow-measurement device
- Comparison of pressure drops across a sudden enlargement and a 90-degree elbow

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Bernoulli's Theorem (H5) 94
- Flow Meter Calibration (H40) 97
- Fluid Friction Apparatus (H408) 102

PRESSURE MEASUREMENT BENCH

H30

Self contained, bench-mounted apparatus that enables a range of practical investigations into manometer and Bourdon gauge pressure measurement techniques, including inclined and U-tube manometers, and Bourdon-type vacuum and pressure gauges.

- Provides practical investigations for pressure measurement using inclined and U-tube manometers, and Bourdon-type vacuum and pressure gauges
- Enables instant comparison of measurement methods
- Includes separate Bourdon gauge with dead-weight calibration apparatus, and Bourdon tube mechanism clearly visible
- Fully self-contained, bench-top apparatus
- Suitable for group demonstrations and individual student experiments

LEARNING OUTCOMES:

A range of investigations into common pressure-measurement techniques, including:

- Comparison of pressure measurement by manometer and Bourdon gauge
- Calibration of a pressure gauge
- Determination of gauge errors as a function of true pressure

The apparatus consists of two units: a manometers and gauges unit, and a Bourdon pressure gauge calibration unit.

ALTERNATIVE PRODUCTS:

- Calibration of a Bourdon Pressure Gauge (H3a) 92
- Hydrostatics and Properties of Fluids (H314) 121

FLOW METER CALIBRATION

H40

A compact unit that compares and demonstrates the accuracy, losses and use of fundamental flow meters.

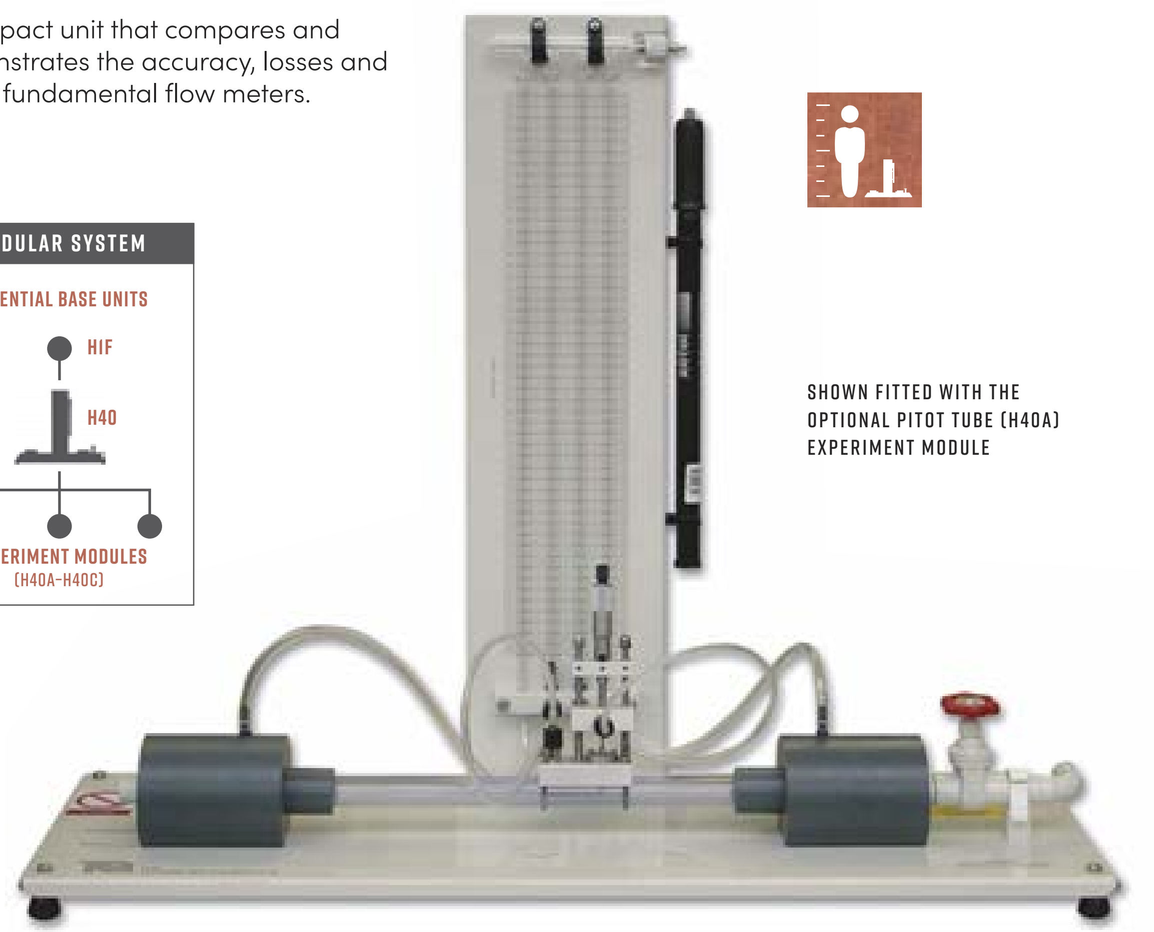
MODULAR SYSTEM

ESSENTIAL BASE UNITS

HIF

H40

EXPERIMENT MODULES (H40A-H40C)



SHOWN FITTED WITH THE OPTIONAL PITOT TUBE (H40A) EXPERIMENT MODULE

FEATURES:		BENEFITS:
Supports and measures pressures in its optional experiment modules	→	Saves space and reduces costs
Nozzle flow meter included as standard	→	Allows tests 'out of the box'
Optional Pitot, Venturi and orifice flow meters	→	For comparisons of accuracy, losses, and tests of velocity profile and boundary layer effect
Unique 'quick-change' adaptors and self-sealing pressure connections	→	Maximises experiment time and reduces water spills
Works with TecQuipment's Digital Hydraulic Bench (H1F)	→	Easy installation and accurate external flow measurement

LEARNING OUTCOMES:

- Accuracy of nozzle flow meters
- Losses and k value
- Calculation of the coefficient of discharge

The Flow Meter Calibration works with TecQuipment's Digital Hydraulic Bench (H1F, available separately) and stands on the hydraulic bench worktop. Four water-filled manometers show the pressure differences at the flow meter and across the overall flow meter assembly.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

AVAILABLE EXPERIMENT MODULES:

- Pitot Tube (H40a) 98
- Venturi Flow Meter (H40b) 98
- Orifice Flow Meter (H40c) 98

ALTERNATIVE PRODUCTS:

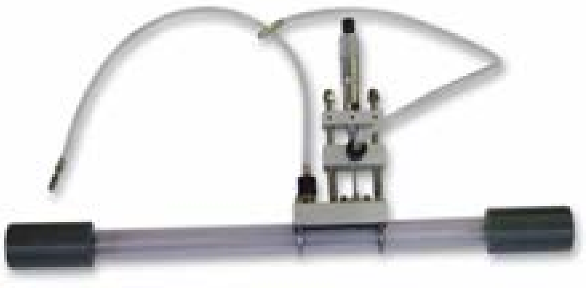
- Bernoulli's Theorem (H5) 94
- Flow Measurement Methods (H10) 95
- Fluid Friction Apparatus (H408) 102

PITOT TUBE

H40A

Pitot tube flow meter for use with the Flow Meter Calibration unit (H40).

- Demonstrates the accuracy and use of a Pitot tube flow meter
- Demonstrates the boundary layer effect and the fluid velocity profile
- Micrometer head for precise adjustment



LEARNING OUTCOMES:

- Accuracy of Pitot tube flow meters
- Losses and k value
- Calculation of the coefficient of discharge
- Velocity profile

ESSENTIAL BASE UNIT:

- Flow Meter Calibration (H40) – with H1F 97

VENTURI FLOW METER

H40B

Venturi flow meter for use with the Flow Meter Calibration unit (H40).

- Demonstrates the accuracy and use of a Venturi flow meter
- Demonstrates how a flow constriction affects pressure
- ISO standard dimensions for more predictable results

LEARNING OUTCOMES:

- Accuracy of Venturi flow meters
- Losses and k value
- Calculation of the coefficient of discharge

ESSENTIAL BASE UNIT:

- Flow Meter Calibration (H40) – with H1F 97

ORIFICE FLOW METER

H40C

Sharp-edged orifice flow meter for use with the Flow Meter Calibration unit (H40).

- Demonstrates the accuracy and use of a sharp-edged orifice flow meter
- Demonstrates how an orifice affects pressure
- ISO standard dimensions for more predictable results

LEARNING OUTCOMES:

- Accuracy of orifice flow meters
- Losses and k value
- Calculation of the coefficient of discharge

ESSENTIAL BASE UNIT:

- Flow Meter Calibration (H40) – with H1F 97

FRICTION LOSS IN A PIPE

H7

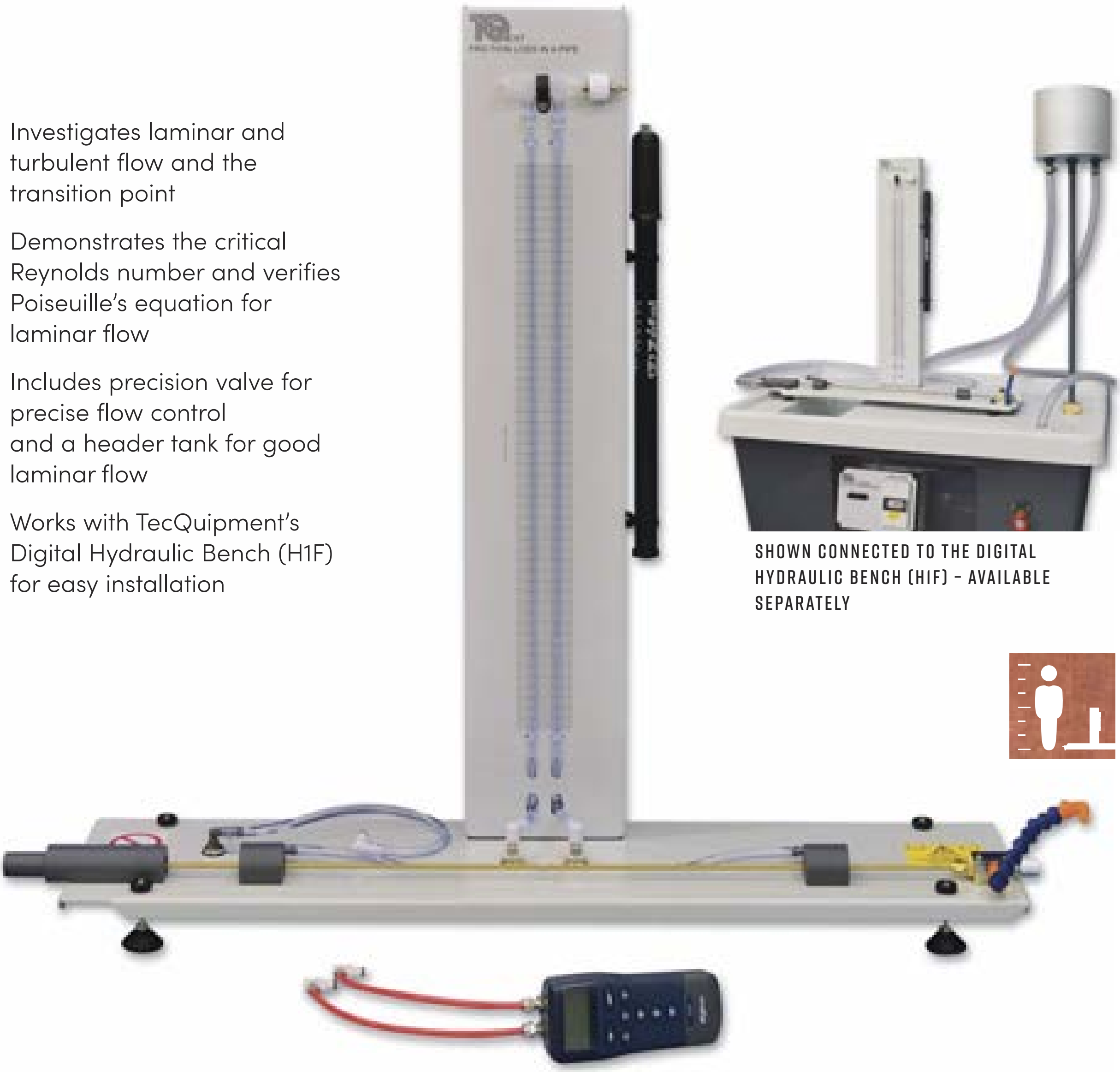
For direct measurement of friction loss in a small-bore horizontal pipe to study the change in the laws of resistance for laminar and turbulent flow, find the critical Reynolds number and demonstrate the flow transition point.

*UPGRADE OLDER GENERATIONS OF THIS EQUIPMENT WITH A:

DIGITAL ELECTRONIC MEASURING KIT H7X

SEE PAGE 111

- Investigates laminar and turbulent flow and the transition point
- Demonstrates the critical Reynolds number and verifies Poiseuille's equation for laminar flow
- Includes precision valve for precise flow control and a header tank for good laminar flow
- Works with TecQuipment's Digital Hydraulic Bench (H1F) for easy installation



SHOWN CONNECTED TO THE DIGITAL HYDRAULIC BENCH (H1F) – AVAILABLE SEPARATELY

LEARNING OUTCOMES:

Study of friction loss in a pipe, including:

- Investigations of laminar and turbulent flows
- Demonstration and measurement in the change of the laws of resistance (friction factor) from laminar to turbulent flow
- Finding the critical Reynolds number
- Verifying Poiseuille's equation and the coefficient of viscosity for water in the laminar flow region

The equipment is a small-bore straight test pipe on a base plate. It works with the Digital Hydraulic Bench (H1F, available separately) and stands on the bench worktop.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Losses in Piping Systems (H16) 100
- Fluid Friction Apparatus (H408) 102
- Osborne-Reynolds Apparatus (H215) 103
- Pipework Energy Losses (H34) 101

LOSSES IN PIPING SYSTEMS

H16

Freestanding apparatus, demonstrates pressure losses in several small-bore pipe circuit components, typical of those found in central heating installations.

*UPGRADE OLDER GENERATIONS OF THIS EQUIPMENT WITH A:

DIGITAL ELECTRONIC MEASURING KIT H16X

SEE PAGE 111

- Includes two colour-coded water circuits
- Works with TecQuipment's Digital Hydraulic Bench for easy installation
- Includes different pipe bends and valves for students to compare losses
- Fitted with a range of piezometers and a pressure gauge to give accurate pressure measurement
- Optional 'roughened pipe' ancillary to investigate flow characteristics in a roughened pipe

The Losses in Piping Systems apparatus comprises a vertical panel with two separate hydraulic circuits, colour-coded for clarity. Each circuit includes various pipe system components. The unit has wheels for mobility.

LEARNING OUTCOMES:

A comprehensive range of investigations into losses in a variety of pipes and pipe system components, including:

- Straight pipe loss
- Sudden expansion
- Sudden contraction
- Bends with different radii
- Valves
- Elbows
- Flow in a roughened pipe – needs the optional Roughened Pipe (H16p)

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

RECOMMENDED ANCILLARIES:

- Roughened Pipe (H16p)

ALTERNATIVE PRODUCTS:

- Friction Loss in a Pipe (H7) 99
- Pipework Energy Losses (H34) 101
- Fluid Friction Apparatus (H408) 102

PIPEWORK ENERGY LOSSES

H34

Compares pressure losses and k value of popular fittings in small-bore pipework.

- Compact, easy to fit and easy to use
- Includes three different bends: mitre, elbow and large radius
- Compares losses in a sudden enlargement (or expansion) and a contraction
- Includes a multi-tube piezometer for fundamental, accurate pressure measurements
- Works with TecQuipment's Digital Hydraulic Bench

LEARNING OUTCOMES:

Measurement and comparison of losses in:

- Mitre bend
- Elbow bend
- Large radius bend
- Sudden expansion
- Sudden contraction

This compact bench-top apparatus uses smooth, industry-standard plastic pipe, commonly used in domestic and other small-bore water systems.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

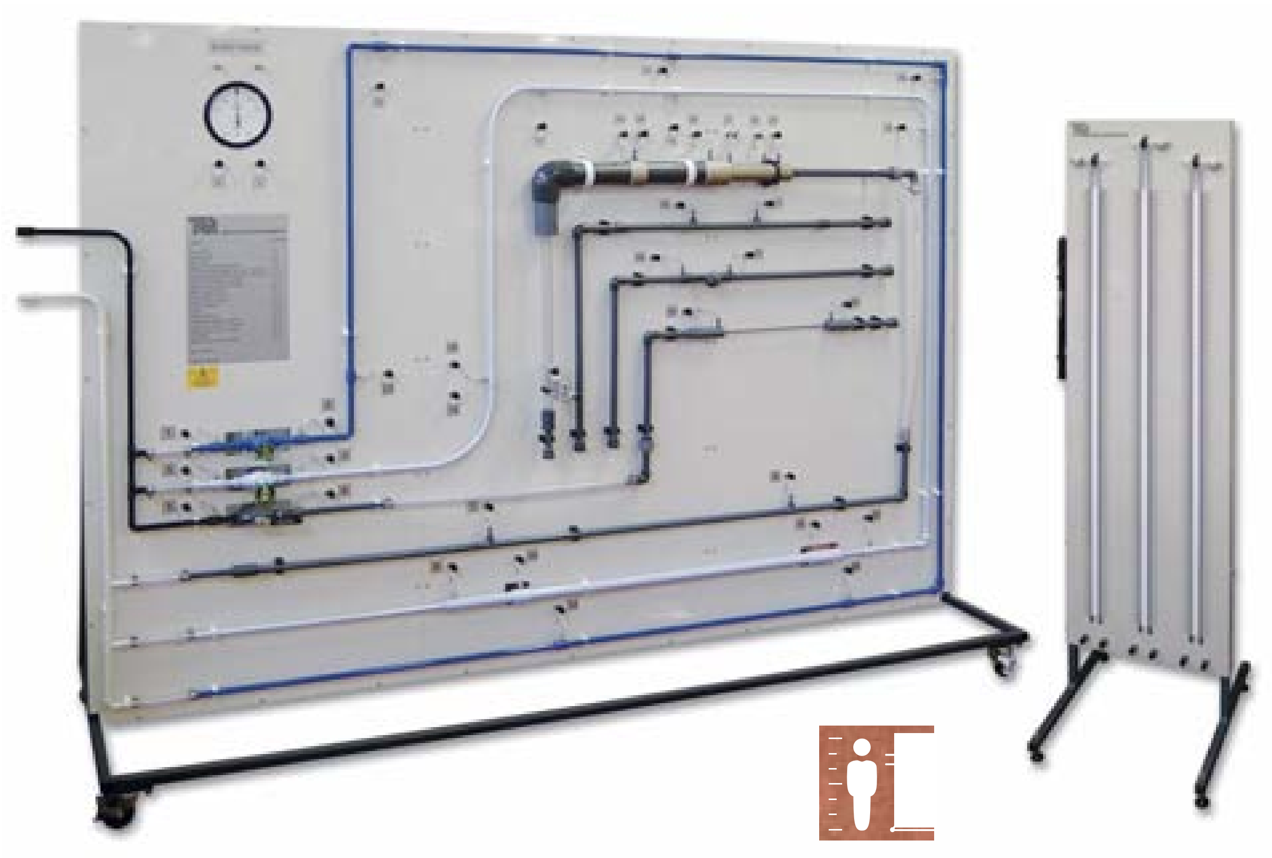
- Friction Loss in a Pipe (H7) 99
- Losses in Piping Systems (H16) 100
- Fluid Friction Apparatus (H408) 102

* Currently only available in the UK

FLUID FRICTION APPARATUS

H408

Demonstrates flow and losses in different pipes, fittings and valves. Shows popular flow measurement instruments.



- A space-saving vertical panel that works with TecQuipment's Digital Hydraulic Bench for easy installation
- Includes experiments on roughened pipes
- Uses Bernoulli's equation
- Demonstrates how to use Venturi and orifice meters to measure flow
- Includes a traversing Pitot tube to measure the velocity profile

TecQuipment's Fluid Friction Apparatus allows students to study flow, flow measurement techniques and losses in a wide variety of pipes and fittings. The equipment has three water circuits with instruments, pipes and pipe system components.

LEARNING OUTCOMES:

- Use of the Pitot static tube
- Flow measurement using a Venturi meter and an orifice meter
- Smooth pipes
- Artificially roughened pipe
- Straight pipe loss
- Sudden expansion and contraction
- Bends and elbows
- Valves
- In-line strainer

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Losses in Piping System (H16) 100
- Pipework Energy Losses (H34) 101
- Flow Meter Calibration (H40) 97
- Flow Measurement Methods (H10) 95
- Bernoulli's Theorem (H5) 94
- Friction Loss in a Pipe (H7) 99

OSBORNE-REYNOLDS APPARATUS

H215

Free-standing apparatus that gives a visual demonstration of laminar and turbulent flow. It also allows students to investigate the effect of varying viscosity and investigate Reynolds numbers.

- Constant head reservoir and flow-smoothing parts for a smooth flow
- Uses dye injector system to demonstrate flow patterns
- Investigates Reynolds number at transition
- Optional heater module available for tests at different viscosities

DYE STREAM SHOWING LAMINAR FLOW

OPTIONAL HEATER MODULE (H215A)

LEARNING OUTCOMES:

- Demonstration of transition between laminar and turbulent flow
- Determination of transition Reynolds numbers and comparison with accepted values
- Investigation of the effect of varying viscosity, and demonstration that the Reynolds number at transition is independent of viscosity

The apparatus consists of a precision-bore glass pipe (test tube) held vertically in a large shroud. The shroud is open at the front and the inside surface is light coloured. This allows the students to see the flow clearly.

ESSENTIAL ANCILLARIES:

- Stopwatch (SW1) – To measure flow rates 28

RECOMMENDED ANCILLARIES:

- Heater Module (H215a) – Free-standing unit to vary and control the water temperature and hence its viscosity 103

ALTERNATIVE PRODUCTS:

- Friction Loss in a Pipe (H7) 99
- Viscosity and Particle Drag (H410) 122

FLOW THROUGH AN ORIFICE

H4

Demonstrates flow through different orifices for different flow rates.

- Direct measurement of total head, head loss and diameter of jet
- Vertical water jet
- Integral Pitot traverse tube
- Sharp-edged orifice included
- Works with TecQuipment's Digital Hydraulic Bench for easy installation

LEARNING OUTCOMES:

Investigations into a variety of orifices over a range of flow rates, including:

- Determination of contraction and velocity coefficients
- Calculation of discharge coefficient
- Determination of actual discharge coefficient, and comparison with calculated values
- Determination of the various coefficients over a range of flow rates to demonstrate the influence of Reynolds number
- Study of the characteristics of different orifices, using a set of four circular orifices (nozzles). Each has the same minimum throat diameter but a different length. Each has a different approach and discharge section. Also included are additional square and triangular orifices.

Water flows from the hydraulic bench and into the cylindrical tank through an adjustable diffuser. The flow rate and an overflow pipe set the water level. To change the level in the tank (and so the head on the orifice), students adjust the flow to the diffuser. Water leaves the tank through the orifice. The jet that leaves the orifice discharges back into the hydraulic bench. The equipment is supplied with a set of interchangeable orifices (nozzles).

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Jet Trajectory and Orifice Flow (H33) 106

SHOWN FITTED TO THE DIGITAL HYDRAULIC BENCH (H1F) - AVAILABLE SEPARATELY

IMPACT OF A JET

H8

Investigates the force generated by a jet striking plates (representing turbine vanes) to aid in the understanding of how turbines work.

- Includes flat and hemispherical plates
- Extra angled and conical plates
- Ideal for demonstrations as well as in-depth experiments
- Works with TecQuipment's Digital Hydraulic Bench for easy installation

120-DEGREE CONICAL PLATE AND 30-DEGREE ANGLED PLATE

LEARNING OUTCOMES:

Measurement of the impact force and comparison with momentum change of four different plates:

- Flat plate
- Hemispherical plate
- Inclined flat plate
- 120-degree conical plate
- 30-degree angled plate

The Impact of a Jet apparatus demonstrates the force produced by a jet of water as it strikes a flat plate or hemispherical cup, which can be compared to the momentum flow rate in the jet. To extend the range of investigations, the 120-degree conical plate and 30-degree angled plate are included.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Pelton Turbine (H19) 127
- Pelton Wheel (Turbine) (MFP101b) 137

UPGRADE YOUR HYDRAULIC BENCH

Using a TecQuipment Gravimetric or Volumetric Hydraulic Bench? It can now be upgraded to include an electronic flow measurement instrument, offering the convenience of the electronic flowmeter display currently found on the **DIGITAL HYDRAULIC BENCH** (H1F).

FEATURES:

- Instant display of flow rate in $l.min^{-1}$ and $l.s^{-1}$
- Comprehensive assembly instructions and drilling templates supplied

BENEFITS:

- Significant time savings for experiments: for example, save 25 minutes for Bernoulli's theorem (H5) experiment
- Purchase from maintenance budget

JET TRAJECTORY AND ORIFICE FLOW

H33

Demonstrates vertical flow and horizontal jet trajectory through different orifices (nozzles) and allows students to study the trajectory profiles of water jets from the nozzles when mounted horizontally.

- Determination of the contraction and velocity coefficients
- Calculation of the discharge coefficient
- Determination of the actual discharge coefficient by measurement of flow rate
- Demonstrates the influence of Reynolds number
- Determination of discharge characteristics (jet trajectory) for an orifice mounted in the side of a vertical tank

With this apparatus students can measure the decrease in flow, contraction of the stream and energy loss as water discharges from four vertically mounted, interchangeable nozzles with different orifice designs.

It works with the Digital Hydraulic Bench (H1F, available separately) and stands on the bench worktop.

SHOWN WITH THE DIGITAL HYDRAULIC BENCH (HIF) - AVAILABLE SEPARATELY

LEARNING OUTCOMES:

- Determination of the contraction and velocity coefficients
- Calculation of the discharge coefficient
- Determination of the actual discharge coefficient by measurement of flow rate
- Demonstrates the influence of Reynolds number
- Determination of discharge characteristics (jet trajectory) for an orifice mounted in the side of a vertical tank

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Flow Through an Orifice (H4) 104

VORTEX APPARATUS

H13

Demonstrates the phenomena of free and fixed vortices with measuring devices for calculating the water surface profile.

SHOWN WITH THE DIGITAL HYDRAULIC BENCH (H1F) – AVAILABLE SEPARATELY

- Transparent vessel – users can see the vortices from all angles
- Includes a traverse probe to measure water surface profile
- Low-voltage variable speed motor for safety
- Ideal for classroom demonstrations as well as laboratory experiments
- Works with TecQuipment's Digital Hydraulic Bench (H1F)

FULL SPECIFICATION DATASHEETS

Datasheets contain full specifications such as size, weight, noise output, fluid capacity, voltage requirements etc. Download from each individual product webpage.

TECQUIPMENT.COM (search product)

LEARNING OUTCOMES:

- Determination of the surface profile of a forced vortex
- Determination of the surface profile of a free vortex
- Determination of the total head variation in a forced vortex
- Comparison of results with theoretical predictions

A transparent vessel on a support frame mounts on a TecQuipment Digital Hydraulic Bench (H1F, available separately). A low-voltage, variable-speed motor rotates the vessel about its vertical axis and a speed-control unit controls the speed of rotation.

To produce a forced vortex, students add water to the rotating vessel until it is about half full. A forced vortex forms. After a few minutes the vortex becomes constant, and students can measure the surface profile using the traverse probe.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

CAVITATION IN A VENTURI

H400

A floor-standing, self-contained apparatus to demonstrate and observe the basic principles of cavitation and its implications on the performance of hydraulic machines and systems.

- Also allows practical and effective study of flow and pressure in a Venturi meter
- Ideal for classroom demonstrations and student experiments
- Fully self-contained recirculating apparatus – no additional water supply needed
- Includes full instrumentation, for pressure, flow and temperature measurement

CAVITATION IN THE VENTURI

LEARNING OUTCOMES:

Investigations into cavitation and the Venturi, including:

- Flow and pressure in the Venturi
- Demonstrations of cavitation
- How to predict the onset of cavitation
- Study of upstream and throat pressures

The apparatus is a self-contained, mobile unit. It consists of a robust frame which holds a water tank (or reservoir), an electric pump, a flow-control valve, a flow meter and a Venturi.

RECOMMENDED ANCILLARIES:

- Stroboscope (ST1) 303

HELE-SHAW APPARATUS

H9

A bench-mounted apparatus to demonstrate two-dimensional laminar flow around differently shaped models, allowing the study of various source and sink arrangements.

- Visually effective demonstration of a wide variety of flow patterns around different shapes
- Models easily cut from sheet (included) – almost any shape possible
- Ideal introduction to incompressible potential flow (aerodynamics)
- Source and sink points provided
- Can demonstrate soil seepage problems

The apparatus works with a steady, air-free water supply and suitable drain. It consists of a channel, formed between two plates, where water flows at a low Reynolds number. A dye flowing through several small holes at the upstream end produces streamlines. To perform experiments, students start the water flow and open a dye valve just enough to produce easily visible streamlines. They then use valves to allow water to flow from a source point or drain into a sink point, or various combinations of flow or sink points.

LEARNING OUTCOMES:

Various flow visualisation experiments in two dimensions, including sink and source points and flow around models, for example:

- Sources and sinks in a uniform stream
- Doublet in a uniform stream
- Flow around a cylinder (disc) and an aerofoil
- Flow through an orifice and a diffuser
- Flow through a heat exchanger
- The momentum equation
- Laminar flow relationship for flow between two parallel plates
- Mean velocity equations (including seepage in soils)
- Potential flow relationships
- Allows lecturers to represent flow in other branches of engineering, such as aerodynamics or electricity and heat flow

RECOMMENDED ANCILLARIES:

- Header Tank (H9a) – A wall-mounted tank with a float valve, overflow and a flow-control valve and pipework

ALTERNATIVE PRODUCTS:

- Flow Visualisation (FC15) 92
- Flow Through an Orifice (H4) 104

PIPE SURGE AND WATER HAMMER

VDAS® H405

A self-contained unit for teaching the transient effects of pipe surge and water hammer caused by sudden flow rate changes in pipes.

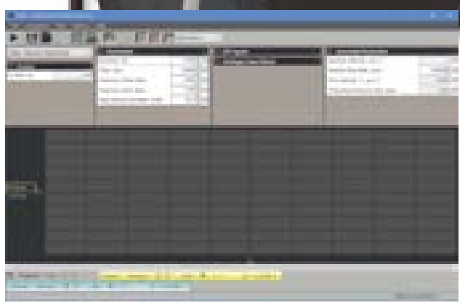
SHOWN WITH A HYDRAULIC BENCH AND VDAS®

- Multiple pipes and valves provide two different experiments in one product
- Two pressure sensors in the water hammer test pipe help calculate velocity of sound in pipes
- Transparent surge tower so students can see what is happening
- Works with TecQuipment's VDAS® for real-time display of the pressure surges and acoustic waves

LEARNING OUTCOMES:

Investigations into the transient effects of pipe surge and water hammer caused by changing flow rates in pipes including:

- Demonstration and analysis of pipe surge
- Demonstration and analysis of water hammer
- Determination of frictional head loss between reservoir and surge tower
- Determination of pressure profiles
- Determination of velocity of sound in the test pipe



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

The apparatus has two separate test pipes: one for water hammer investigations and one for surge investigations. A header tank supplies both test pipes, and includes an internal overflow weir to keep a constant head.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – bench-mounted version (VDAS-B) 299

NOTE: This equipment needs the latest VDAS® and will not work with early versions of VDAS®. Contact TecQuipment or your local agent if unsure.

ALTERNATIVE PRODUCTS:

- Water Hammer Apparatus (TE86) 111

WATER HAMMER APPARATUS

TE86

Demonstrates water hammer and cavitation and the propagation of shock waves at sonic velocity in water.

- Illustrates the propagation of shock waves at sonic velocity in water
- Demonstrates how to calibrate an electronic pressure transducer
- Includes an electric valve to stop flow instantly
- Contains over 60 m of pipe in one compact unit to save space
- Includes mechanical and electronic pressure measurement
- Includes connectors for extra (optional) equipment for transient measurements

LEARNING OUTCOMES:

- Water hammer
- Propagation of shock waves in water
- Velocity of sound in a water filled pipe
- Transducer calibration

The apparatus is made up of a coil of copper pipe 60 m long. The inlet connects to a water supply and the discharge end has a solenoid valve.

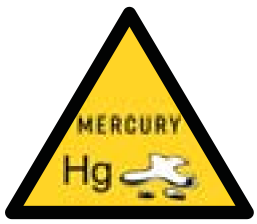
ESSENTIAL ANCILLARIES:

- Dual Beam Storage Oscilloscope (H405a) 303

ALTERNATIVE PRODUCTS:

- Pipe Surge and Water Hammer (H405) 110

UPGRADE YOUR KIT



Upgrade mercury-filled older generation TecQuipment **LOSSES IN PIPING SYSTEMS** (H16) and **FRICTION LOSS IN A PIPE** (H7) with upgrade kits (H16x and H7x) – eliminate the use of mercury.

FEATURES:

- Easy to use with quick-connect couplings
- Electronic pressure measuring instrument specification:
  - – Range 0-2 bar
  - – Accuracy 0.15% rdg + 0.1 fs + digit

BENEFITS:

- Health and safety – eliminates the use of mercury, which is widely prohibited from use in the teaching laboratory
- Improved accuracy
- Purchase from maintenance budget

OPEN CHANNEL FLOW EQUIPMENT AT THE UNIVERSITY OF DERBY

Reliability, expansive functionality, customer service and competitive price were the main reasons why the University of Derby chose to invest in a sizeable piece of fluid mechanics equipment from TecQuipment.

EXPANDING FACILITIES

With the completion of the University of Derby's STEM (science, technology, engineering and maths) centre, the academic team were very keen on expanding their fluid mechanics and hydraulics capabilities. They turned to the engineering education equipment market to source a large flow channel that would be accurate, provide excellent visualisation of flow channel characteristics, while also being flexible enough to perform a wide range of experiments for undergraduate and postgraduate study and research. The limited space available within the newly built STEM centre meant that the challenge was on to deliver a ten-metre flow channel that would fit in between pillars with a relatively low ceiling, while still enabling students to move around the apparatus.

REDUCING EXPERIMENT TIME WHILE INCREASING DEPTH OF STUDY

TecQuipment offers a range of flume/flow channel lengths and widths to suit the space available and learning outcomes required: from the narrower channels of 50 mm width and 2.5 metres long, through to the wider 300 mm width channels available in 2.5 metre steps between five metres and 15 metres.

It was the wider 300 mm flume/flow channel in ten metres (FC300-10) that the University of Derby selected for their fluids laboratory. Not only was this equipment larger than their existing flow channel, and therefore made it easier to see the specific phenomena such as hydraulic jump, it also had much more advanced measurement functionality. That functionality, coupled with TecQuipment's Versatile Data Acquisition System (VDAS®) connected to a 32-way pressure display unit, allowed for more in-depth study and research. Mathew Whomsley, Technical Instructor at the University of Derby, commented: "The addition of VDAS® also meant that the experiments could be performed much more quickly, taking a fraction of the time it would have done previously."

THE SPACE CHALLENGE

The limited physical size of the room with its various pillars and low ceiling was a point of concern for the team at the University of Derby.

"One of the biggest constraints in our original specification was the space constraints in the room. TecQuipment was exemplary when dealing with this, by conducting a site survey of the space and having discussions about key dimensions within the room, such as columns. TecQuipment subsequently provided the university with floor plans and 3D views of the flume within the room, to give us peace of mind that the equipment will be useable within our space requirements," explained Whomsley.

RETURNING TIME AND TIME AGAIN

The University of Derby already had a range of TecQuipment products within their engineering department and were confident in the quality of the products and ongoing customer support available, which contributed to the decision to select TecQuipment over other equipment providers.

Summarising, Whomsley explained: "Overall, our excellent history with TecQuipment is the reason we continue to purchase equipment through them. Their team is always friendly, helpful, and they offer good equipment at a reasonable price."

THE UNIVERSITY OF DERBY CLIMBS THE LEAGUE TABLES

The University of Derby has recently gained a significant increase in credibility, particularly among universities offering mechanical engineering undergraduate and postgraduate degrees within the UK, ranking 18th in the 2019 Guardian University League Tables. In another league table offered by the Times, they are ranked the 13th best university in the UK for teaching quality.

In addition, the team at the University of Derby has a mission-focused outlook that aims to continue to attract well-motivated undergraduate and postgraduate civil engineering students, and prepare them for work within the growing water sector, offering a full range of courses in civil engineering, i.e. MEng, MSc, BEng and BSc.

A PROFESSIONAL AND KNOWLEDGEABLE TEAM

"The experience throughout the whole process of buying the flume from TecQuipment has been very good. From when the order of the flume went in, we were given regular updates on the progress of the flume, alongside reliable delivery schedules. During the installation and induction, the team were professional and knowledgeable on both the practical and theoretical aspects of the flume," explained Whomsley.

"TecQuipment are well established as a provider of innovative and well developed science and technology equipment to the education sector, and having previous experience of the services offered and their reliability, then as a local supplier, TecQuipment fits our needs. Installation of the equipment went smoothly, including thoughtful and dedicated induction for both technicians and academics; the example experiments including example data are particularly useful. To date, the FC300 flume/flow channel has been very effective in contributing to our objectives."

2.5-METRE FLOW CHANNEL

FC50-2.5

Demonstrates flow around weirs and other objects in an open channel. Supplied with all the models and instrumentation required for a complete package in flow channel investigations.

SHOWN WITH THE DIGITAL HYDRAULIC BENCH (H1F) – AVAILABLE SEPARATELY

FLOW OVER BROAD CRESTED WEIR

- Inclinable acrylic channel providing maximum flow visualisation
- Inlet includes baffle section to provide steady flow conditions
- Works with TecQuipment's Digital Hydraulic Bench (H1F) for easy installation
- Includes:
  - Broad-crested weir
  - Sluice gate (undershot weir)
  - Venturi flume
  - Sharp-crested weir
  - Cylindrical gate
  - Crump weir
  - Instrument level gauge
  - Pitot tube

The apparatus consists of a floor-standing 2.5-metre, 53 mm wide flow channel, together with various gates, weirs and blocks, enabling the phenomena of flow channels to be easily demonstrated and studied. The FC50 is TecQuipment's most compact flume, providing simple installation and flexible storage in the laboratory.

LEARNING OUTCOMES:

- Study of sluice and drum gates including investigation into hydraulic jump, specific energy and the determination of discharge coefficient
- Study of submerged narrow-crested and crump weirs revealing the relationship between head over a weir and discharge
- Study of a broad-crested weir (by combining the square and radius jump blocks) and the effects of changing the profile of the weir
- Study of uniform flow in an inclined channel with investigations into the Chézy factor and coefficient
- Study of a Venturi flume to indicate the discharge and surface profile, thus the derivation of the discharge coefficient

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ALTERNATIVE PRODUCTS:

- Sediment Transport Channels (FC80) 115
- Flow Channels (FC300) 117

FLOW AND SEDIMENT TRANSPORT CHANNELS

FC80 (2.5 AND 5)

Open channel flumes that provide students with the ability to study the varying effects of sediment transport, bedform dynamics and fluid flow in an open channel.

2.5-METRE SEDIMENT TRANSPORT CHANNEL

- Includes four models with the flume for comprehensive experimentation options
- Digital flowmeter for quick and accurate measurements
- Transparent sides for clear visibility, ideal for group demonstrations
- Stainless steel beam and toughened glass channel walls, provides long-lasting use with sedimentation
- Built-in recirculating water supply for convenient laboratory use
- Includes two bags of graded sand for sediment experiments, e.g. bed form development or scour

SUBCRITICAL AND CRITICAL FLOW PAST A PIER

ALTERNATIVE PRODUCTS:

- 2.5-Metre Flow Channel (FC50-2.5) 114
- Flow Channels (FC300) 117

The FC80 Flow and Sediment Transport Channel working sections are 80 mm in width and 247 mm deep. They are available in 2.5 metre and 5 metre lengths. Each flume has a built-in recirculating water supply connected to a digital flowmeter for accurate measurements during experimentation.

The models included with each flume are:

- Broad-crested weir
- Sharp-crested weir
- Venturi flume
- Sluice gate

BROAD-CRESTED WEIR

LEARNING OUTCOMES:

- Investigations in fixed and smooth bedform
- Mechanics of sediment transport
- Local (bridge) scour experiments, to understand scour holes and effects on the integrity of a structure
- Sluice gate for investigations into hydraulic jump, specific energy and the determination of discharge coefficient
- Submerged sharp-crested weir reveals the relationship between head over a weir and discharge
- A broad-crested weir and the effects of changing the profile of the weir
- Uniform flow in an inclined channel with investigations into the Chezy factor and coefficient
- A Venturi flume to indicate the discharge and surface profile, thus the derivation of the discharge coefficient

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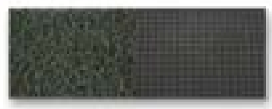
FLOW AND SEDIMENT TRANSPORT CHANNELS (FC80) CONTINUED FROM PREVIOUS PAGE

5-METRE SEDIMENT TRANSPORT CHANNEL

FLOW UNDER A SLUICE GATE

RECOMMENDED ANCILLARIES:

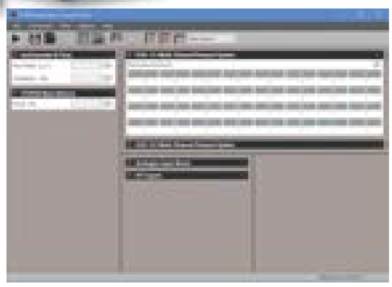
OPTIONAL MODELS:

			
DRUM GATE FC80A	RADIAL SECTOR GATE FC80B	CRUMP WEIR FC80D	DAM SPILLWAY FC80E
			
STREAMLINED HUMP FC80G	PARSHALL FLUME - REQUIRES VENTURI SIDES (INCL) FC80H	BRIDGE PIERS - CYLINDER, ROUND, SQUARE, SHARP NOSE FC80J	ROUGHENED BED FC80K
			
WAVE GENERATOR AND BEACH FC80N	SIPHON SPILLWAY FC80L	CULVERT MODEL FC80P	FLOW SPLITTER FC80V

FLOW CHANNELS

VDAS® FC300

Large open channel flumes that provide the opportunity for advanced research and student study on a wide range of fluid flow topics. Select a length (5 to 15 m) to suit needs and the space available.



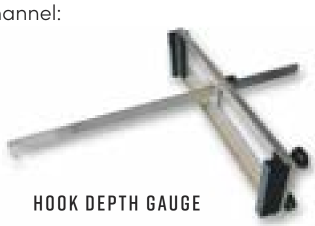
SCREENSHOT OF THE VDAS® SOFTWARE

- Digital data acquisition for quick and accurate measurements
- Transparent sides for clear visibility – ideal for group demonstrations
- Stainless-steel channel base plate and toughened-glass channel walls provide long-lasting use
- Built-in re-circulating water supply for convenient laboratory use
- Bed plate pressure tappings at 0.25-metre intervals, providing detailed analysis potential

The FC300 series flume working sections are 300 mm in width and 450 mm deep. They come in 2.5-metre sections and are available in 5-metre, 7.5-metre, 10-metre, 12.5-metre and 15-metre lengths.

Included with the flow channel:

- Sluice gate
- Level gauges
- Pitot tube
- Sharp-crested weir
- Powered end gate



HOOK DEPTH GAUGE

ALTERNATIVE PRODUCTS:

- 2.5-Metre Flow Channel (FC50-2.5) 114
- Sediment Transport Channels (FC80) 115

LEARNING OUTCOMES:

- Sluice gate for investigations into hydraulic jump, specific energy and the determination of discharge coefficient
- Submerged sharp-crested weir reveals the relationship between head over a weir and discharge
- A broad-crested weir and the effects of changing the profile of the weir (optional ancillary)
- Uniform flow in an inclined channel with investigations into the Chezy factor and coefficient
- A Venturi flume to indicate the discharge and surface profile, thus the derivation of the discharge coefficient
- Further experimentation with additional optional models
- With the optional Sediment Loop (FC300sl) sediment transport, scouring, ripple and dune formation and similar studies can be performed

FC300 CONTROL BOX AND INSTRUMENT FRAME (SHOWN WITH VDAS® – INCLUDED)

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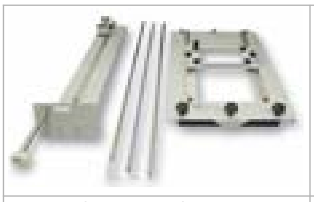
FLOW CHANNELS (FC300) CONTINUED FROM PREVIOUS PAGE

RECOMMENDED ANCILLARIES:

INSTRUMENTATION:


INSTRUMENT CARRIER
FC300IC


WATER VELOCITY METER
FC300X


MULTI-TUBE MANOMETER
FC300W


32-WAY PRESSURE DISPLAY
FCAI


DIGITAL INSTRUMENT CARRIER
FC300IC2

MODELS:


RADIAL GATE
FC300B

SLUICE GATE (UNDERSHOT WEIR)
FC300C

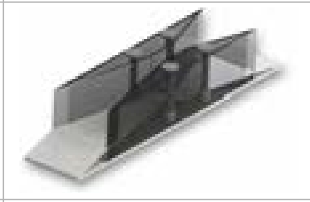

CRUMP WEIR
FC300D


DAM SPILLWAY
FC300E

OGEE WEIR WITH TAPPINGS
FC300E2


ENERGY DISSIPATION
FC300E3


VENTURI FLUME
FC300F


PARSHALL FLUME
FC300H


BRIDGE PIERS: CYLINDER, ROUND AND SHARP NOSE, SQUARE FC300J

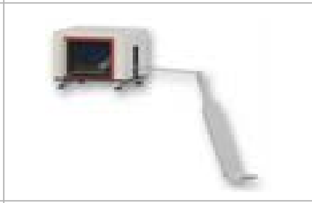

ROUGHENED BED FC300K
SAND FC300K2, TURF FC300K3


SIPHON SPILLWAY
FC300L


SELF REGULATING SIPHON
FC300L2


LIFT AND DRAG
FC300LD


VIBRATING PILES
FC300M


WAVE GENERATOR AND BEACH
FC300N


CULVERT MODEL
FC300P


RECTANGULAR AND V-NOTCH WEIRS
FC300Q


BROAD CRESTED WEIRS: SHARP AND STREAMLINED FC300R


TRAPEZOIDAL FLUME
FC300Z


SEDIMENT LOOP
FC300SL

METACENTRIC HEIGHT AND STABILITY

H2 MKII

A bench-mounted apparatus to determine the stability of a pontoon with its centre of gravity, metacentric height and metacentre at various heights.

- Full and accurate experimental analysis
- Ideal for classroom demonstrations
- Bench-mounted
- No services required
- Compact and requires minimal storage space

H2 MKII HULL AND SAIL

LEARNING OUTCOMES:

Determination of the metacentric height, and thus the metacentre, of a floating pontoon. This is by graphic analysis of the angles of tilt of the pontoon with various centres of gravity.

OPTIONAL VEE (HARD) CHINE AND HALF ROUND (ROUND BILGE) HULLS (H2A MKII)

The experiment consists of a rectangular pontoon floating in water. Plastic materials and corrosion-resistant finishes throughout the equipment give the fullest possible protection against corrosion.

RECOMMENDED ANCILLARIES:

- Vee (Hard) Chine and Half Round (Round Bilge) Hulls (H2a MkII)

ALTERNATIVE PRODUCTS:

- Hydrostatics and Properties of Fluids (H314) 121

CENTRE OF PRESSURE

H11

A pivoted, clear-plastic assembly which students use to find the centre of pressure of a totally or partially submerged plane surface. Compact, self-contained and excellent for classroom demonstrations.

- Compact and self-contained – just needs clean water
- Determines theoretical centre of pressure and compares actual and theoretical hydrostatic thrust
- Simple but accurate balance to measure moment due to hydrostatic thrust
- Tests a vertical and inclined plane surface

LEARNING OUTCOMES:

- Studying the relationship between hydrostatic force and head of water for a fully and partially submerged vertical and inclined plane
- Comparison of actual and theoretical hydrostatic force on a fully or partially submerged plane for any given head of water
- Theoretical calculation of the position of centre of pressure on a fully or partially submerged plane

The equipment consists of a vertical panel that holds a clear plastic quadrant, to which students add water. The plane works in either a vertical or inclined (angled) position. Students then compare their measurements with theoretical analysis.

ALTERNATIVE PRODUCTS:

- Hydrostatics and Properties of Fluids (H314) 121

METICULOUSLY PACKED

TecQuipment's dedicated packing department uses specialist equipment, custom-made transit crates and the most reliable global carriers to ensure products are delivered in perfect condition.

HYDROSTATICS AND PROPERTIES OF FLUIDS

H314

Self-contained, mobile unit for many experiments in fluid mechanics, from Archimedes' principle to the stability of a floating body.

- Wide range of experiments
- Determination of fluid properties including density, specific gravity, surface tension and viscosity
- Demonstration of hydrostatic principles, including Pascal's law, Archimedes' principle and determination of pressure at a point in a fluid
- Experiments cover study of buoyancy, flotation and stability of floating bodies, forces on a plane surface, centre of pressure, operation and calibration of a Bourdon pressure gauge and liquid column manometers

LEARNING OUTCOMES:

- Determination of fluid density and specific gravity
- Principles and use of a hydrometer
- Capillarity in tubes and between plates
- Measurement of viscosity by falling sphere method
- Demonstration of Pascal's law
- Measurement of fluid levels by Vernier hook gauge
- Fluid flow head relationship
- Verification of Archimedes' principle and demonstration of principles of flotation
- Stability of a floating body and determination of metacentric height
- Measurement of force and centre of pressure on a plane surface
- Operation and calibration of a Bourdon pressure gauge
- U-tube manometers with fluids of different density

CONTINUED ON NEXT PAGE

HYDROSTATICS AND PROPERTIES OF FLUIDS (H314) CONTINUED FROM PREVIOUS PAGE

The apparatus consists of a self-contained bench, complete with all necessary equipment for a wide range of demonstrations and experiments in hydrostatics and properties of fluids. Much of the equipment is rigidly mounted on the bench, the remainder being free-standing items suitable for use on the bench top.

RECOMMENDED ANCILLARIES:

- Surface Tension Balance (H314a)
- Hares Tube (H314b)

ALTERNATIVE PRODUCTS:

- Metacentric Height and Stability (H2 Mk II) 119
- Calibration of a Bourdon Pressure Gauge (H3a) 92
- Centre of Pressure (H11) 120
- Pressure Measurement Bench (H30) 96

SURFACE TENSION BALANCE (H314A)

HARES TUBE (H314B)

VISCOSITY AND PARTICLE DRAG

H410

Demonstrates the drag coefficient of different sized particles (spheres) and the viscosity of liquids.

- Chemically inert, high-quality clear-glass tube for use with water and other suitable fluids
- Safe, low-voltage backlighting so students can see the falling test spheres through dark fluids (low translucence)
- Includes test spheres of different sizes and densities to help match a range of test fluids
- Includes stopwatch and timing marks for accurate results

LEARNING OUTCOMES:

- Determination of the viscosity of different fluids
- Determination of the drag coefficient of various spheres

The self-standing Viscosity and Particle Drag apparatus is a simple falling-sphere viscometer. A back plate holds a glass tube filled with the test fluid.

ALTERNATIVE PRODUCTS:

- Osborne-Reynolds Apparatus (H215) 103

LIQUID SEDIMENTATION APPARATUS

H311

A self-contained, bench-mounting apparatus for studies into the settling characteristics of suspended solids and the display of wall effects.

- Finds settling characteristics and particle sizes of suspended solids
- Five identical sedimentation columns for comparison of different sediments
- Translucent rear panel with back lighting for better visibility
- Includes stopwatch, measuring beakers and specific gravity bottle

LEARNING OUTCOMES:

- Comparison of settling characteristics of different sediments
- Determination of the effect of concentration on settling characteristics (hindered settlement)
- Determination of velocity distribution curves
- Comparison of flocculent and particle suspensions
- Determination of particle size distribution (grading curve) by liquid sedimentation

The bench-mounted apparatus consists of five long, transparent sedimentation columns mounted on a rigid frame.

ALTERNATIVE PRODUCTS:

- Sediment Transport Channel (FC80) 115

DOWNLOAD POSTERS, SOFTWARE AND CATALOGUES

TecQuipment offers a wide range of digital content such as posters, brochures, catalogues, charts and software on the website.

TECQUIPMENT.COM/DOWNLOADS

PERMEABILITY, FLOW NETS AND DARCY'S LAW

H312

Demonstrates flow through permeable media with common structures, such as dams or walls.

- Dye-injector system to help demonstrate flow lines
- Clear plate glass resists abrasion and allows students to see flow patterns
- Includes pressure tappings and piezometer tubes to measure head distribution
- Plates supplied to simulate models of walls, sheet piling and dams
- Self-contained, floor-standing unit – only needs water supply and drain

The apparatus is a transparent-sided tank, mounted on a steel-framed bench with worktop. The tank is clear so students can see the flow patterns. The sides are plate glass to resist abrasion from the permeable medium. The rear of the tank contains pressure tappings with filters that stop any unwanted particles. The tappings connect to a bank of piezometer tubes at the side of the apparatus, which allows measurement of the head distribution along the tank.

RECOMMENDED ANCILLARIES:

- Permeable Medium (H312a) – Washed sand, graded 0.5 mm to 1.5 mm

LEARNING OUTCOMES:

- Determination of seepage beneath a structure
- Construction of flow nets and determination of coefficient of permeability
- Flow under a sheet pile and determination of critical seepage force at which 'piping' occurs
- Seepage flow under an impermeable dam
- Flow through an earth dam with and without a toe drain
- Drawdown in horizontal flow (simulation of groundwater flow into a river or well)
- Determination of uplift pressures on structures such as building foundations
- General studies of seepage and drainage
- Flow through a porous medium (Darcy's law)

HYDROLOGY AND RAINFALL APPARATUS

H313

For studying hydrology principles, including rainfall, through flow and movement of water over land and rivers.

- Permeable catchment area fed with 'rain' from overhead spray nozzles and/or by groundwater flow from ends of tank
- Spray nozzles to supply half or all of catchment area
- Can measure 'drawdown' due to single or two interacting wells
- Self-contained – requires only an electrical supply

The apparatus is a sturdy metal frame which holds a large rectangular stainless-steel tank (catchment area) and a reservoir tank. Students can fill the catchment area with a granular medium (not included) to form a permeable catchment area. A jacking mechanism allows adjustment of the angle of the catchment area. Above the catchment area is a frame that holds spray nozzles which simulate rainfall on the catchment. A valve selects all or half the nozzles. Students can use this facility to vary the lag time on a hydrograph, or to simulate a moving storm. At each end of the catchment area are end compartments, separated from the catchment by weir plates with porous 'port holes'. The port holes can be opened to drain water from the catchment area, or to supply water to it from the end compartments. In the middle of the catchment area are two 'wells' for experiments with water wells. A row of 20 tappings along the centre line of the catchment area allows the measuring of the water table profile. Each tapping has special slotted ends to stop the permeable media entering its pipe. The tappings connect to a bank of piezometer tubes at the front of the catchment area.

LEARNING OUTCOMES:

- Investigation of rainfall/run-off relationships for dry, saturated and impermeable catchments of various slopes (surface run-off only)
- Effect of interflow on outflow hydrograph surface run-off (plus groundwater flow)
- Simulation of multiple and moving storms
- Measurement of cone of depression for a single well, and comparison with theory interaction of cones of depression for two adjacent wells
- De-watering of excavation sites by use of wells
- Flow from a well in a confined aquifer
- Demonstration of watersheds for a simulated island with rainfall and well flows
- Sediment transport and meanders in simulated rivers
- Studies of scour around simulated bridge piers

RECOMMENDED ANCILLARIES:

- Permeable Medium (H313a) – Washed sand, graded 0.5 mm to 1.5 mm

FRANCIS TURBINE

H18

Demonstrates how a Francis turbine works and tests its performance.

- Mounts onto TecQuipment's Digital Hydraulic Bench (H1F) for flow measurement and easy installation
- Includes band brake to measure turbine torque
- Fully adjustable guide vanes with position indicator
- Includes pressure gauge to measure inlet pressure

LEARNING OUTCOMES:

- Efficiency of a Francis turbine
- Performance of a Francis turbine at different flow rates
- The effect of different guide vane settings on turbine performance

The turbine has a sturdy base which sits on the top of the hydraulic bench (H1F). The turbine connects to the pumped supply of the hydraulic bench. The bench measures the flow rate. A mechanical gauge measures the inlet pressure to the turbine. Adjustable guide vanes in the turbine alter the flow rate and direction of flow to the impeller (runner) of the turbine. The end of the turbine outlet tube (draft) sits in the recess in the top of the hydraulic bench.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

ESSENTIAL ANCILLARIES:

- Optical Tachometer (OT1) 303

RECOMMENDED ANCILLARIES:

- Stroboscope (ST1) 303

ALTERNATIVE PRODUCTS:

- Francis Turbine (MFP101d) 138
- Pelton Turbine (H19) 127

PELTON TURBINE

H19

A compact unit for demonstrations and performance tests on a Pelton turbine.

- Works with TecQuipment's Digital Hydraulic Bench for easy installation
- Includes dynamometer to load the turbine and help find the power absorbed (needs an optional tachometer to find speed)
- Includes inlet pressure gauge
- Screw-controlled spear valve for precise inlet flow control

LEARNING OUTCOMES:

- Performance charts of power, speed, torque and efficiency
- The effect of spear valve position

The product consists of a Pelton wheel mounted in a corrosion-resistant enclosure. A transparent front panel allows students to see the turbine working. An optional stroboscope (ST1, available separately) can 'freeze' the image of the turbine to help students better understand how it works. An adjustable spear valve directs a jet of water through a nozzle to the buckets of the Pelton wheel to make it turn. Manual adjustment of the spear valve controls the water jet from the nozzle.

ESSENTIAL BASE UNIT:

ESSENTIAL ANCILLARIES:

RECOMMENDED ANCILLARIES:

ALTERNATIVE PRODUCTS:

HYDRAULIC RAM PUMP

H31

Demonstrates the use of water hammer to create a pumping action.

- Works with TecQuipment's Digital Hydraulic Bench for easy installation
- Includes air vessel to reduce hydraulic shock
- Ideal for demonstrations to small groups of students
- Includes header tank and all necessary pipework

SHOWN WITH THE DIGITAL HYDRAULIC BENCH (H1F) - AVAILABLE SEPARATELY

LEARNING OUTCOMES:

- Demonstration of the water hammer effect to produce a pumping action

The ram pump is not a normal mechanically-operated pump. A column of water in the supply (drive) pipe from a header tank, moving at low velocity, is similar to a 'plunger'. The energy in the plunger forces water from the supply into a delivery pipe. This exchanges the momentum of a large amount of water into energy that pumps a smaller amount of water up a hill or gradient.

ESSENTIAL BASE UNIT:

- Digital Hydraulic Bench (H1F) 91

TECQUIPMENT BLOG

Read the TecQuipment blog for informative posts from topics focused on engineering education, through to guest posts from academics sharing view points and relevant teaching projects and perspectives.

TECQUIPMENT.COM/KNOWLEDGE

PUMPS AND TURBINES

FLUID MECHANICS

CENTRIFUGAL PUMP TEST SET

VDAS® H47

For a comprehensive range of investigations into the performance and characteristics of a centrifugal pump. Demonstrates cavitation and the use of a Venturi tube.

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

TEST SET WITH ANALOGUE PRESSURE MEASUREMENT, DIGITAL PRESSURE MEASUREMENT AND VERSATILE DATA ACQUISITION UNIT

- Pump has a transparent 'window' to allow students to see clearly its impeller, the water flow and cavitation
- Demonstrates how to use a Venturi meter and differential pressure measurement to find flow rate
- Optional stroboscope allows students to see clearly the effects of cavitation around the pump impeller
- Optional easy-to-read analogue instrumentation

LEARNING OUTCOMES:

Comprehensive demonstrations and investigations into a centrifugal pump including:

- Centrifugal pump performance and characteristics, typically head versus flow and efficiency versus flow
- Non-dimensional performance characteristics
- Flow measurement using a Venturi tube
- Demonstration of cavitation

CONTINUED ON NEXT PAGE

A motor mounted in bearings drives the pump. The pump draws water from the integral reservoir. The water travels up through a valve and filter, through an inlet valve to the pump body, then out through a delivery valve. It then passes through a Venturi meter and returns to the reservoir for re-use. This self-contained water supply keeps water consumption to a minimum. The pump has a transparent 'window' so students can see the impeller turning and how the water vapour bubbles form in the pump at cavitation. The optional stroboscope makes the effect easier to see.

CAVITATION DEMONSTRATION

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299
- Stroboscope (ST1) 303
- Analogue Pressure Display (AP1)
- Digital Pressure Display (DP1)

ALTERNATIVE PRODUCTS:

- Series and Parallel Pumps (H52) 131
- Two-Stage (Series and Parallel) Pumps (H83) 132
- Centrifugal Pump Module (MFP101) 135

DIGITAL PRESSURE DISPLAY (DP1)

SOCIAL MEDIA

Find out all the latest up-to-the-minute news, promotions, stories from users and videos etc.

Plus, embrace the opportunity to interact with other academics, students and get fresh ideas.

SERIES AND PARALLEL PUMPS NEW

H52

Bench-top test set that allows students to investigate the operation and performance of a single centrifugal pump and two centrifugal pumps in both series and parallel.

- Self-contained, compact, bench-top, easy-to-use test set for a range of experiments and demonstrations
- Easily configurable system to enable pumps to be tested individually, in series and in parallel, with a manually adjustable water flow rate
- Long-life, robust valves with large handles allow students to change the water circuit in seconds, ready for the next experiment
- Includes pressure gauges to measure intake and delivery pressures
- Discharge flow measurement

LEARNING OUTCOMES:

Comprehensive demonstration and investigation into a centrifugal pump including:

- Centrifugal pump performance and characteristics, typically: head versus flow and efficiency versus flow
- Operation of centrifugal pumps in series
- Operation of centrifugal pumps in parallel

The apparatus comprises two identical centrifugal pumps, together with two bearing-mounted motors driving each pump independently. The pumps draw water from the clear acrylic reservoir. The water travels through a series of valves to be delivered to a flow measurement device. The water then returns to the reservoir for re-use, keeping water use to a minimum.

ALTERNATIVE PRODUCTS:

- Centrifugal Pump Test Set (H47) 129
- Two-Stage (Series and Parallel) Pumps (H83) 132
- Centrifugal Pump Module (MFP101) 135

TWO-STAGE (SERIES AND PARALLEL) PUMPS

VDAS® H83

For a comprehensive range of investigations into the operation and characteristics of a single centrifugal pump, and two centrifugal pumps in both series and parallel.

TEST SET SHOWN WITH ALL INSTRUMENTATION OPTIONS AND VERSATILE DATA ACQUISITION SYSTEM

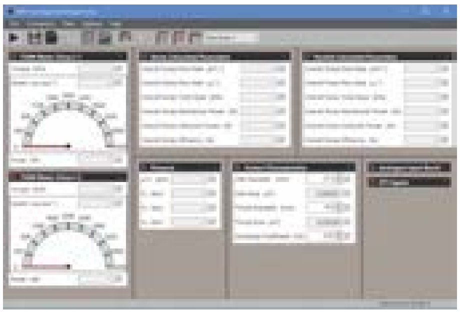
- Pumps have a transparent 'window' to clearly see the impellers, water flow and cavitation
- Pumps can be tested individually, in series and in parallel, with independent speed control
- Demonstrates how to use a Venturi meter and differential pressure measurement to find flow rate
- Optional stroboscope allows students to see clearly the effects of cavitation around a pump impeller
- Works with TecQuipment's Versatile Data Acquisition System (VDAS®) and software

LEARNING OUTCOMES:

Comprehensive demonstrations and investigations into a centrifugal pump including:

- Centrifugal pump performance and characteristics, typically head versus flow and efficiency versus flow
- Non-dimensional performance characteristics
- Flow measurement using a Venturi tube
- Demonstration of cavitation
- Operation of centrifugal pumps in series
- Operation of centrifugal pumps in parallel

Two bearing-mounted motors drive each pump independently. The pumps draw water from the integral reservoir. The water travels through strainers and a series of valves to be delivered to a Venturi meter. The water then returns to the reservoir for re-use, keeping water use to a minimum. The pumps each have a transparent 'window' so students can see the impeller turning and how the water vapour bubbles form in the pump at cavitation. The optional stroboscope makes the effect easier to see.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299
- Stroboscope (ST1) 303
- Analogue Pressure Display (AP2)
- Digital Pressure Display (DP1)

ALTERNATIVE PRODUCTS:

- Centrifugal Pump Test Set (H47) 129
- Series and Parallel Pumps (H52) 131
- Centrifugal Pump Module (MFP101) 135

SUBSONIC WIND TUNNEL (AF1600)

FREE VIBRATIONS (TM160 SERIES)

BENCH-TOP TENSILE TESTING MACHINE (SM1002)

2.5 METRE FLOW CHANNEL (FC50)

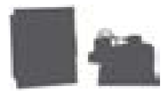
UNIVERSAL DYNAMOMETER

MFP100

Provides motive power with speed, torque and power measurements for TecQuipment's Modular Fluid Power range.

MODULAR SYSTEM

ESSENTIAL BASE UNIT (MFP100)



EXPERIMENT MODULES (MFP101–MFP107)

FEATURES:		BENEFITS:
Provides motive power to seven different experiment modules	→	Modular design saves space and reduces costs
Multiple electrical outlets for instruments	→	No need for extra power sockets and increases safety
Quick and easy transfer from one experiment module to another	→	Maximises experiment time
Direct drive	→	No belts or pulleys to adjust

A precision-machined base plate holds the motor and its sensors. The base plate has location points to give accurate and repeatable alignment onto each Fluid Power module. The coupling between the Universal Dynamometer and all Fluid Power machines is a jaw-type coupling with a rubber element. The Universal Dynamometer directly drives the Fluid Power machines. This means that the user has no need to fit or adjust the tension of belts and pulleys.

AVAILABLE EXPERIMENT MODULES:

CENTRIFUGAL PUMP MODULE

VDAS® MFP101

Allows students to study and perform tests on a centrifugal pump and optional turbines, to understand how they work and calculate performance.

SHOWN FITTED WITH THE UNIVERSAL DYNAMOMETER (MFP100), TURBINE DYNAMOMETER AND A TURBINE

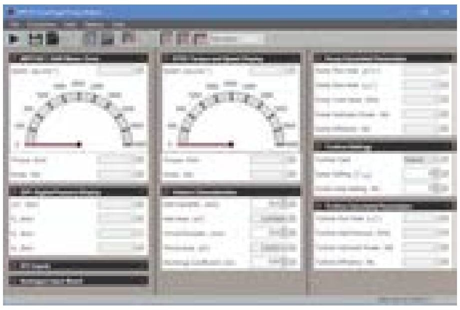
- Centrifugal pump mounted in mobile frame with full instrumentation
- Part of TecQuipment's Modular Fluid Power range which connects with the Universal Dynamometer (MFP100) as a common motive power source, for a cost-effective solution
- Inlet and delivery valves for wide range of operating conditions
- Turbine dynamometer and turbines (available separately) – propeller, Francis and Pelton

LEARNING OUTCOMES:

- Centrifugal pump performance and characteristics, typically head against flow and efficiency against flow
- Variation of pump performance with inlet pressure
- Variation of pump performance with speed
- Non-dimensional performance characteristics
- Flow measurement using a Venturi tube

CONTINUED ON NEXT PAGE

The module includes a centrifugal pump, a Venturi flowmeter, valves, a reservoir and instrumentation – all mounted on a robust, mobile trolley for ease of use. The separate Universal Dynamometer (MFP100) measures and displays the speed and torque of the pump to calculate and display mechanical (shaft) power. Electronic pressure transducers measure the pump inlet and delivery pressures and the Venturi differential pressure (flow rate). Speed is fully variable up to the maximum allowable for the pump.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

ESSENTIAL BASE UNIT:

- Universal Dynamometer (MFP100) 134

AVAILABLE EXPERIMENT MODULES:

- Pelton Wheel (Turbine) (MFP101b) 137
- Propeller Turbine (MFP101c) 138
- Francis Turbine (MFP101d) 138

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299
- Stroboscope (ST1) 303

ALTERNATIVE PRODUCTS:

- Centrifugal Pump Test Set (H47) 129
- Series and Parallel Pumps (H52) 131
- Two-Stage (Series and Parallel) Pumps (H83) 132

MODULAR FLUID POWER

FLUID MECHANICS

TURBINE DYNAMOMETER

VDAS® MFP101A

Dynamometer for the turbines of the Centrifugal Pump Module (MFP101).

- Dynamometer that fits on the Centrifugal Pump Module to test the optional turbines
- Electrically powered from outlets on the Universal Dynamometer motor drive
- Measures and displays torque, speed and shaft power
- Can connect to TecQuipment's Versatile Data Acquisition System (VDAS®)

The Turbine Dynamometer is required for tests on the optional turbines. It fits on the Centrifugal Pump Module (MFP101), near the outlet end of the centrifugal pump. Fit any of the three optional turbines to the Turbine Dynamometer. Each turbine has a brake drum that fits inside the dynamometer.

ANCILLARY FOR:

- Pelton Wheel (MFP101b) 137
- Propeller Turbine (MFP101c) 138
- Francis Turbine (MFP101d) 138

NOTE: Only one Turbine Dynamometer is needed to test all three turbines.

PELTON WHEEL (TURBINE)

MFP101B

Impulse turbine for use with the Centrifugal Pump Module (MFP101).

- Optional turbine that fits on the Turbine Dynamometer (MFP101a) of the Centrifugal Pump Module (MFP101)
- Impulse turbine
- Variable spear jet

LEARNING OUTCOMES:

- Variation of turbine performance with inlet pressure and flow rate
- Variation of turbine performance with speed
- Non-dimensional performance characteristics

The Pelton wheel has a large wheel or 'runner' that has 'buckets' (turbine blades) that absorb the energy in the water. The buckets are in pairs to correctly balance the wheel and to work efficiently. The Pelton wheel has a variable spear jet at its inlet. This allows students to understand the effect of changing the velocity of the water that hits the buckets. A clear viewing window on the side of the turbine allows students to see how the turbine works.

ESSENTIAL BASE UNIT:

- Centrifugal Pump Module (MFP101) 135
  (with Universal Dynamometer MFP100) 134

ESSENTIAL ANCILLARIES:

- Turbine Dynamometer (MFP101a) 136

ALTERNATIVE PRODUCTS:

- Impact of a Jet (H8) 105
- Pelton Turbine (H19) 127

PROPELLER TURBINE

MFP101C

Propeller turbine for use with the Centrifugal Pump Module (MFP101).

- Optional turbine that fits on the Turbine Dynamometer (MFP101a) of the Centrifugal Pump Module (MFP101)
- Inward flow reaction turbine
- Four-blade propeller
- Fully adjustable guide vanes

The turbine has adjustable guide vanes that control the water flow in the turbine. They also direct the water at an angle to the back of the propeller. Students learn how the guide vane setting affects how the turbine works. The turbine has a clear viewing window around the guide vanes and a clear draft tube so that students can see the turbine working.

LEARNING OUTCOMES:

- Variation of turbine performance with inlet pressure and flow rate
- Variation of turbine performance with speed
- Non-dimensional performance characteristics

ESSENTIAL BASE UNIT:

- Centrifugal Pump Module (MFP101) 135
  (with Universal Dynamometer MFP100) 134

ESSENTIAL ANCILLARIES:

- Turbine Dynamometer (MFP101a) 136

FRANCIS TURBINE

MFP101D

Reaction turbine for use with the Centrifugal Pump Module (MFP101).

- Optional turbine that fits on the Turbine Dynamometer (MFP101a) of the Centrifugal Pump Module (MFP101)
- Reaction turbine
- Ten-blade runner
- Fully adjustable guide vanes

LEARNING OUTCOMES:

- Variation of turbine performance with inlet pressure and flow rate
- Variation of turbine performance with speed
- Non-dimensional performance characteristics

The turbine has adjustable guide vanes that control the water flow in the turbine. They also direct the water at an angle to the blades of the impeller. Students learn how the guide vane setting affects how the turbine works. The turbine has a clear viewing window and draft tube so that students can see the turbine working.

ESSENTIAL BASE UNIT:

- Centrifugal Pump Module (MFP101) 135
  (with Universal Dynamometer MFP100) 134

ESSENTIAL ANCILLARIES:

- Turbine Dynamometer (MFP101a) 136

ALTERNATIVE PRODUCTS:

- Francis Turbine (H18) 126

AXIAL FLOW PUMP MODULE

VDAS® MFP102

Allows students to study and perform tests on an axial flow pump, to understand how it works and calculate its performance.

SHOWN FITTED WITH THE UNIVERSAL DYNAMOMETER (MFP100)

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Axial flow pump, mounted in a mobile frame with full instrumentation, including a digital pressure display
- Self-contained – has its own water reservoir and needs no external water supply
- Part of TecQuipment's Modular Fluid Power range which connects with the Universal Dynamometer (MFP100) as a common motive-power source for a cost-effective solution
- Connection plate with schematic diagram shows the water flow circuit and how parts of the module connect to each other

LEARNING OUTCOMES:

- Variation of pump performance with speed
- Variation of pump performance with different outlet pressures and flow rate
- Non-dimensional performance curves
- Determination of the specific speed of the pump

The pump fitted to this module has two sections - one fixed and one moving, each with a set of blades. Water moves from a water tank through a calibrated nozzle. It then passes through the pump and down to a fully adjustable delivery valve. It then returns to the water tank. The delivery valve allows the user to gradually shut the downstream water flow for a range of pump performance tests.

ESSENTIAL BASE UNIT:

- Universal Dynamometer (MFP100) 134

RECOMMENDED ANCILLARIES:

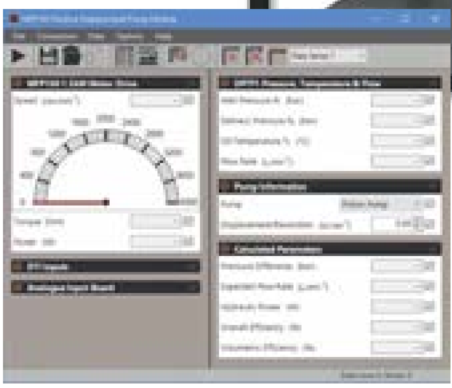
- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

POSITIVE DISPLACEMENT PUMP MODULE

VDAS® MFP103

Allows students to study and perform tests on a range of positive displacement pumps, to understand how they work and calculate their performance.

SHOWN FITTED WITH THE UNIVERSAL DYNAMOMETER (MFP100) AND A PUMP



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Mobile pump-support module with full instrumentation
- Part of TecQuipment's Modular Fluid Power range which connects with the Universal Dynamometer (MFP100) as a common motive-power source for a cost-effective solution
- Allows students to study and test a range of popular positive displacement pumps (available separately)
- Connection plate with schematic diagram clearly shows oil flow circuit and how parts of the module connect to each other

The module consists of a mobile frame with an oil reservoir, a flowmeter, valves and instruments to measure pump performance. The flowmeter is a positive displacement unit, so that it still works correctly at any oil viscosity. Any of the optional pumps fit to the module. Two flexible, high-pressure pipes with quick-release, self-sealing connections connect the pump to the oil circuit.

AVAILABLE EXPERIMENT MODULES:

- Piston Pump (MFP103a) 141
- Gear Pump (MFP103b) 141
- Vane Pump (MFP103c) 142
- Swash Plate Pump (MFP103d) 142

NOTE: At least one of the optional pumps must be chosen to use with the Positive Displacement Pump Module. Tests or experiments cannot be performed without an optional pump.

ESSENTIAL BASE UNIT:

- Universal Dynamometer (MFP100) 134

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

PISTON PUMP

MFP103A

Piston pump for use with the Positive Displacement Pump Support Module (MFP103).

- Popular design, ideal for student experiments, demonstrations and projects
- Quick-release, self-sealing connections for simple and safe fitting
- Demonstrates the characteristics of a twin-piston pump

LEARNING OUTCOMES:

- Performance and characteristics of a piston pump
- Volumetric and overall efficiencies
- Use of an oval gear flowmeter

When two or more optional pumps are ordered:

- Comparison of positive displacement pumps (economy, flow rate and output pressure pulses)

The piston pump is a positive displacement pump. It has twin vertically-opposed pistons that deliver a given volume of fluid (oil) for each full rotation of the pump shaft.

ESSENTIAL BASE UNIT:

- Positive Displacement Pump Module (MFP103) 140
  (with Universal Dynamometer MFP100) 134

GEAR PUMP

MFP103B

Gear pump for use with the Positive Displacement Pump Support Module (MFP103).

- Popular design, ideal for student experiments, demonstrations and projects
- Quick-release, self-sealing connections for simple and safe fitting
- Demonstrates the characteristics of a gear pump

LEARNING OUTCOMES:

- Performance and characteristics of a gear pump
- Volumetric and overall efficiencies
- Use of an oval gear flowmeter

When two or more optional pumps are ordered:

- Comparison of positive displacement pumps (economy, flow rate and output pressure pulses)

The gear pump is a positive displacement pump. It has double gears that deliver a given volume of fluid (oil) for each full rotation of the pump shaft.

ESSENTIAL BASE UNIT:

- Positive Displacement Pump Module (MFP103) 140
  (with Universal Dynamometer MFP100) 134

VANE PUMP

MFP103C

Vane pump for use with the Positive Displacement Pump Support Module (MFP103).

- Popular design, ideal for student experiments, demonstrations and projects
- Quick-release, self-sealing connections for simple and safe fitting
- Demonstrates the characteristics of a vane pump

LEARNING OUTCOMES:

- Performance and characteristics of a vane pump
- Volumetric and overall efficiencies
- Use of an oval gear flowmeter

When two or more optional pumps are ordered:

- Comparison of positive displacement pumps (economy, flow rate and output pressure pulses)

The vane pump is a positive displacement pump. It has a fixed displacement balanced vane that delivers a given volume of fluid (oil) for each full rotation of the pump shaft.

ESSENTIAL BASE UNIT:

- Positive Displacement Pump Module (MFP103) 140
  (with Universal Dynamometer MFP100) 134

SWASH PLATE PUMP

MFP103D

Swash plate pump for use with the Positive Displacement Pump Support Module (MFP103).

- Popular design, ideal for student experiments, demonstrations and projects
- Quick-release, self-sealing connections for simple and safe fitting
- Demonstrates the characteristics of a swash plate pump

LEARNING OUTCOMES:

- Performance and characteristics of a swash plate pump
- Volumetric and overall efficiencies
- Use of an oval gear flowmeter

When two or more optional pumps are ordered:

- Comparison of positive displacement pumps (economy, flow rate and output pressure pulses)

The Swash Plate Pump is a positive displacement pump. It has a fixed displacement axial piston assembly that delivers a given volume of fluid (oil) for each full rotation of the pump shaft.

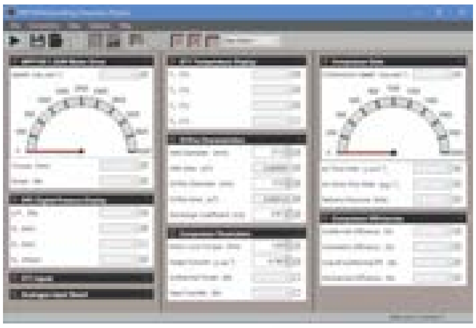
ESSENTIAL BASE UNIT:

- Positive Displacement Pump Module (MFP103) 140
  (with Universal Dynamometer MFP100) 134

RECIPROCATING COMPRESSOR MODULE

VDAS® MFP104

Allows students to study and perform tests on a reciprocating compressor, to understand how it works and calculate its performance.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Reciprocating compressor and air receiver mounted in a mobile frame with full instrumentation
- Allows students to study and test a popular fluid power machine
- Temperature and pressure measurements at key points in the system
- Connection plate with schematic diagram clearly shows how parts of the module connect together

LEARNING OUTCOMES:

- Energy balance for a compressor
- Variation of compressor performance with pressure
- Variation of compressor performance with speed
- Mechanical, volumetric and isothermal efficiencies
- Thermodynamics of a compressor

The module includes a small compressor with an air receiver and instrumentation, all mounted on a robust, mobile trolley for ease of use. Speed is fully variable up to the maximum allowable for the compressor. Air enters the compressor, which then delivers it under pressure to the receiver. A valve releases pressure from the receiver to atmosphere through an orifice. The valve sets the pressure in the receiver and hence the flow rate; the orifice allows an accurate measurement of the mass flow rate of the outlet air. These values help students to discover how the compressor flow rate relates to the pressure delivered by the compressor.

ESSENTIAL BASE UNIT:

- Universal Dynamometer (MFP100) 134

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

ALTERNATIVE PRODUCTS:

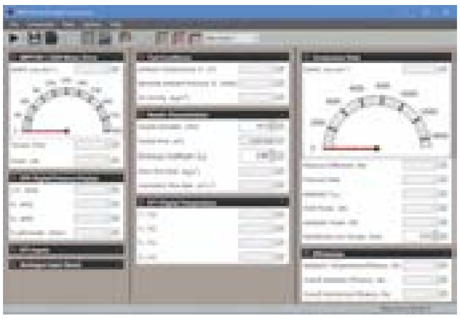
- Two-Stage Compressor Test Set (GT103) 268

CENTRIFUGAL COMPRESSOR MODULE

VDAS® MFP105

Allows students to study and perform tests on a centrifugal compressor, to understand how it works and calculate its performance.

- Centrifugal compressor, mounted in a mobile frame with full instrumentation
- Part of TecQuipment's Modular Fluid Power range that connects with the Universal Dynamometer (MFP100) as a common motive power source for a cost-effective solution
- Pressure and temperature measurements at key points in the system
- Connection plate with schematic diagram clearly shows the arrangement of the module



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

- Performance of a compressor
- Variation of compressor performance with speed
- Investigation of non-dimensional characteristics
- Comparison of performance with that of an ideal adiabatic system

The module consists of a compressor and instrumentation. Speed is fully variable up to the maximum allowable for the compressor. Air enters the compressor through a shaped nozzle, used to measure the air flow rate. The air then moves past a hand-operated delivery valve and out to atmosphere. The delivery valve controls the air flow rate (and therefore delivery pressure).

ESSENTIAL BASE UNIT:

- Universal Dynamometer (MFP100) 134

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

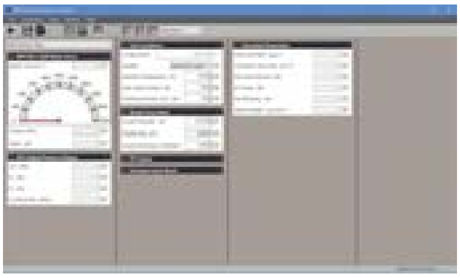
CENTRIFUGAL FAN MODULE

VDAS® MFP106

Allows students to study and perform tests on a centrifugal fan, to understand how it works and calculate its performance.

- Centrifugal fan, mounted in a mobile frame with full instrumentation
- Part of TecQuipment's Modular Fluid Power range that connects with the Universal Dynamometer (MFP100) as a common motive power source for a cost-effective solution
- Three interchangeable impellers provided as standard
- Optional Pipe Flow and Nozzle Kit for more experiments

SHOWN FITTED WITH THE UNIVERSAL DYNAMOMETER (MFP100)



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

The module consists of a fan and instrumentation. Speed is fully variable up to the maximum allowable for the fan. Air enters the fan through a shaped nozzle, used to measure the air flow rate. The air then moves past a slide valve and out to atmosphere. The slide valve controls the air flow rate (and therefore delivery pressure). The fan impeller (moving part) is interchangeable. Supplied with the fan are three different impellers for more tests on fan performance.

LEARNING OUTCOMES:

- Performance of a centrifugal fan
- Variation of fan performance with speed
- Variation of fan performance with type of impeller
- Non-dimensional performance curves
- Determination of the specific speed of the fan

ESSENTIAL BASE UNIT:

- Universal Dynamometer (MFP100) 134

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299
- Pipe Flow and Nozzle Kit (MFP106a) 146

PIPE FLOW AND NOZZLE KIT

MFP106A

Optional pipe flow and nozzle kit for use with the Centrifugal Fan Module (MFP106).

- Includes a multiway pressure display with additional instrument frame
- Includes different pipe fittings to compare losses in bends and elbows
- Axial probe and additional nozzle to find pressures along a nozzle
- Pitot traverse to find pressure profile and calculate theoretical flow
- Orifice plate to calculate theoretical flow and compare with the Pitot and standard nozzle measurement

LEARNING OUTCOMES:

- Axial pressure profile along a nozzle
- Velocity profile across a pipe
- Losses in straight pipes
- Losses in bends and elbows (fittings)
- Flow through an orifice

Optional Pipe Flow and Nozzle Kit for the Centrifugal Fan Module (MFP106). This kit includes two long lengths of smooth-walled pipe with multiple pressure tappings and a Pitot traverse. The pipes connect to the inlet of the MFP106 (the standard inlet nozzle is moved), so it becomes a suction fan for tests on the pipes. The pipe tappings connect to a multiway pressure display (supplied with the kit).

ANCILLARY FOR:

- Centrifugal Fan Module (MFP106) 145

DIGITAL DATASHEETS

Visit individual product pages on the TecQuipment website to view and download the digital datasheets.

TECQUIPMENT.COM

AXIAL FAN MODULE

VDAS® MFP107

Allows students to study and perform tests on an axial fan, to understand how it works and calculate its performance.

SHOWN FITTED WITH THE UNIVERSAL DYNAMOMETER (MFP100)

- Part of TecQuipment's Modular Fluid Power range which connects with the Universal Dynamometer (MFP100) as a common motive-power source for a cost-effective solution
- Multiple pressure measurement points along the fan duct allow students to examine a full range of performance characteristics
- Connection plate with schematic diagram clearly shows air flow circuit and how parts of the module connect to each other
- Traversing, calibrated Pitot tube allows investigations of velocity distribution

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

- Characteristics of an axial fan, including head against flow efficiency
- Relationship between power and speed (power law)
- Velocity distribution in a round duct
- Calibration of an inlet nozzle
- Duct resistance and matching to fan to find operating point

The module has an axial fan mounted in a cylindrical steel duct. Air enters the duct through an inlet nozzle. The pressure at a set of tappings just downstream of the nozzle allows calculation of the inlet air flow rate. A slide valve (downstream of the fan) controls flow rate and delivery pressure. Air exits the duct through a silencer to reduce noise in the laboratory.

ESSENTIAL BASE UNIT:

- Universal Dynamometer (MFP100) 134

RECOMMENDED ANCILLARIES:

- Pitot-Static Traverse – 450 mm (MFP107a) 148
- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

PITOT-STATIC TRAVERSE (450 MM)

VDAS® MFP107A

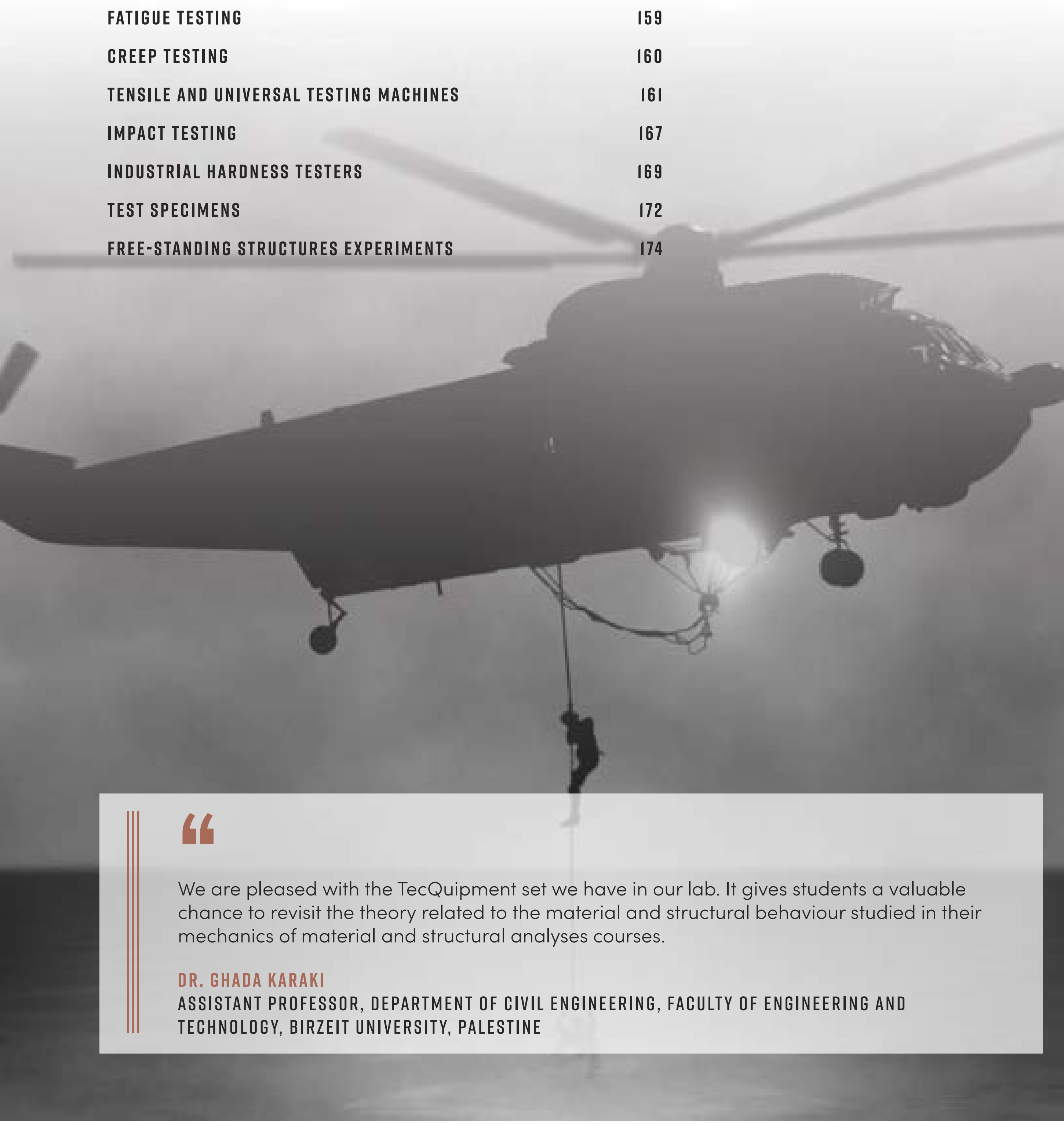
A traversing Pitot-static tube with electronic position measurement for use with TecQuipment's Axial Fan Module (MFP107)

The Pitot-Static Traverse allows students to find the velocity distribution across the duct of the Axial Fan Module (MFP107). This optional ancillary comprises a Pitot-static tube which fits on the duct of the Axial Fan Module and has a digital indicator to show the tube position across the duct.

ANCILLARY FOR:

- Axial Fan Module (MFP107) 147

MATERIALS TESTING AND PROPERTIES



"We are pleased with the TecQuipment set we have in our lab. It gives students a valuable chance to revisit the theory related to the material and structural behaviour studied in their mechanics of material and structural analyses courses.

DR. GHADA KARAKI
ASSISTANT PROFESSOR, DEPARTMENT OF CIVIL ENGINEERING, FACULTY OF ENGINEERING AND TECHNOLOGY, BIRZEIT UNIVERSITY, PALESTINE

MATERIALS TESTING AND PROPERTIES

The Materials Testing and Properties products offer a wide range of teaching equipment to demonstrate key materials' properties; they cover Hooke's law and Young's modulus associated with elastic properties, and stress/strain analysis. For more advanced learning, experiments available progress to hardness testing, complex analysis of stress and strain, testing specimens to destruction and various apparatus for learning about material fatigue.

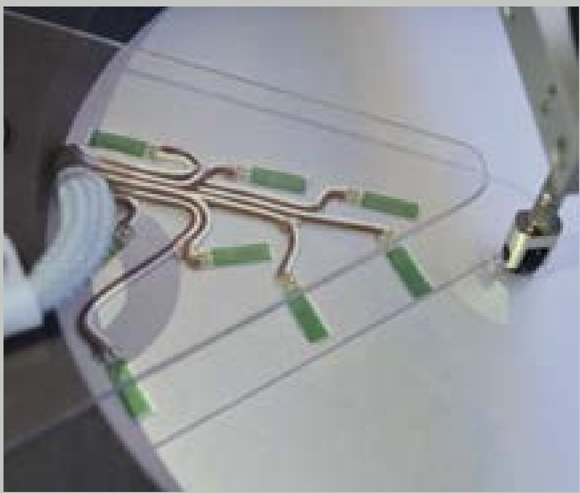
The range also extends into the area of structures and structural elements, providing supplementary products to the complete modular Structures range – **SEE PAGE 185**.

KEY FEATURES AND BENEFITS:

REFINED PRODUCTS: Meets the needs of a modern materials course.

BROAD AND PROGRESSIVE RANGE OF EXPERIMENTS: Teaches the fundamental principles, progressing to complex stress and strain analysis.

AUTOMATIC DATA ACQUISITION: Multiple and fast-changing measurements make data acquisition a valuable tool.



LOOK AT THE OTHER RANGES

The **STRUCTURES** (page 185) and **ENGINEERING SCIENCE** (page 5) ranges also include products that demonstrate how the choice of materials affects the performance of structural elements.

AUTOMATIC DATA ACQUISITION VDAS®

Many of the products in this range work with TecQuipment's unique Versatile Data Acquisition System (VDAS®) – **SEE PAGE 299**.

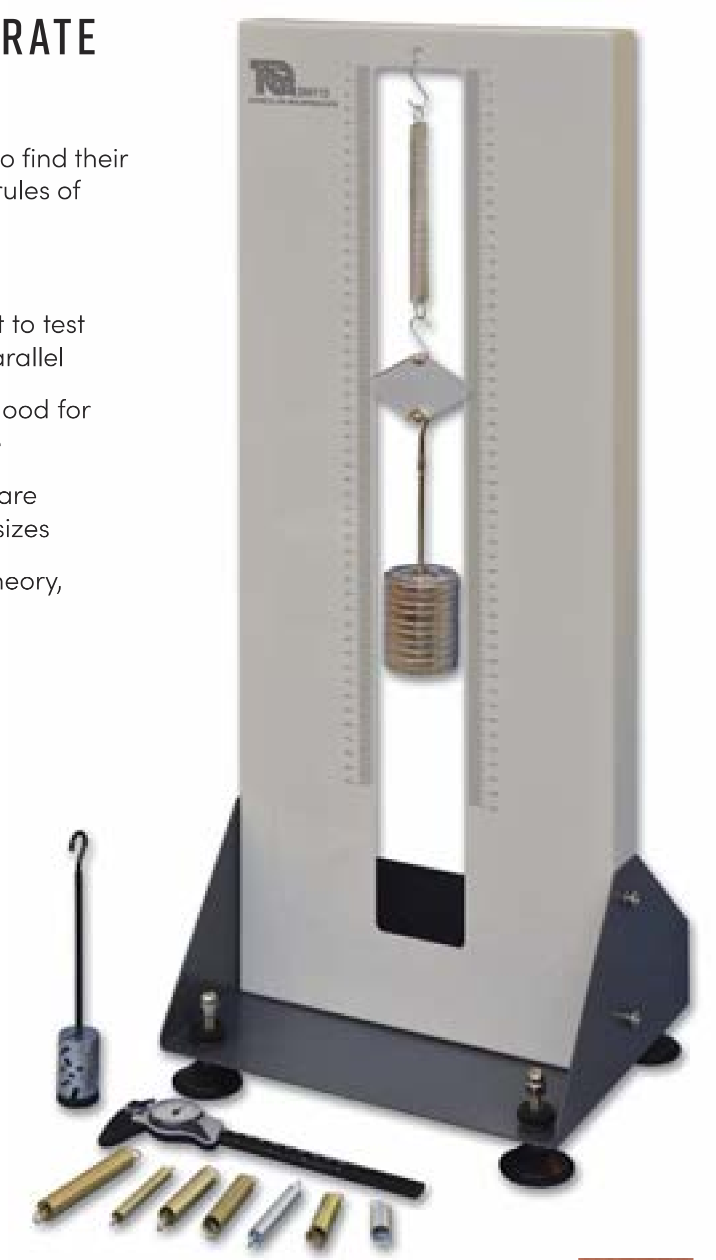
VDAS® ENABLED PRODUCTS	PAGE
Thin Cylinder (SM1007)	153
Diaphragm (SM1008)	154
Thick Cylinder (SM1011)	155
Strain Gauge Trainer (SM1009)	156
Digital Strain Display (SM1010)	157
Torsion Testing Machine–30 Nm (SM1001)	158
Rotating Fatigue Machine (SM1090)	159
Creep Machine (SM1006)	160
Bench-Top Tensile Testing Machine (SM1002)	161
Universal Testing Machine (SM1000)	163
Unsymmetrical Cantilever Apparatus (SM1003)	174
Beam Apparatus (SM1004)	175
Euler Buckling Apparatus (SM1005)	177

HOOKE'S LAW AND SPRING RATE

SM110

Bench-top apparatus tests extension springs to find their properties. Proves Hooke's law and the basic rules of spring design.

- Fundamental and accurate test instrument to test single springs and springs in series and parallel
- Tests springs and finds their properties – good for mechanical workshops and classroom use
- Includes a set of different springs to compare spring rates and effect of different spring sizes
- Supplied with user guide which includes theory, experiments and results



LEARNING OUTCOMES:

- Spring rate and Hooke's law
- To prove the basic rules of spring design
- Simple spring scale
- Springs in series
- Springs in parallel

The Spring Testing Apparatus uses a fundamental variable mass and scale measurement to test springs. It demonstrates how to find the properties of a spring and proves some basic laws of physics (Hooke's law, Newton's law and spring design rules). It is also a useful tool for a workshop, to check the properties of a spring before it is used, or after it has been used.

ALTERNATIVE PRODUCTS:

- Coil Spring (SM1000f) 165
- Spring Tester Kit (ES19) 14

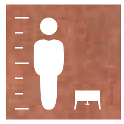
QUALITY CONTROL WITH IN-HOUSE PRODUCTION

To maintain high quality and keep lead times to a minimum, products are designed and manufactured all under one roof in the TecQuipment headquarters based in the UK.

STIFFNESS – BENDING AND TORSION

TE16

Compact, bench-mounted apparatus enabling a variety of investigations into material stiffness.



BASIC ELASTIC PROPERTIES

MATERIALS TESTING AND PROPERTIES

- Allows investigations into stiffness in bending of beams of different materials and cross-section
- Easy-to-use precision parts and instruments for accurate, repeatable and reliable results
- The standard TE16 kit includes test beams of different materials and cross-section
- Optional additional kits (TE16a and TE16b) available for experiments with different beam fixings (cantilever and encastré) and torsional stiffness experiments

A rigid metal frame supplied with two adjustable knife edges that work as simple supports for test beams. A linear scale allows accurate positioning of the knife edges. Also included are weights, a magnetic dial gauge, a set of different beams and a Vernier gauge.

RECOMMENDED ANCILLARIES:

- Additional Experimentation Kit (TE16a)
- Additional Torsion Testing Kit (TE16b)

LEARNING OUTCOMES:

STANDARD TE16 KIT:

- Investigation of the stiffness in bending of different materials of the same cross-section (Young's modulus/stiffness)
- Investigation of the stiffness of a single material with different cross-section geometries (second moment of area, or I value)

WHEN USED WITH THE OPTIONAL TE16A:

- Experiments to find the deflected shape of a beam and bending of a beam clamped at one end (a cantilever)
- Comparison of a simply supported beam, a cantilever and an encastré beam

WHEN USED WITH THE OPTIONAL TE16B:

- Experiments to find the relationship between angular deflection and the dimensional and material properties of rods and tubes (torsional stiffness)

ALTERNATIVE PRODUCTS:

- Beam and Leaf Spring (SM1000g) 165
- Beam Apparatus (SM1004) 175
- Deflection of Beams and Cantilevers (STR4) 202
- Continuous and Indeterminate Beams (STR13) 204
- Deflection of Beams and Cantilevers Kit (ES4) 11

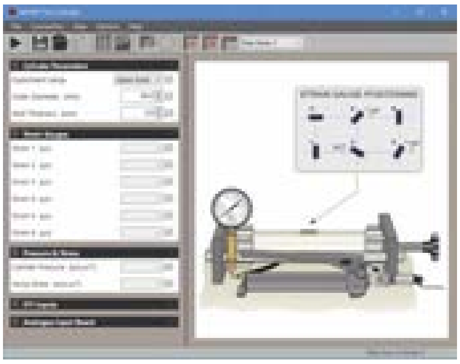
WHEN USED WITH THE ADDITIONAL TORSION TESTING KIT (TE16B):

- Torsion of Circular Sections Kit (ES5) 12
- Torsion Testing Machine – 30 Nm (SM1001) 158
- Torsion of Circular Sections (STR6) 211

THIN CYLINDER

VDAS® SM1007

Bench-mounted machine to allow students to perform stress and strain tests on a thin-walled cylinder.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

A thin-walled, oil-filled aluminium cylinder held in a robust frame so that the cylinder is free to move along its axis. The cylinder is stressed using a hydraulic hand-pump to pressurise the oil. Strain gauges on the cylinder surface measure strain, and a gauge and electronic sensor measure hydraulic pressure.

- Includes experiments to find Young's modulus and Poisson's ratio
- Closed-end and open-end conditions to allow circumferential or biaxial stress tests
- Includes built-in microprocessor-controlled display of strain measurements
- Self-contained, hand-operated hydraulic pressurising system for accurate pressure control

LEARNING OUTCOMES:

Investigations into stresses and strains in a thin cylinder, to give students an understanding of:

- Longitudinal stress, hoop (or circumferential) stress, radial stress and biaxial stress
- The behaviour of the cylinder under both open and closed-end conditions
- The use of strain gauges
- The stress/strain relationship and value of Young's modulus for the cylinder material
- Indirect strain and stress
- The value of Poisson's ratio for the cylinder material
- The use of Mohr's circle to calculate the shear strain at any position in the cylinder
- The use of the 'superposition method' to find the principal strains
- The effect of the biaxial stress system
- Sources of errors in experiments

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ALTERNATIVE PRODUCTS:

- Thick Cylinder (SM1011) 155

DIAPHRAGM

VDAS® SM1008

Bench-mounted machine to allow students to perform stress, strain and deflection tests on a diaphragm.

- Measurement of effect of pressure on surface profile of a diaphragm
- Measurement of circumferential and radial strains of a diaphragm under pressure
- Includes built-in microprocessor-controlled display of strain measurements
- Self-contained, hand-operated hydraulic pressurising system for accurate pressure control

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

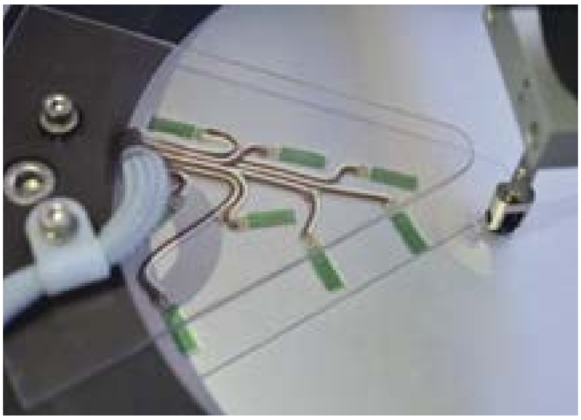
LEARNING OUTCOMES:

Experiments possible with this apparatus include the effect of pressure on:

- Surface profile – the results are presented as a non-dimensional curve
- Radial and circumferential strains
- Radial and circumferential strain gradients across the diaphragm

Experimental measurements are compared with theory. The student is encouraged to use their results to determine the accuracy of the location of the strain gauges.

The diaphragm is clamped at the edges and has eight strain gauges across its surface. The area beneath the diaphragm contains oil. A digital dial gauge can be traversed across the diaphragm to measure its surface profile. A hydraulic pump increases the pressure under the diaphragm.



RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

THICK CYLINDER

VDAS® SM1011

Bench-mounted machine to allow students to perform stress and strain tests on a thick-walled cylinder.

- For comprehensive analysis of the stresses and strains in a thick-walled cylinder, under internal pressure
- Experiment results compared with Lamé predictions
- Includes built-in microprocessor-controlled display of strain measurements
- Self-contained, hand-operated hydraulic pressurising system for accurate pressure control

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

- Radial and hoop strains throughout the cylinder wall
- Radial and hoop stress distribution in the wall
- Longitudinal stress and strain at the outer surface
- Circumferential stress and strains at the inner and outer surfaces
- Comparison with Lamé predictions
- Principal stresses and maximum shear stress
- Appraisal of accuracy of location of strain gauges

The apparatus consists of a thick-walled aluminium cylinder held in a frame. The cylinder is in two halves cemented together. One face of the joint has an eccentric shallow groove that contains ten strain gauges at precise radii and orientation. These gauges measure the radial and hoop strains. Jointing cement fills the groove. Strain gauges on the inner and outer walls of the cylinder measure longitudinal and circumferential strains. The cylinder is stressed using a hydraulic hand-pump.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ALTERNATIVE PRODUCTS:

- Thin Cylinder (SM1007) 153

STRAIN GAUGE TRAINER

VDAS® SM1009

Illustrates how resistance strain gauges work, and methods of measuring strains in different structures. Can be used to demonstrate Young's modulus and Poisson's ratio.

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Clear layout with printed graphics to help students understand how strain gauges work
- Includes electronic strain display to show all readings, and automatically calculates strain
- Fully open bridge connection, with dummy resistors to allow quarter, half and full-bridge connection, to demonstrate how strain bridge connections work
- Uses strain gauges on three different, popular structures for realistic experiments

The bending system uses gauges to measure direct tensile and compression strain. The torsion system shows the use of shear/torque strain gauges. The tension system shows the use of two gauges at right angles in a 'Tee' rosette.

LEARNING OUTCOMES:

- Introduction to the equipment and the different bridge connections (quarter, half and full-bridge)
- Strains and stresses in a bending system
- Strains and stresses in a torsion system
- Strains and stresses in a tension system, Poisson's ratio and Young's modulus
- Tensile strains and stresses in different materials (needs optional tensile specimens) and comparison of Poisson's ratio and Young's modulus
- Comparison of different strain measurement systems and how they could measure force

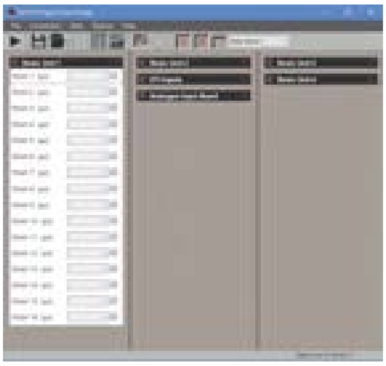
RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299
- Optional Tension Specimens (SM1009a) – Aluminium, brass and copper

DIGITAL STRAIN DISPLAY

VDAS® SM1010

A 16-channel instrument that connects to industry-standard strain gauges to give direct readings of strain.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Direct connections for half and full-strain bridge connections, with internal 'make-up' resistors
- Supplied with cable, self-locking connectors and a crimp tool to reduce connection problems
- Fully programmable to match most types of strain gauges and connections
- Ideal for use with TecQuipment's Strain Gauge Kit (E19)

The Digital Strain Display accepts up to 16 channels from strain gauges connected in quarter, half or full-bridge. The display is fully programmable to match the strain gauges and their bridge connections. The display includes precision internal 'make-up' resistors to work with half-bridge connections, if needed. Two channels include additional individually adjusted dynamic outputs. They can connect to suitable instruments, e.g. oscilloscope (not supplied).

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ANCILLARY FOR:

- Strain Gauge Kit (E19) 157

STRAIN GAUGE KIT

E19

Selection of resistance strain gauges and necessary accessories and consumable materials – for use with TecQuipment's SM1010 Digital Strain Display.

- All expendable items required for cementing gauges included
- Reduced risk of spillage of chemicals
- Refills available (E19a)
- Step-by-step instructions supplied
- Supplied in a PVC carrying case

RECOMMENDED ANCILLARIES:

- Digital Strain Display (SM1010) 157
- Refill Kit for E19 (E19a)

STRAIN GAUGE INSTRUMENTATION

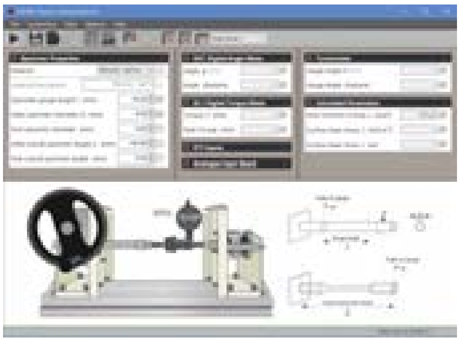
TecQuipment offers the following instrumentation for monitoring and display of strain:

- Digital Strain Display (SM1010) – **SEE ABOVE**

TORSION TESTING MACHINE – 30 NM

VDAS® SM1001

Bench-mounted machine to allow students to do torsion tests on different materials. Demonstrates Bauschinger effect.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Suitable for destructive tests on specimens
- Forward and reverse loading
- Wide range of test specimens
- Optional Torsiometer (SM1001a) available for tests which need increased accuracy

The Torsion Testing Machine consists of a rigid frame. The specimens fit between a strain head at one end and a torque reaction and measurement system at the other. To apply torque, students turn a handle on the gearbox. The output shaft of the gearbox slides to allow for any change in length of the specimen during tests. A guard protects the user when performing destructive tests.

LEARNING OUTCOMES:

- Determination of modulus of rigidity (shear modulus) and yield strength (when used with the optional torsiometer)
- Determination of upper and lower yield stresses for normalised steel specimens
- Reversed torsion tests to demonstrate the Bauschinger effect and the effects of residual body and textural stresses on torsional strength
- Comparison of the different elastic and plastic properties of materials (optional specimens required)

RECOMMENDED ANCILLARIES:

- Torsion Test Specimens (TR) 172
- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299
- Torsiometer (SM1001a) – Mechanical torsiometer for use with 6 mm diameter specimens in both the elastic and plastic regions

ALTERNATIVE PRODUCTS:

- Additional Torsion Testing Kit (TE16b) 152
- Torsion of Circular Sections (STR6) 211
- Torsion of Circular Sections Kit (ES5) 12

ROTATING FATIGUE MACHINE

VDAS® SM1090

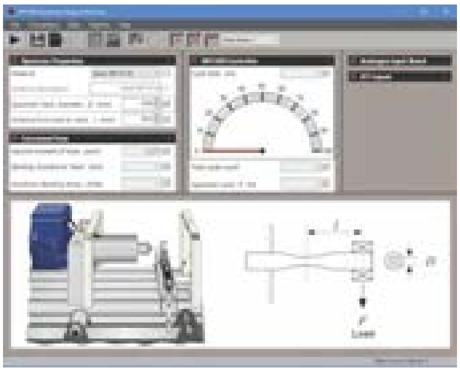
Demonstrates the failure of materials when subjected to an alternating stress, showing both low and high-cycle fatigue.

- Demonstrates clearly both high and low-cycle fatigue
- Adjustable ‘dead weight’ and load cell system – to apply and measure a consistent and accurate load on the test specimens
- Automatic switch stops the experiment when the specimen breaks – lets the equipment run unattended
- Includes tools and three sets of specimens of different metals

LEARNING OUTCOMES:

The user guide includes suggested experiments that show:

- Low and high-cycle fatigue
- How to create and use Wohler (*S-N*) curves for various materials
- Comparison of fatigue properties of various materials



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

Based on Wohler’s design, the SM1090 uses a variable-speed drive to control a motor. The motor turns a compliant coupling and a precision shaft. A collet-type chuck at the end of the shaft grips the specimen. The free end of the specimen is held in a gimbal-mounted, self-aligning bearing. Specimens are designed so their midpoint is the point of maximum stress. A clear guard locks in place during experiments for safety. The separate control and instrumentation unit freezes readings at the point of specimen failure.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299
- Additional specimens: RF1010 (steel), RF1020 (aluminium) and RF1030 (brass) 172

CREEP MACHINE

VDAS® SM1006

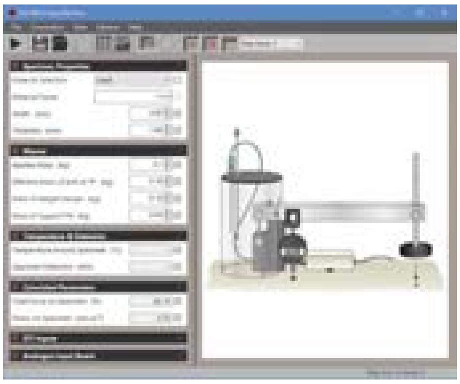
Bench-mounted machine which demonstrates the phenomenon of creep under different conditions and in different materials.

- Demonstrates the three phases of creep
- Demonstrates effect of temperature on creep
- Supplied with weights and test specimens
- Inexpensive specimens readily available in lead and plastics

LEARNING OUTCOMES:

An extensive range of experiments may be carried out with this apparatus, including:

- The normal breaking load of a specimen over a fixed time
- Relationship between breaking load and time for lead specimens
- Time extension curves to show the three phases of creep (primary, secondary and tertiary)
- The effect of temperature on the creep rate of specimens
- Creep recovery



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

A load beam gives a steady and uniform tensile load. A digital indicator measures the extension (creep) of the specimen under load. Load is applied by adding weights to a weight hanger. For temperature tests, a cool pack is frozen or heated and placed next to the specimen. A transparent enclosure preserves the temperature during the test.

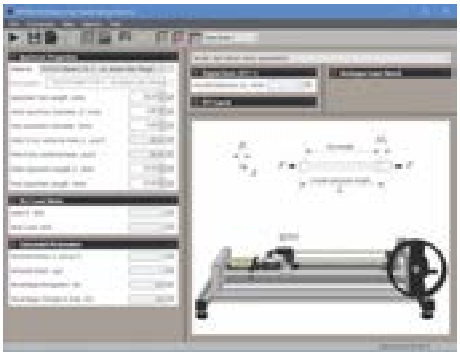
RECOMMENDED ANCILLARIES:

- Creep Test Specimens (CP) 172
- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

BENCH-TOP TENSILE TESTING MACHINE

VDAS® SM1002

A laboratory-scale, hand-driven bench-top tensile testing machine, 20 kN capacity.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

OPTIONAL EXTENSOMETER (SM1002A) FITTED TO TL SPECIMEN

FEATURES:		BENEFITS:
Simple hand-operated load application	→	For safe and easy operation that minimises risks to students
Supplied with chucks for standard 20 mm² specimens	→	Compatible with older Hounsfield specimens and chucks – cost saving
Optional Extensometer (SM1000d)	→	For tests of Young's modulus
Optional Compression Cage and Brinell Test Set (SM1002b and SM1002c)	→	Combines hardness testing with tensile testing for flexibility and cost saving

LEARNING OUTCOMES :

- Tensile tests up to 20 kN on specimens made of different metals, to find material characteristics such as upper and lower yield strengths, tensile strength and overall extension.
- Tests of Young's modulus (E) for the specimen material (needs SM1002a and TL specimens)

CONTINUED ON NEXT PAGE

A sturdy base holds a hand-driven worm and wheel gearbox, driving a lead screw with approximately 400 mm of travel. The mechanism uses ball races and self-aligning ball thrust races in the direction of loading. These low-friction bearings with the large handwheel allow the user to apply maximum load with minimum effort.

The load-measuring mechanism is a strain-gauged load cell that connects to a microprocessor-controlled digital display. The load display unit has a 'peak hold' function to register the maximum load before the specimen breaks. A sliding digital display measures the tensile displacement (extension) over the entire movement. The tensile specimens mount between the load application mechanism and load cell, in collet chucks via ball-jointed spigots. This ensures purely axial loading.

AVAILABLE EXPERIMENT MODULES:

- Brinell Hardness Test Set (SM1002c) 162

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299
- Extra TL and TS specimens 173
- Extensometer (SM1002a) 161

ALTERNATIVE PRODUCTS:

- Universal Testing Machine (SM1000) 163
- Materials Laboratory with Data Capture (MF40 MKII) 166
- Tensile Tester Kit (ES6) 13

BRINELL HARDNESS TEST SET

SM1002C

Fits in the Compression Cage (SM1002b) of the Bench Top Tensile Testing Machine (SM1002) for Brinell hardness tests.

- Includes specimens of different basic engineering materials
- Includes magnifier with graticule to accurately measure the indentation
- Works with TecQuipment's hardness test specimens (HTP)

LEARNING OUTCOMES:

- Brinell hardness tests of different basic engineering materials

An extra experiment module for the test machine, parts of this test set fit into the optional Compression Cage (SM1002b) for simple Brinell hardness tests. The set includes a magnifier with graticule (measurement scale) and test specimens made of basic engineering materials.

THE OPTIONAL COMPRESSION CAGE (SM1002B) FITS INTO THE TENSILE TEST AREA, ADAPTING THE MACHINE FOR EXPERIMENTS THAT NEED A COMPRESSIVE LOAD.

ESSENTIAL BASE UNIT:

- Bench-Top Tensile Testing Machine (SM1002) 161

ESSENTIAL ANCILLARIES:

- Compression Cage (SM1002b)

RECOMMENDED ANCILLARIES:

- Extra hardness specimens (HTP) 173

ALTERNATIVE PRODUCTS:

- Materials Laboratory with Data Capture (MF40 MKII) 166
- Brinell Indenter (SM1000e) 164

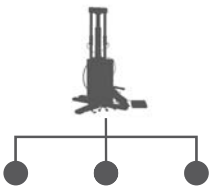
UNIVERSAL TESTING MACHINE

VDAS® SM1000

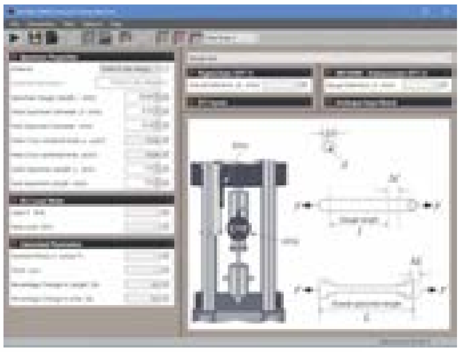
A compact machine for compressive and tensile tests on different materials and structures.

MODULAR SYSTEM

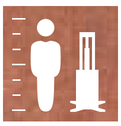
ESSENTIAL BASE UNIT (SM1000)



EXPERIMENT MODULES (SM100E–SM1000G)



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE



FEATURES:		BENEFITS:
Supports and provides tensile or compressive force to three different experiment modules	→	Modular design saves space and reduces costs
Optional Brinell, coil spring, beam and leaf spring modules	→	Additional tests in material hardness and deflections of beam and springs
Includes a set of tensile specimens	→	Allows tensile tests 'out of the box'
Optional Extensometer (SM1000d)	→	For accurate tests of Young's modulus on tensile specimens
Works with VDAS®	→	Quick and reliable tests with data capture

CONTINUED ON NEXT PAGE

LEARNING OUTCOMES:

- Tensile tests on different materials
- Compression tests on different materials

A steel frame with four columns supports a hydraulic ram. The ram pushes up a loading platform. The area above the loading platform is for compression tests on a wide range of materials, such as wood, brick and mortar. The space below the platform is for tensile tests.

AVAILABLE EXPERIMENT MODULES:

- Brinell Indenter (SM1000e) 164
- Coil Spring (SM1000f) 165
- Beam and Leaf Spring (SM1000g) 165

RECOMMENDED ANCILLARIES:

- Bench-mounted version of the Versatile Data Acquisition System (VDAS-B) 299
- Support Table and Cupboard (SM1000a) – A steel-frame table with a pre-drilled work-top to accept the Universal Testing Machine. Includes a cupboard underneath.
- Extensometer (SM1000d) – A precision sliding gauge with a digital indicator
- Tensile test (TH) specimens 172

ALTERNATIVE PRODUCTS:

- Materials Laboratory with Data Capture (MF40 MKII) 166
- Bench-Top Tensile Testing Machine (SM1002) 161
- Tensile Tester Kit (ES6) 13

BRINELL INDENTER

SM1000E

Fits in the Universal Testing Machine (SM1000) for Brinell hardness tests.

- Includes magnifier with graticule to accurately measure the indentation
- Includes specimens of different basic engineering materials
- Works with TecQuipment's hardness test specimens (HTP)

LEARNING OUTCOMES:

- Brinell hardness tests of different basic engineering materials

The Brinell Indenter (SM1000e) fits in the area above the loading platform of TecQuipment's Universal Testing Machine (SM1000).

ESSENTIAL BASE UNIT:

- Universal Testing Machine (SM1000) 163

RECOMMENDED ANCILLARIES:

- Extra hardness specimens (HTP) 173

ALTERNATIVE PRODUCTS:

- Materials Laboratory with Data Capture (MF40 MKII) 166
- Brinell Hardness Test Set (SM1002c) 162

COIL SPRING

SM1000F

Fits in the Universal Testing Machine (SM1000) for compression spring tests on a coiled spring. Demonstrates Hooke's law.

- Includes fittings to hold the spring securely
- Demonstrates Hooke's law and how to find 'spring rate' by experiment
- Heavy-duty coil spring for a more practical experience

The Coil Spring (SM1000f) fits in the area above the loading platform of TecQuipment's Universal Testing Machine (SM1000).

LEARNING OUTCOMES:

- Compression tests on a coiled spring

ESSENTIAL BASE UNIT:

- Universal Testing Machine (SM1000) 163

ALTERNATIVE PRODUCTS:

- Hooke's Law and Spring Rate (SM110) 151
- Spring Tester Kit (ES19) 14

BEAM AND LEAF SPRING

SM1000G

Fits in the Universal Testing Machine (SM1000) for tests on bending beams and a leaf spring.

- Includes two different test beams – flat steel and channel section aluminium
- Knife-edge supports for the beams, and rollers for the leaf spring for accurate results
- Includes tools needed to fit the parts to the testing machine
- Heavy-duty leaf spring for a more practical experience

The Beam and Leaf Spring (SM1000g) parts fit into the compressive test area of TecQuipment's Universal Testing Machine (SM1000).

LEARNING OUTCOMES:

- Beam bending tests on beams of different shape, material and length
- Spring rate tests on a leaf spring

ESSENTIAL BASE UNIT:

- Universal Testing Machine (SM1000) 163

ALTERNATIVE PRODUCTS:

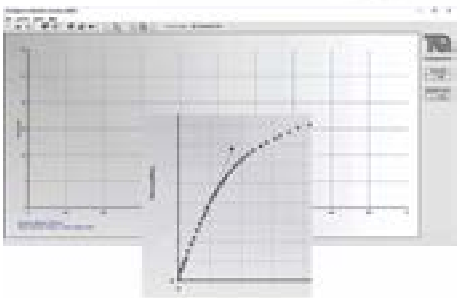
- Beam Apparatus (SM1004) 175
- Deflection of Beams and Cantilevers (STR4) 202
- Deflection of Beams and Cantilevers Kit (ES4) 11
- Continuous and Indeterminate Beams (STR13) 204
- Stiffness – Bending and Torsion (TE16) 152
- Plastic Bending of Beams (STR15) 200

MATERIALS LABORATORY WITH DATA CAPTURE

MF40 MKII

A hydraulic machine with electronic instruments and software. It tests the hardness and tensile properties of materials.

- For Brinell hardness tests and tensile tests of materials
- Includes an extensometer for accurate tensile test results
- Supplied with a set of test specimens – additional test specimens available separately
- Includes software to automatically record results and produce charts (a suitable computer is required)



LEARNING OUTCOMES:

- Tensile testing to destruction and Brinell hardness testing of various specimens
- Modulus of elasticity
- Yield stress
- Ultimate tensile stress
- Percentage elongation
- Brinell hardness test and hardness number derivation

The MF40 MkII consists of a load frame, a digital display of force (load), a ball indenter for Brinell hardness testing, and an extensometer with a digital display for tensile testing. To apply loads, students pump a handle connected to a hydraulic pump.

RECOMMENDED ANCILLARIES:

- Additional tensile test specimens of different materials: 173

  ML1MS – Mild Steel ML4AL – Aluminium
  ML2CS – Carbon Steel ML5BR – Brass
  ML3SS – Stainless Steel
- Hardness test specimens of different materials: 173

  HTPAL – Aluminium HTPMS – Carbon Steel
  HTPBR – Brass HTPNY – Nylon

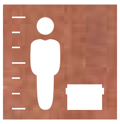
ALTERNATIVE PRODUCTS:

- Tensile Tester Kit (ES6) 13
- Bench-top Tensile Testing Machine (SM1002) 161
- Universal Testing Machine (SM1000) 163

ENERGY ABSORBED AT FRACTURE

TE15

Compact, bench-top apparatus for introducing students to impact testing.



- Many safety features, including enclosure of all moving parts and mechanically interlocked guard
- Allows investigations into the resistance of materials to crack propagation
- Includes digital display of energy absorbed at impact, and angular position before and after impact
- Visually-effective, interesting and motivating experiments

LEARNING OUTCOMES:

- Introduction to the principles of common impact testing methods, such as Izod and Charpy tests
- Investigations into the resistance of materials to crack propagation

The apparatus consists of a main unit, an instrumentation unit and a power supply. The main unit consists of a pendulum supported in a rigid frame by low-friction bearings. The pivot arrangement includes an angular encoder to measure the angular position of the pendulum over its range of movement. The apparatus is fully enclosed with an interlocking guard covering all moving parts. Adjustable feet on the base of the unit enable accurate levelling of the equipment.

ROCKWELL
HARDNESS TESTER
(SMI015)

ROCKWELL HARDNESS TESTER

SM1015

A bench-top industrial-standard tester for accurate measurements of Rockwell hardness.

- Nose-mounted indenter allows 360-degree access
- Fully automatic testing cycle and automatic conversion to alternative scales eliminates operator influence on the test results
- High level of test result repeatability
- Robust construction with a play-free screw spindle running on ball-bearings
- Visual and audible signals when specified tolerance exceeded and during pre-load setting

LEARNING OUTCOMES:

Hardness testing of classical Rockwell methods according to ISO 6508 and ASTM E18

The machine performs Rockwell hardness tests in accordance with established specifications, including BS EN ISO 6508:1999 and ASTM E18. The machine is supplied with a diamond cone indenter and a 1/16" diameter ball indenter, as standard.

RECOMMENDED ANCILLARIES:

- Hardness Reference Blocks (HTB-R) 173

METICULOUSLY PACKED

TecQuipment's dedicated packing department uses specialist equipment, custom-made transit crates and the most reliable global carriers to ensure products are delivered in perfect condition.

VICKERS HARDNESS TESTER

SM1016

A bench-top industrial-standard tester for accurate measurements of Vickers hardness.

MEASURING THE HARDNESS OF AN INTERNAL BORE

- Capable of performing tests using forces: 1, 3, 5, 10, 20, 30 kgf
- Unique nose-mounted indenter, allows access to awkward-to-reach test points
- Test scale designation on display, for simple operation and data gathering
- Fully automatic testing cycle – eliminates operator influence on the test results
- Calculation of average ($\bar{x}$) and range (R)
- Audible and visual indication of 'out of tolerance' results, eliminating operator decisions

LEARNING OUTCOMES:

Vickers testing to ISO 6507, ASTM E384 and ASTM E92, UKAS accredited Key Specifications

The machine performs the Vickers hardness test, in accordance with established specifications including BS EN ISO 6507 and ASTM E92.

RECOMMENDED ANCILLARIES:

- Hardness Reference Blocks (HTB-V) 173

UNIVERSAL HARDNESS TESTER

SM1017

A bench-top industrial-standard tester for accurate measurements of Vickers, Brinell and Rockwell hardness.

HARDNESS TESTER DISPLAY

- Dead weight load combinations up to 187.5 kg
- Setting of hardness tolerance and statistics ($\bar{x}$ and R), for a range of experiments
- Integral microscope with measuring shutters and push button for transfer of dimensional data
- Simple operation

LEARNING OUTCOMES:

Hardness testing of a range of different materials, using three different methods:

- Vickers (HV) DIN EN ISO 6507, ASTM E92
- Brinell (HB) DIN EN ISO 6506, ASTM E10
- Rockwell (HR) DIN EN ISO 6508, ASTM E18

The machine performs Brinell, Vickers and Rockwell tests in accordance with established specifications:

- Brinell: ISO 6506, ASTM E10
- Vickers: ISO 6507, ASTM E92
- Rockwell: ISO 6508, ASTM E18

RECOMMENDED ANCILLARIES:

- Hardness Reference Blocks (HTB-B) – Brunel 173
- Hardness Reference Blocks (HTB-R) – Rockwell 173
- Hardness Reference Blocks (HTB-V) – Vickers 173

SPECIMENS AVAILABLE EX-STOCK

CREEP TEST SPECIMENS

CP

Creep test specimens of different materials for use with TecQuipment's Creep Machine (SM106 or SM1006).

CP1010: Lead

CP1020: Polypropylene

CP1025: Nylon 66 (unfilled)

CP1030: Unplasticised PVC

ROTATING FATIGUE SPECIMENS

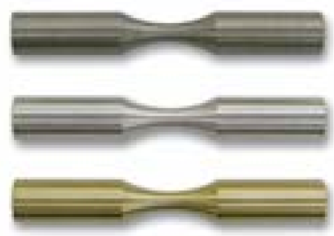
RF

Fatigue test specimens of different metals for use with TecQuipment's Rotating Fatigue Machine (SM1090).

RF1010: Mild Steel

RF1020: Aluminium

RF1030: Brass



TENSILE TEST SPECIMENS

TH

Tensile test specimens of different grade steel for use with TecQuipment's Universal Testing Machine (SM100 or SM1000).

TH4010: 0.1% Carbon Steel. As drawn. To British Standard Specification 230M07. Has no identity rings.

TH4015: 0.1% Carbon Steel. Normalised at 900°C. To British Standard Specification 230M07. Has one identity ring.

TH4035: 0.4% Carbon Steel. Normalised at 860°C. To British Standard Specification 212A42. Has two identity rings.

TORSION TEST SPECIMENS

TR

Torsion test specimens of different metals for use with TecQuipment's Torsion Testing Machine (SM1 or SM1001).

TR1010: 0.1% Carbon Steel. As drawn. To British Standard Specification 230M07. No grooves.

TR1011: 0.1% Carbon Steel. Normalised at 900°C. To British Standard Specification 230M07. 1 groove.

TR1020: 0.4% Carbon Steel. As drawn. To British Standard Specification 212A42. 2 grooves.

TR1021: 0.4% Carbon Steel. Normalised at 860°C. To British Standard Specification 212A42. 3 grooves.

TR1040: Half-hard Brass. 60% Copper, 40% Zinc. To British Standard Specification CZ121. No grooves.

TR1050: Cast iron. Grade 260. To British Standard BS1452. 4 grooves.

TENSILE TEST SPECIMENS

TL AND TS

Long (TL) and short (TS) tensile test specimens of different metals for use with TecQuipment's Tensile Testing Machine (SM1002). Will also fit Hounsfield or Monsanto tensometer.

TL1010 AND TS1010: 0.1% Carbon Steel. As drawn. To British Standard Specification 220M07 or 230M07.

TL1011 AND TS1011: 0.1% Carbon Steel. Normalised at 900°C. To British Standard Specification 220M07 or 230M07.

TL1020 AND TS1020: 0.4% Carbon Steel. As drawn. To British Standard Specification 080M040.

TL1021 AND TS1021: 0.4% Carbon Steel. Normalised at 860°C. To British Standard Specification 080M040.

TL1030 AND TS1030: Aluminium 2011 – T3.

TL1040 AND TS1040: Half hard Brass. To British Standard Specification CZ121.

HARDNESS TEST SPECIMENS

HTP

Hardness test specimens of different materials for use with the Materials Laboratory with Data Capture (MF40 series), Bench-Top Tensile Testing Machine (SM1002) and Brinell Indenter (SM1000e).

HTPAL: Aluminium (6026-T9)

HTPBR: Brass (CZ121/CW614N)

HTPMS: 0.1% Carbon steel (230M07)

HTPNY: Nylon 6

TENSILE TEST SPECIMENS

ML

Tensile test specimens of different materials for use with the Materials Laboratory with Data Capture (MF40 series).

ML1MS: Mild steel – specification EN1A or 230M07

ML2CS: Carbon steel – specification EN8 or 080M40

ML3SS: Stainless steel – specification SAE303

ML4AL: Aluminium – specification 2011-T3

ML5BR: Brass – specification CZ121

HARDNESS REFERENCE BLOCKS

HTB

For use with the Rockwell Hardness Tester (SM1015), Vickers Hardness Tester (SM1016) and Universal Hardness Tester (SM1017).

HTB-R: Rockwell block for use on the SM1015 or SM1017

HTB-V: Vickers block for use on the SM1016 or SM1017

HTB-B: Brunel block for use on the SM1017 only

UNSYMMETRICAL CANTILEVER APPARATUS

VDAS® SM1003

Examines and displays bending of an unsymmetrical cantilever; demonstrates the use of Mohr's circle.

- Self-contained – needs no other parts
- Explains 'shear centre' and the use and construction of Mohr's circle
- Supplied with structural and stress analysis textbook with full theory
- Supplied with set of different specimens

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

Investigations into bending of unsymmetrical cantilevers, including:

- Vertical and horizontal displacement measurement for varying angles of applied load
- Demonstration that maximum and minimum vertical deflection occurs when horizontal deflection is zero
- Use of Mohr's circle
- Experimental and theoretical determination of the principal moments of area of test sections
- Location of shear centre of each section

A beam is mounted vertically in the test frame and the top fixes to a ring that can rotate through 360 degrees. An incremental load is added to the free end of the test beam. Beam deflections are measured in two directions at right angles to each other. To find shear stress, a cross piece is used to allow loads to be applied across and outside the section of the cantilever.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

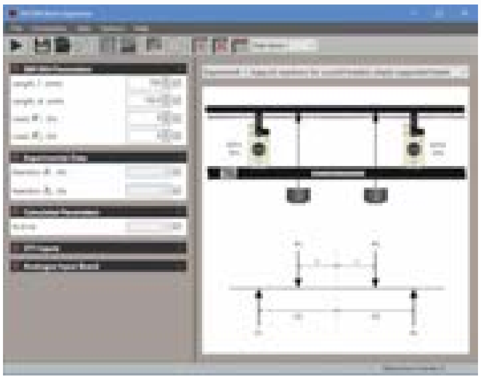
ALTERNATIVE PRODUCTS:

- Unsymmetrical Bending and Shear Centre (STR7) 212

BEAM APPARATUS

VDAS® SM1004

Examines the deflection and forces on different types of beams for a wide range of supports and loads; also demonstrates Young's modulus.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Includes textbook with full theory
- Simply supported and cantilever beam tests with up to four supports with any loading
- Three load cells with digital indicators measure reaction forces or act as rigid sinking supports
- Precision digital indicators for accurate deflection measurements

LEARNING OUTCOMES:

- Verification of the bending equation
- Determination of flexural rigidity and elastic modulus (Young's modulus)
- Verification of static equilibrium
- Deflection of beams on two simple supports with point loads
- Reciprocal properties for loads and deflection
- Simple and propped cantilevers with any loading
- Continuous beams – statically indeterminate cases for simply supported beams and cantilevers on more than two supports with any loading (including measurement of unknown reactions)
- Simply supported and cantilever beams with sinking supports

With the SM1004a Specimen Beams, these additional experiments can be done:

- The effects of material and section shape on flexural rigidity
- Bending characteristics of a brass/steel compound beam, with and without shearing connection between the two layers
- Equivalent sections – characteristics of a metal-faced wooden beam
- Deflections on a non-uniform (tapered) beam or cantilever

CONTINUED ON NEXT PAGE

BEAM APPARATUS (SM1004) CONTINUED FROM PREVIOUS PAGE

The apparatus consists of an upper cross-member carrying graduated scales, and two lower members bolted to T-legs to form a rigid assembly. The three load cells and cantilever-support pillar slide along the lower members and can be clamped firmly in any position. The load cells have direct digital readout and each is fitted with a hardened steel knife edge which can be adjusted to set the initial level, or to simulate a sinking support. Locking pins can convert each load cell to a rigid support when required. The cantilever support is a rigid pillar with a sturdy clamping arrangement to hold the beams when built-in end conditions are required. Four weight hangers and a set of weights are supplied to apply static loads.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299
- Additional Specimen Beams (SM1004a)

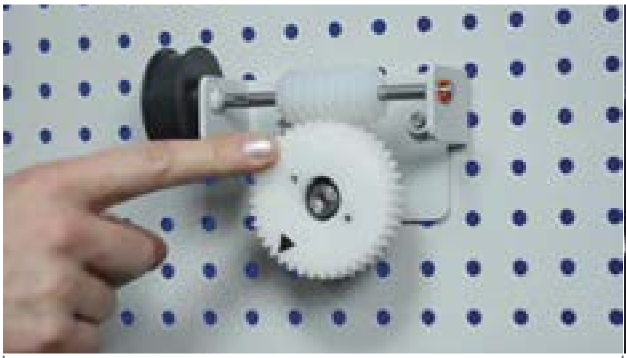
ALTERNATIVE PRODUCTS:

- Deflection of Beams and Cantilevers Kit (ES4) 11
- Stiffness – Bending and Torsion (TE16) 152
- Beam and Leaf Spring (SM1000g) 165
- Deflection of Beams and Cantilevers (STR4) 202
- Continuous and Indeterminate Beams (STR13) 204

PLAY NOW – TECQUIPMENT YOUTUBE CHANNEL

Visit and subscribe to the TecQuipment YouTube channel for all the latest products showcase, installation and user videos. **YOUTUBE.COM/C/TECQUIPMENT**

YouTube

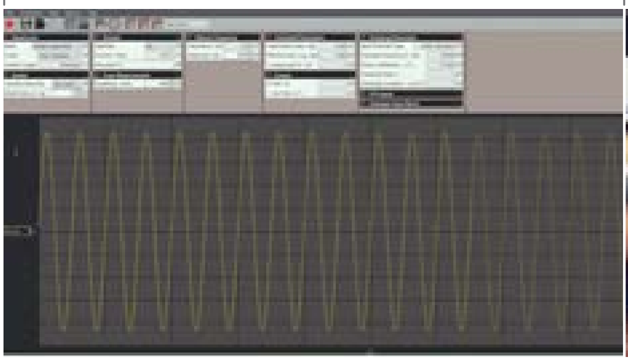


GEAR TRAINS (ES13)

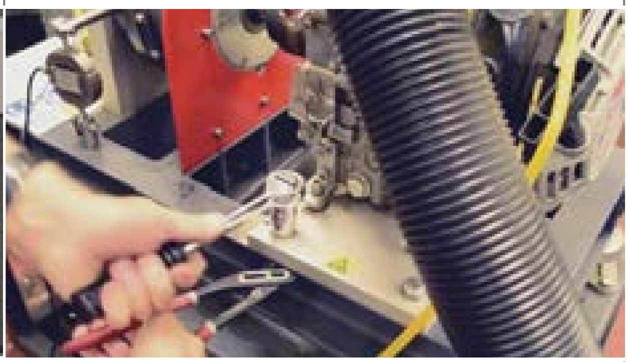
AIR CONDITIONING TRAINER (EC1501)

ROTATING FATIGUE MACHINE (SM1090)

HYDROLOGY AND RAINFALL (H313)



TRACE DAMPING MODELS (VDAS®)

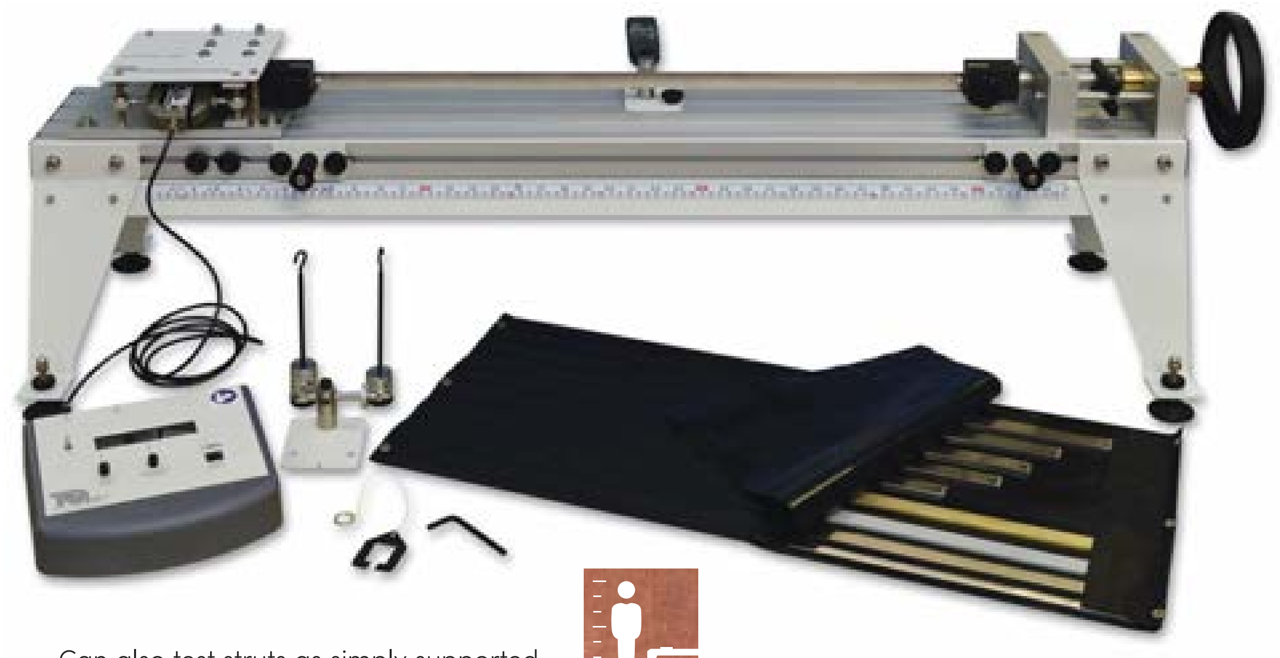


SMALL ENGINE TEST SET (TD200)

EULER STRUT BUCKLING APPARATUS

VDAS® SM1005

Bench-top apparatus tests different types of struts and demonstrates how they deflect under load, and demonstrates the use of Southwell's method.



- Can also test struts as simply supported beams – to extend experiments and find flexural rigidity of the struts
- Buckling tests cover pinned and clamped (encastré) ends for various strut lengths and cross-sections
- Special end fittings allow tests with eccentric loading
- Range of ten struts supplied as standard
- Extra specimen struts available for more advanced experiments

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

WITH THE STANDARD SET OF TEN SPECIMENS:

- Demonstration of buckled (crippled) shape of struts with different end conditions
- Determination of load/deflection curves and buckling loads for struts of different lengths and cross-sections, with any combination of 'pinned' or clamped end fixings
- Comparing experiment results with those using Euler's buckling theory
- Investigation of the effects of side load and eccentric loading on strut buckling characteristics
- Flexural rigidity and buckling loads for struts of different materials
- The use of Southwell's method to estimate buckling loads and strut eccentricities from experimental results
- Determination of flexural rigidity and comparison with calculated values
- Deflections of a simply supported beam with a point load, including the verification of general deflection formulae, and the deflected shape

WITH THE SM1005A OPTIONAL SET OF ADDITIONAL STRUTS:

- Flexural rigidity and buckling loads for struts of a further range of different materials
- Tests on typical engineering sections (circular, angle, channel and irregular section specimens); the significance of the neutral axes; combined bending and twisting due to eccentric loading.
- The effect of flexibility in end fixings
- Tests on a compound strut with imperfect shearing connections between the two components

CONTINUED ON NEXT PAGE

A sturdy base that at one end has a loading device which uses a screw to apply loads to the struts. The screw is in fixing blocks with bearings to give precise and easy load application. At the opposite end is the load measuring device. This is a precision mechanism that resists the bending moments produced by the struts as they deflect, and transmits the pure axial force to an electronic load cell. This gives an accurate measurement of buckling load. A digital load meter (DL1 – included) shows the load.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299
- Set of Additional Struts (SM1005a)

ALTERNATIVE PRODUCTS:

- Euler Buckling of a Column (STR12) 199

HERE TO HELP YOU

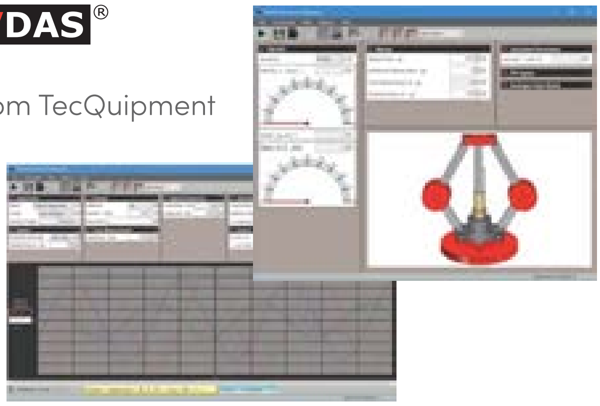
A team of specialist customer care personnel is available to answer a range of questions relating to technical details, spare parts and maintenance.

CUSTOMER.CARE@TECQUIPMENT.COM

CAPTURE THE POWER OF VDAS®

...the Versatile Data Acquisition System from TecQuipment

Our Versatile Data Acquisition System (VDAS®) is a highly effective way of collecting and using data from experiments using TecQuipment's educational teaching equipment.



LOOK AT THE BENEFITS...

VERSATILE – can be used across a wide range of TecQuipment products

DATA – transforms raw data instantly which easily exports or creates sophisticated graphs and tables

ACQUISITION – USB connectivity, multiple-source real-time data capture

SYSTEM – an expandable modular approach providing easy-to-use digital plug-and-play technology

LABVIEW

All TecQuipment products compatible with VDAS® have the capability to interface with a LabVIEW environment.

Visit **TECQUIPMENT.COM** for more information.

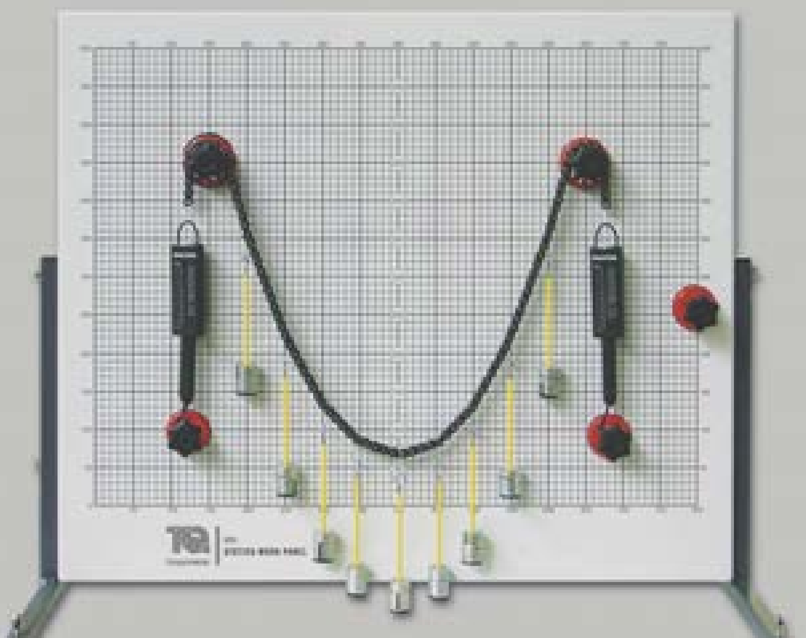
STATICS FUNDAMENTALS

> After inviting companies to bid for the new equipment, we selected TecQuipment based on the premium specifications, competitive price, and reputation for quality of service supported by the excellent pre-sales experience.
>
> **PAUL MATTHEWS**
> SENIOR LECTURER AND COORDINATOR AT SOLIHULL COLLEGE

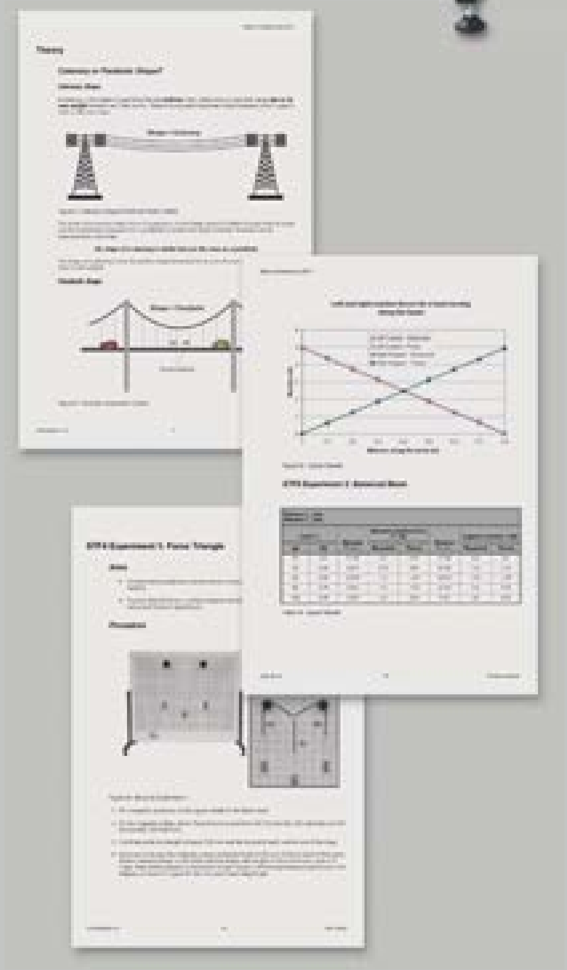
STATICS FUNDAMENTALS

The Statics Fundamentals range offers teaching equipment for understanding the core principles required for civil and mechanical engineering disciplines. The range brings theories, such as concurrent and non-concurrent coplanar forces, Bow's notation, equilibrium theory, parabola theory, and many more, to life.

The range consists of a series of modular experiment modules that fit to the essential base unit (Statics Work Panel), these can be mixed and matched to suit teaching requirements.



A STATICS FUNDAMENTALS EXPERIMENT KIT FITTED TO THE WORK PANEL



EACH KIT IS SUPPLIED WITH A FULLY ILLUSTRATED USER GUIDE CONTAINING THEORY, EXPERIMENTS AND TYPICAL RESULTS.

KEY FEATURES AND BENEFITS:

FLEXIBILITY: Share one work panel between experiment kits, or one work panel for each kit.

HANDS-ON: Large tactile parts for students to fit and adjust.

HIGHLY VISUAL: For classroom demonstrations or groups of students.

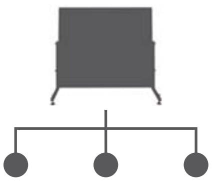
STATICS WORK PANEL

STF1

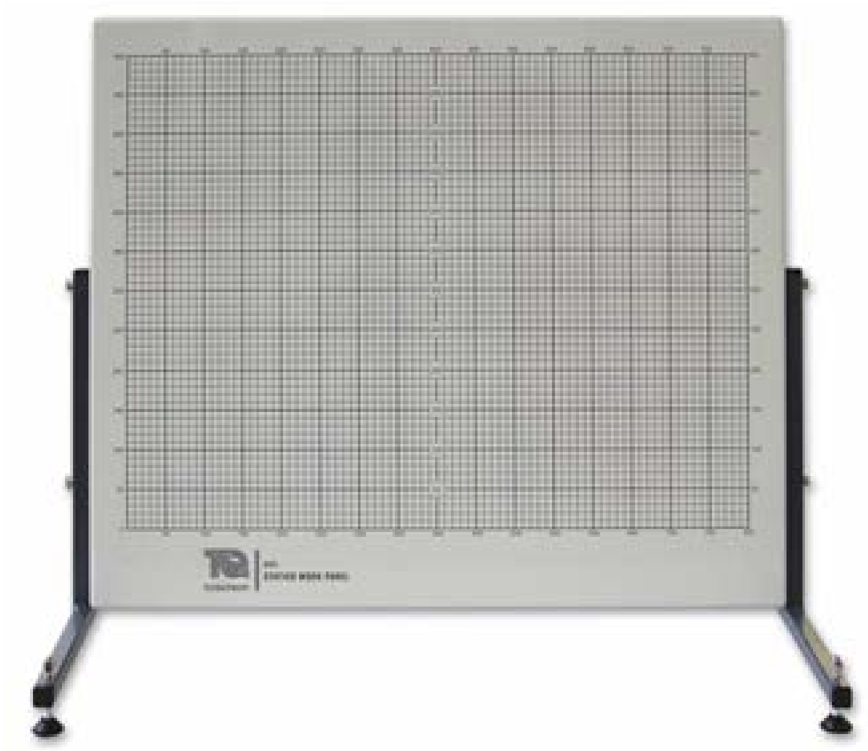
Work panel for use with TecQuipment's Statics Fundamentals (STF) range.

MODULAR SYSTEM

ESSENTIAL BASE UNIT (STF1)



EXPERIMENT MODULES (STF2–STF5)



FEATURES:		BENEFITS:
Supports four different experiment kits	→	Modular design saves space and reduces costs
Large working area	→	Ideal for classroom demonstrations
Clear metric grid	→	Repeatable positioning of parts with accurate results
Easy set-up – all experiment kits can be removed and fitted in minutes	→	Maximises experiment time
Highly visual, hands-on design	→	Improves student understanding, even with a large class

For use with TecQuipment's Statics Fundamentals range, the work panel fits on most desk or bench tops. Students or teachers fit the magnetic parts of their Statics Fundamentals kits to the work panel to study or demonstrate one of the fundamental topics of static forces.

AVAILABLE EXPERIMENT KITS:

- Suspension Cable Demonstration (STF2) 182
- Equilibrium of a Rigid Body (STF3) 182
- Equilibrium of Forces (STF4) 183
- Equilibrium of a Beam (STF5) 183

FULL SPECIFICATION DATASHEETS

Datasheets contain full specifications such as size, weight, noise output, fluid capacity, voltage requirements etc. Download from each individual product webpage.

TECQUIPMENT.COM (search product)

SUSPENSION CABLE DEMONSTRATION

STF2

Demonstrates the tensions and shapes in a suspension cable, comparing them with theory.

LEARNING OUTCOMES:

- Analysis using catenary and parabola theory
- Cable weight and tension
- Comparison of a symmetrical suspension cable and catenary
- Unsymmetrical suspension cable
- A point load on a suspension cable

For use with the Work Panel (STF1), the kit allows several experiments with a suspension cable. Students or teachers fit the magnetic parts of the kit to the work panel to study or demonstrate the shapes and tensions in a suspension cable.

ESSENTIAL BASE UNIT:

- Work Panel (STF1) 181

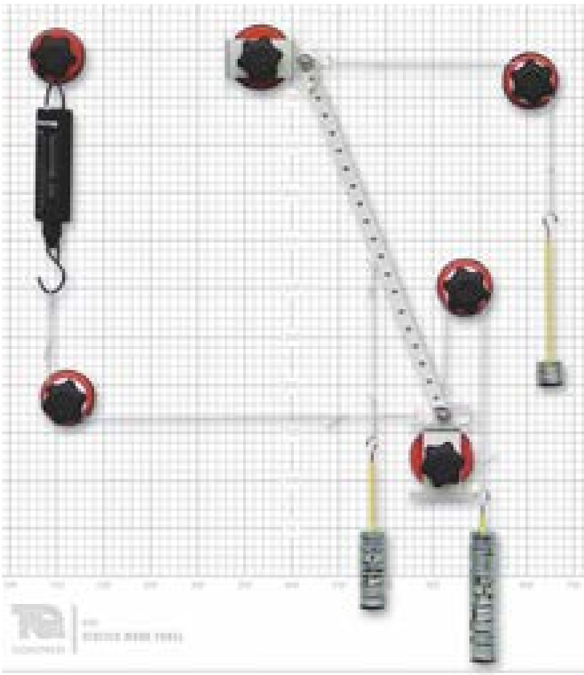
ALTERNATIVE PRODUCTS:

- Simple Suspension Bridge (STR19) 197

EQUILIBRIUM OF A RIGID BODY

STF3

Demonstrates the forces around a ladder-type structure.



LEARNING OUTCOMES:

- Horizontal and vertical reaction forces on a ladder
- Safe angles for a ladder
- A climbing mass on a ladder
- A ladder at different angles

For use with the Work Panel (STF1), the kit allows several experiments with a rigid body – a ladder structure. Students or teachers fit the magnetic parts of the kit to the Work Panel (STF1) to study or demonstrate the forces around an inclined ladder-type structure.

ESSENTIAL BASE UNIT:

- Work Panel (STF1) 181

EQUILIBRIUM OF FORCES

STF4

For experiments with three or more coplanar forces at equilibrium and an introduction to Bow's notation.

LEARNING OUTCOMES:

- Concurrent and non–concurrent coplanar forces
- An introduction to Bow's notation and graphical analysis
- Force triangles, polygons and link polygons

For use with the Work Panel (STF1), the kit allows several experiments with forces pulling on one or more points at different angles. Students or teachers fit the magnetic parts of the kit to the Work Panel (STF1) to study or demonstrate three coplanar concurrent forces (triangle of forces) or more (force polygons).

ESSENTIAL BASE UNIT:

- Work Panel (STF1) 181

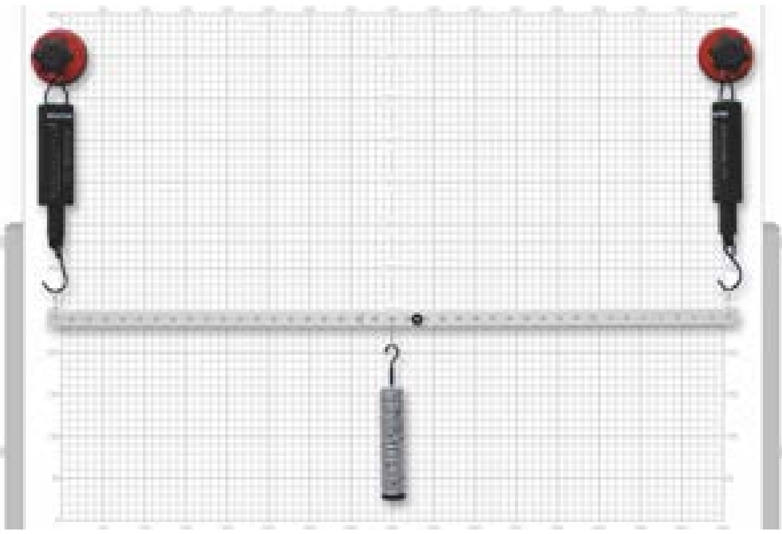
ALTERNATIVE PRODUCTS:

- Forces Kit (ES2) 9

EQUILIBRIUM OF A BEAM

STF5

For experiments with forces, moments and reactions around a beam at equilibrium.



LEARNING OUTCOMES:

- Using moments and the theory of equilibrium to find beam reaction and other unknown forces
- Simply-supported beams
- Balanced beams

For use with the Work Panel (STF1), the kit allows several experiments with a rigid beam. Students or teachers fit the magnetic parts of the kit to the Work Panel (STF1) to study or demonstrate forces, moments and reaction forces around a rigid beam at equilibrium.

ESSENTIAL BASE UNIT:

- Work Panel (STF1) 181

ALTERNATIVE PRODUCTS:

- Moments Kit (ES3) 10

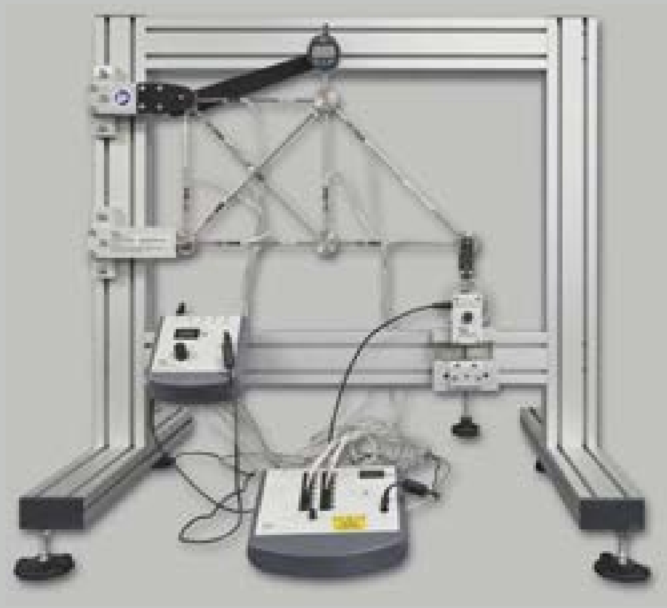
PRODUCTS ARE MANUFACTURED IN-HOUSE AT THE TECQUIPMENT HEADQUARTERS IN THE UK

STRUCTURES

> TecQuipment's Structures line was chosen to enhance the learning experience of our engineering students. The products were delivered in a timely manner and were easy to set up. After-sales support has been very accommodating, allowing us to modify the experiment manuals as we saw fit, giving us flexibility in learning objectives. Students have shown great interest and have found operating the units to be easy and simple.
>
> RIAD RAJAB
> YORK UNIVERSITY, ONTARIO, CANADA

ÖRESUND BRIDGE BETWEEN SWEDEN AND DENMARK

STRUCTURES



The Structures range consists of teaching equipment for understanding basic structural principles, focusing on beams, bridges and cantilevers for students of mechanical, civil and structural engineering.

The 19 desk-mounted experiment modules can be used stand alone or with TecQuipment's powerful Structures software which provides automatic data acquisition (ADA). To complement laboratory learning, experiments can also be performed virtually, using only the software.

FLEXIBLE AND MODULAR	AUTHENTIC SOFTWARE SIMULATION
• Experiment modules and instrumentation fix easily to the test frame • Easily removeable and changeable experiments, making good use of laboratory space • The modularity of the range allows for expansion as required	• The Structures software offers an affordable and effective method for students to quickly learn structures principles by performing virtual experiments on a computer • Allows students the flexibility of working away from the laboratory • Expands experiments beyond the limits of the hardware
AUTOMATIC DATA ACQUISITION	**HIGH FUNCTIONALITY, AFFORDABLY PRICED**
• The use of automatic data acquisition and digital instrumentation means students can get quick and accurate results, optimising laboratory time • There are no difficult-to-read instruments or abstract experiment set-ups to distract students	• One experiment can demonstrate several principles, for excellent value • Extensive experiment capabilities and choice of hardware and software, mean our Structures range provides an unsurpassed teaching solution at an unbeatable price

THE STRUCTURES TEST FRAME STR1

This strong, sturdy and bench-mounted test frame holds the interchangeable experiment modules and instruments of TecQuipment's Structures range.

THE EXPERIMENT MODULES STR2-STR20

Interchangeable experiment modules give realistic and verifiable experiment results.

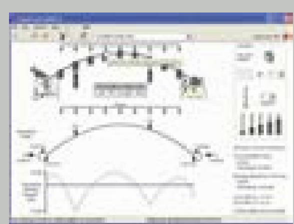
AUTOMATIC DATA ACQUISITION UNIT STR2000

Links to load cells and other instruments in the Structures range to send data to a suitable computer (not supplied).

INCLUDES STRUCTURES SOFTWARE (STRS)

STRUCTURES SOFTWARE STRS

The software accurately simulates all 19 experiment modules on a suitable computer (not supplied) without the need of the Structures hardware.



INCLUDES EXTENSIVE USER GUIDES AND EXAMPLE EXPERIMENTS

ORDERING

The modular nature of our Structures range means items can be chosen to create the right combination of products that best suits teaching needs.

SOFTWARE (STRS) = VIRTUAL EXPERIMENTS, EXTENDED EXPERIMENTS

TEST FRAME (STR1) + EXPERIMENT MODULES (STR2-STR20) = HARDWARE EXPERIMENTS

TEST FRAME (STR1) + EXPERIMENT MODULES (STR2-STR20) + ADA UNIT (STR2000 – INCLUDES STRS SOFTWARE) = HARDWARE EXPERIMENTS, VIRTUAL EXPERIMENTS, EXTENDED EXPERIMENTS, AUTOMATIC DATA ACQUISITION

PACKAGES

The following packages are available which offer great value for money. Each hardware package is supplied with a 25-seat software license.

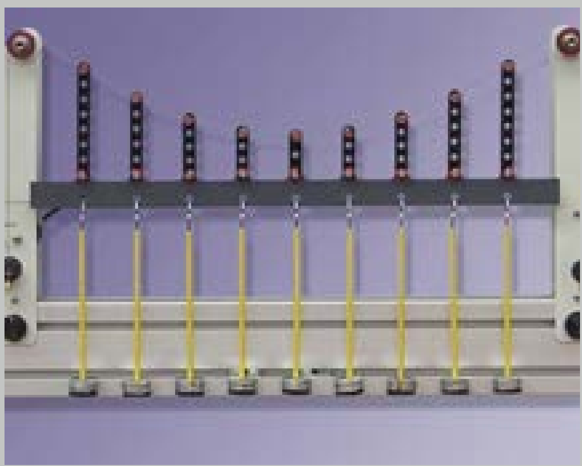
ARCHES, BRIDGES AND TRUSSES PACKAGE STRA

FAILURE PACKAGE STRC

DEFLECTIONS AND STRESS PACKAGE STRB

MOMENTS PACKAGE STRD

TORSION PACKAGE STRE



STRUCTURES TEST FRAME

STR1

A strong frame that holds the experiments of TecQuipment's Structures range.

- Holds the interchangeable Structures experiment modules and instruments
- Strong, bench-mounted frame
- Easy-to-use fixings and slots so students can quickly set up, remove or change experiments
- Also ideal for holding experiments during storage
- Includes textbook with full theory and explanations of different structures

AVAILABLE EXPERIMENT MODULES:

- One or more Structures experiment modules (STR2–STR20) 191–212

TEST FRAME (STR1) FITTED WITH THE EXPERIMENT MODULE BENDING STRESS IN A BEAM (STR5) AND DIGITAL FORCE DISPLAY (STR1A)

AUTOMATIC DATA ACQUISITION UNIT

STR2000

Connects any of the Structures range experiments to a computer – includes TecQuipment's Structures software for automatic data acquisition and virtual experiments.

- Interface unit links to load cells and other instruments in the Structures range to send data to a suitable computer
- Allows students to compare results from actual experiments with results from simulation software
- Fully automatic and simple connection to a computer – no need to add any extra circuit boards

THE STR2000 COMPUTER INTERFACE UNIT SENDING DATA FROM ONE OF THE STRUCTURES HARDWARE EXPERIMENT MODULES TO THE STRUCTURES SOFTWARE

ESSENTIAL ANCILLARIES:

- Suitable computer (not supplied by TecQuipment)

ANCILLARY FOR:

- One or more experiment modules from the Structures range (STR2–STR20) 191–212

DIGITAL FORCE DISPLAY

STR1A

For use with TecQuipment's Structures range, this display shows the forces from up to four force sensors on the Structures experiments.

- Fits onto the Structures Test Frame (STR1) to give a tidy work area
- Real-time display of each of up to four forces
- Can connect to TecQuipment's Automatic Data Acquisition Unit (STR2000) to automatically measure all four forces at the same time

ANCILLARY FOR:

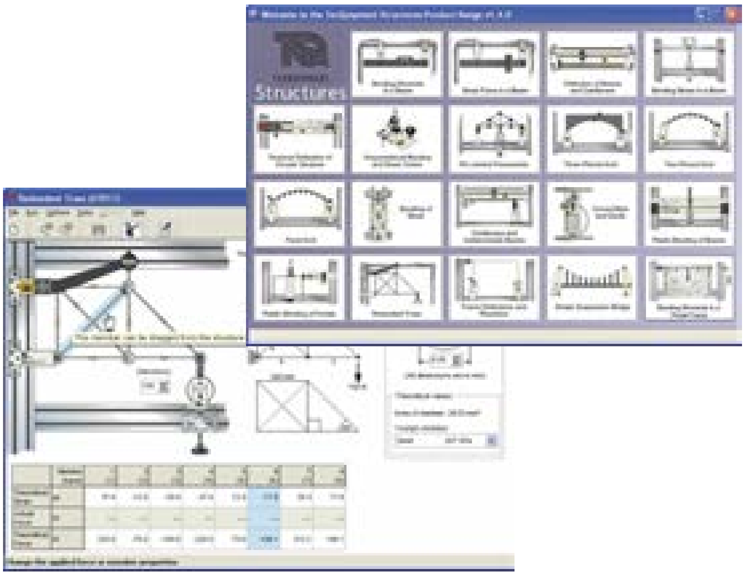
- One or more Structures experiment modules (STR2–STR20) 191–212

STRUCTURES SOFTWARE

STRS

Software that allows computer simulation of structures. Simulates and extends TecQuipment's Structures range.

- Accurately simulates all 19 of TecQuipment's Structures range experiments
- Includes user guides with suggested experiments and typical answers
- Gives virtual experiments that extend beyond the limits of the experiment hardware
- Single-user and networked options available
- Latest version of the software can be downloaded from the website



SOFTWARE

STRUCTURES

LEARNING OUTCOMES:

Computer-simulated examination of a wide variety of structures principles, including:

- Bending moments in a beam
- Shear force in a beam
- Deflection of beams and cantilevers
- Bending stress in a beam
- Torsional deflection of circular sections
- Unsymmetrical bending and shear centre
- Pin-jointed frameworks
- Three-pinned arch
- Two-pinned arch
- Fixed-arch
- Euler buckling of a column
- Continuous and indeterminate beams
- Curved bars and davits
- Plastic bending of beams
- Plastic bending of portals
- Redundant truss
- Frame deflections and reactions
- Simple suspension bridge
- Bending moments in a portal frame

SEE FOR YOURSELF!

DOWNLOAD A DEMONSTRATION VERSION FROM THE 'DOWNLOADS' PAGE OF OUR WEBSITE

TecQuipment's Structures Software is ideal for students of civil, mechanical and structural engineering. It allows them to perform computer-simulated experiments which study the principles of structures.

NOTE: The Structures Software (STRS) can be bought by itself, but it is also included free with the Automatic Data Acquisition Unit (STR2000) – **SEE PAGE 189**.

The software is also supplied with the Structures packages – **SEE PAGE 187**.

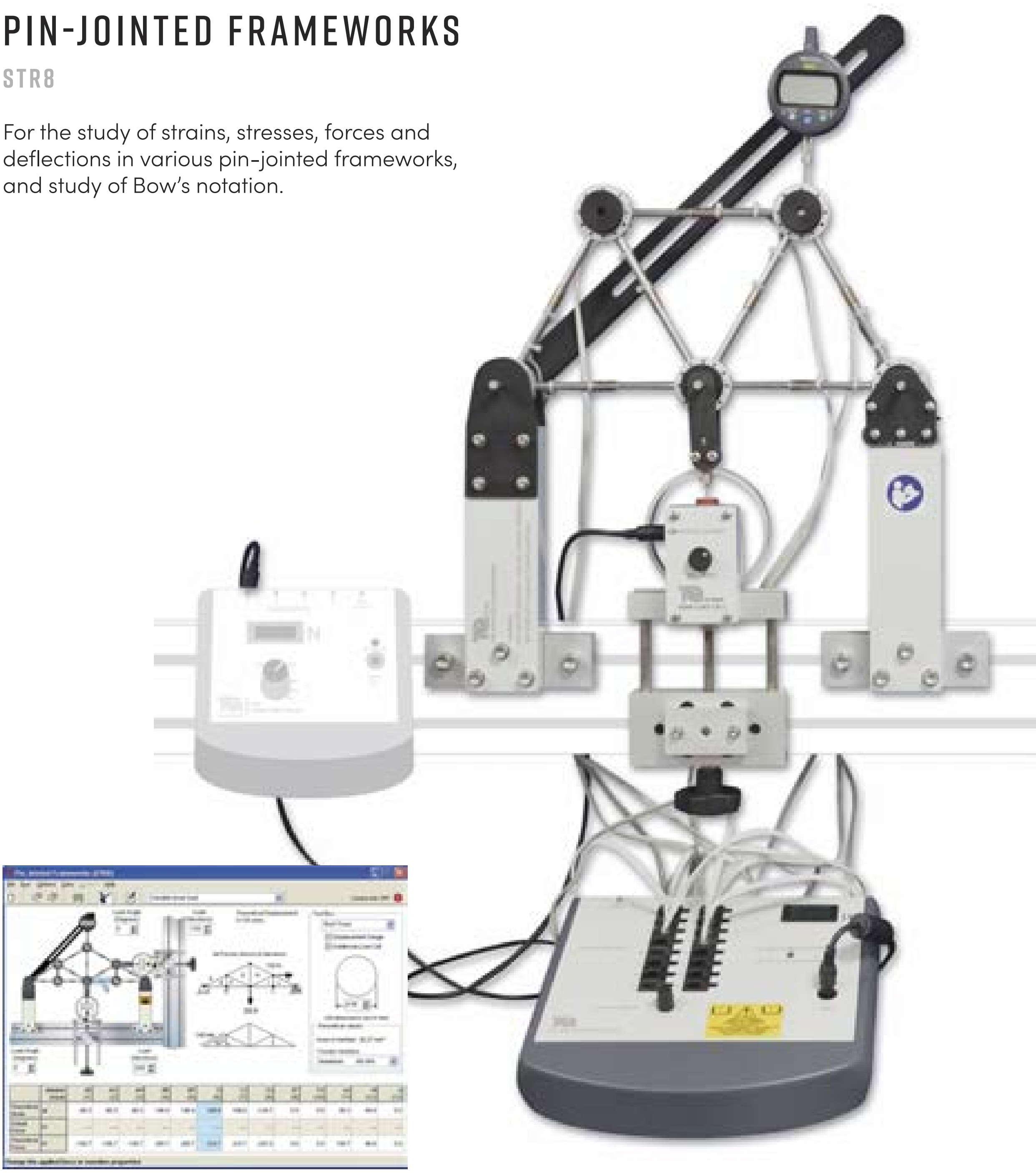
ESSENTIAL ANCILLARIES:

- Suitable computer (not supplied by TecQuipment)

PIN-JOINTED FRAMEWORKS

STR8

For the study of strains, stresses, forces and deflections in various pin-jointed frameworks, and study of Bow's notation.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

- Study of Bow's notation, strains, stresses, forces and deflections in various frameworks, including a Warren girder and roof truss
- Comparison of different frameworks

Students use stainless-steel members to build different pin-jointed frameworks. The equipment includes two framework supports: a pivoting support, and a pivoting and rolling support. Each member has a strain gauge attached that connects to a digital strain bridge. Load cells measure the load applied at various angles. A second load cell can be fitted to simulate lateral forces on the truss (STR8a).

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189
- Additional Load Cell (STR8a)

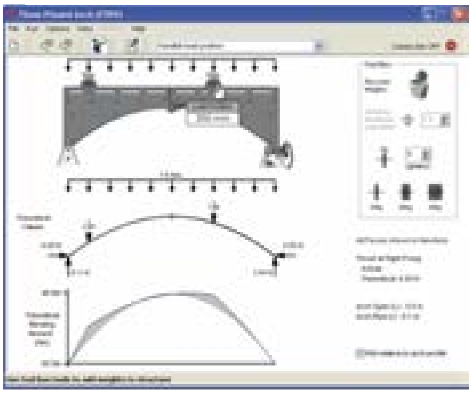
ALTERNATIVE PRODUCTS:

- Redundant Truss (STR17) 195

THREE-PINNED ARCH

STR9

For the study of the characteristics of a three-pinned arch under various load conditions.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

Students apply various loads at set positions along the top of a simple 'determinate' three-pinned arched structure. They can also apply a uniformly distributed load. A load cell measures the thrust reaction.

LEARNING OUTCOMES:

Studies of:

- The characteristics of a three-pinned arch
- The relationship between applied loads and horizontal thrust produced from a simple determinate arched structure

Also:

- Appreciation of footing stability and economy.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

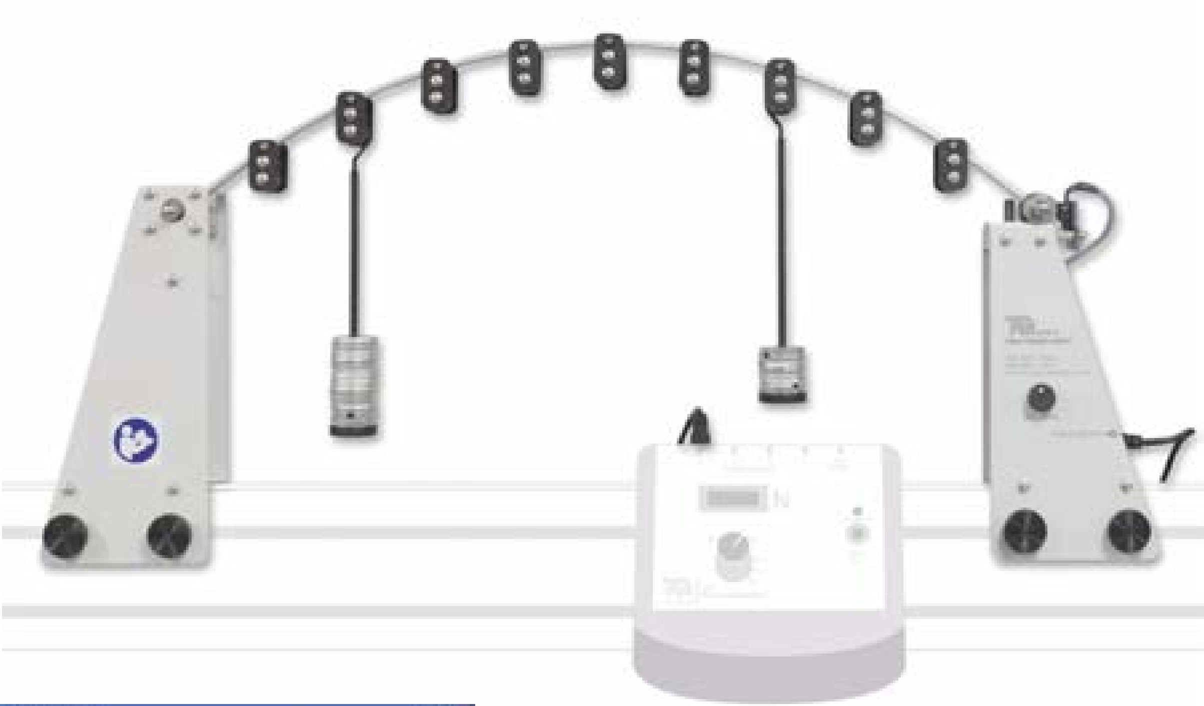
ALTERNATIVE PRODUCTS:

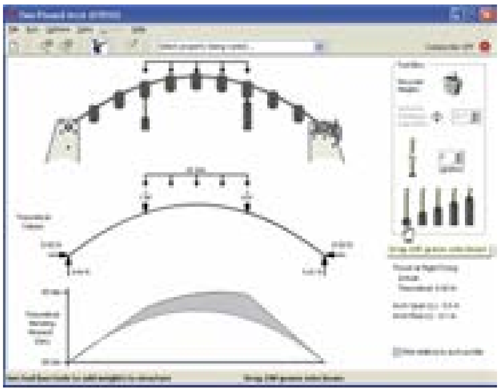
- Two-Pinned Arch (STR10) 193
- Fixed Arch (STR11) 194

TWO-PINNED ARCH

STR10

For studies of the characteristics of a two-pinned arch under various load conditions.





SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

Students use masses on weight hangers to apply various loads to the arch at set positions along its span. A load cell measures the thrust reaction.

LEARNING OUTCOMES:

- Demonstration of the characteristics of a two-pinned arch
- Examination of the relationship between applied loads and horizontal thrust produced from a redundant (in one degree) arched structure
- Comparison of behaviour to simplified theory based on the Secant assumption

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

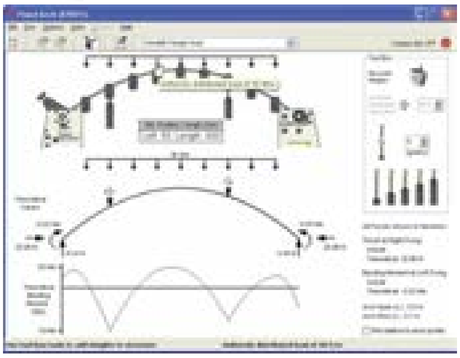
ALTERNATIVE PRODUCTS:

- Three-Pinned Arch (STR9) 192
- Fixed Arch (STR11) 194

FIXED ARCH

STR11

For the study of the characteristics of a fixed arch under various load conditions.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

- Demonstration of the characteristics of a fixed arch
- Examination of the relationship between applied loads, horizontal thrust and fixing moment produced from a fixed (thus redundant in three degrees) arched structure.
- Comparison of behaviour to simplified theory based on the Secant assumption.

To load the arch, students fit masses on weight hangers to set positions along the arch span. Load cells measure the fixed moment reaction and horizontal thrust.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

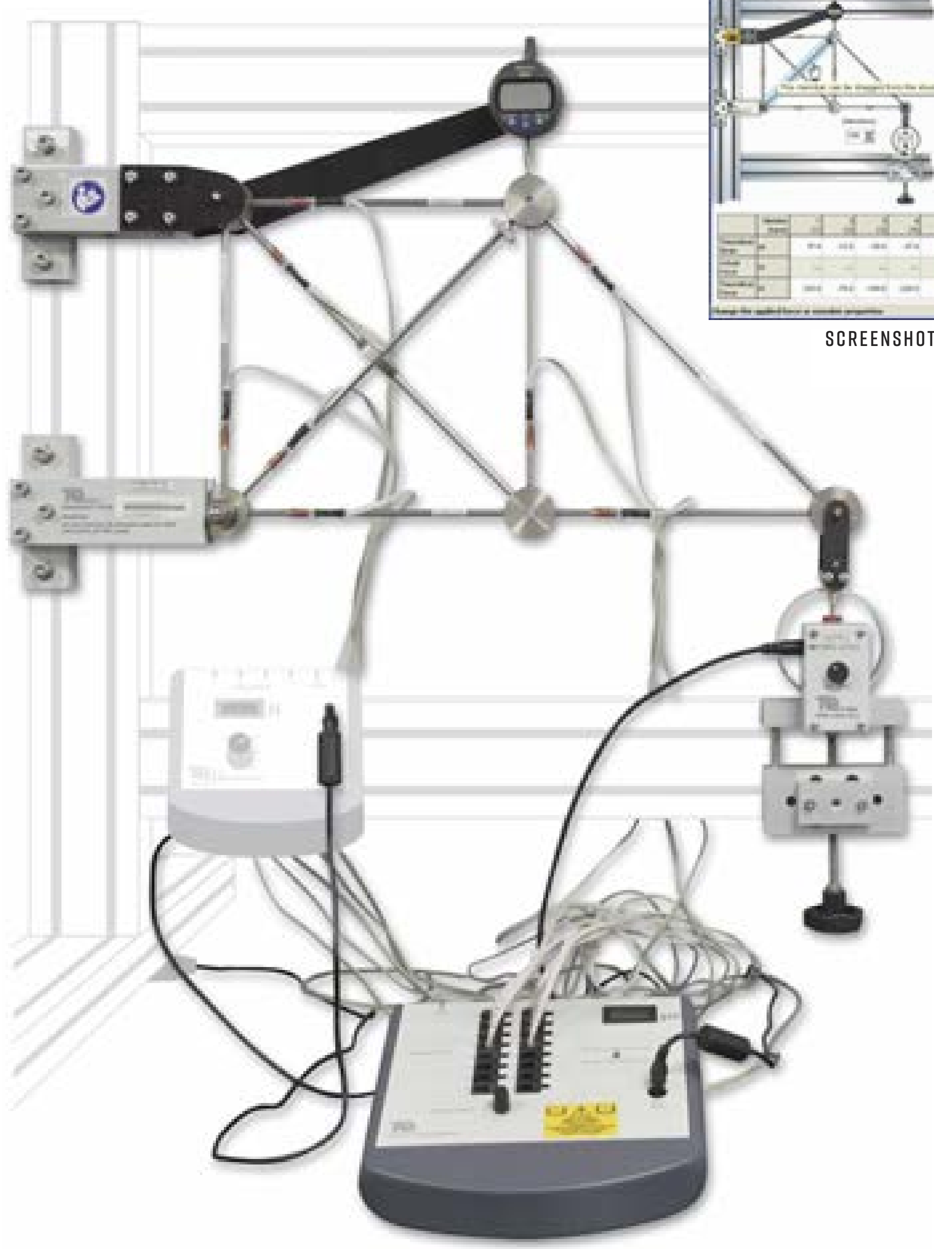
ALTERNATIVE PRODUCTS:

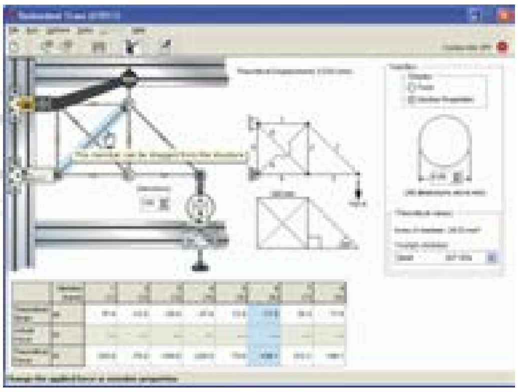
- Three-Pinned Arch (STR9) 192
- Two-Pinned Arch (STR10) 193

REDUNDANT TRUSS

STR17

For the study of determinate and indeterminate structures.





SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

Study of strains, stresses, forces and deflections in a:

- statically determinate structure; and
- statically indeterminate structure

Two supports hold the top and base of one side of a structure. The top support allows pivoting, the base support allows pivoting and rolling. Initially, one of the members is missing from the structure, making it determinate. To make the structure indeterminate, students refit the missing member. A load cell measures the applied force.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

ALTERNATIVE PRODUCTS:

- Pin-Jointed Frameworks (STR8) 191

STRUCTURAL MECHANICS LABORATORY, BIRZEIT UNIVERSITY

For many years, Birzeit University in Palestine has trusted TecQuipment to be their number one provider of engineering laboratory products to aid the teaching of mechanical, civil and environmental engineering courses. Knowing from personal experience that the equipment is built to last, and that they can rely heavily on local support from the TecQuipment agent in Palestine, backed up by the dedicated TecQuipment Customer Services team, it was the logical choice to choose TecQuipment once again for their new laboratory equipment.

NEW STRUCTURAL MECHANICS LABORATORY

The structural mechanics laboratory at Birzeit University is an expansion of the facilities dedicated to the Department of Civil and Environmental Engineering. The aim of the laboratory is to develop students' skills by integrating theoretical and practical aspects of structural behaviour.

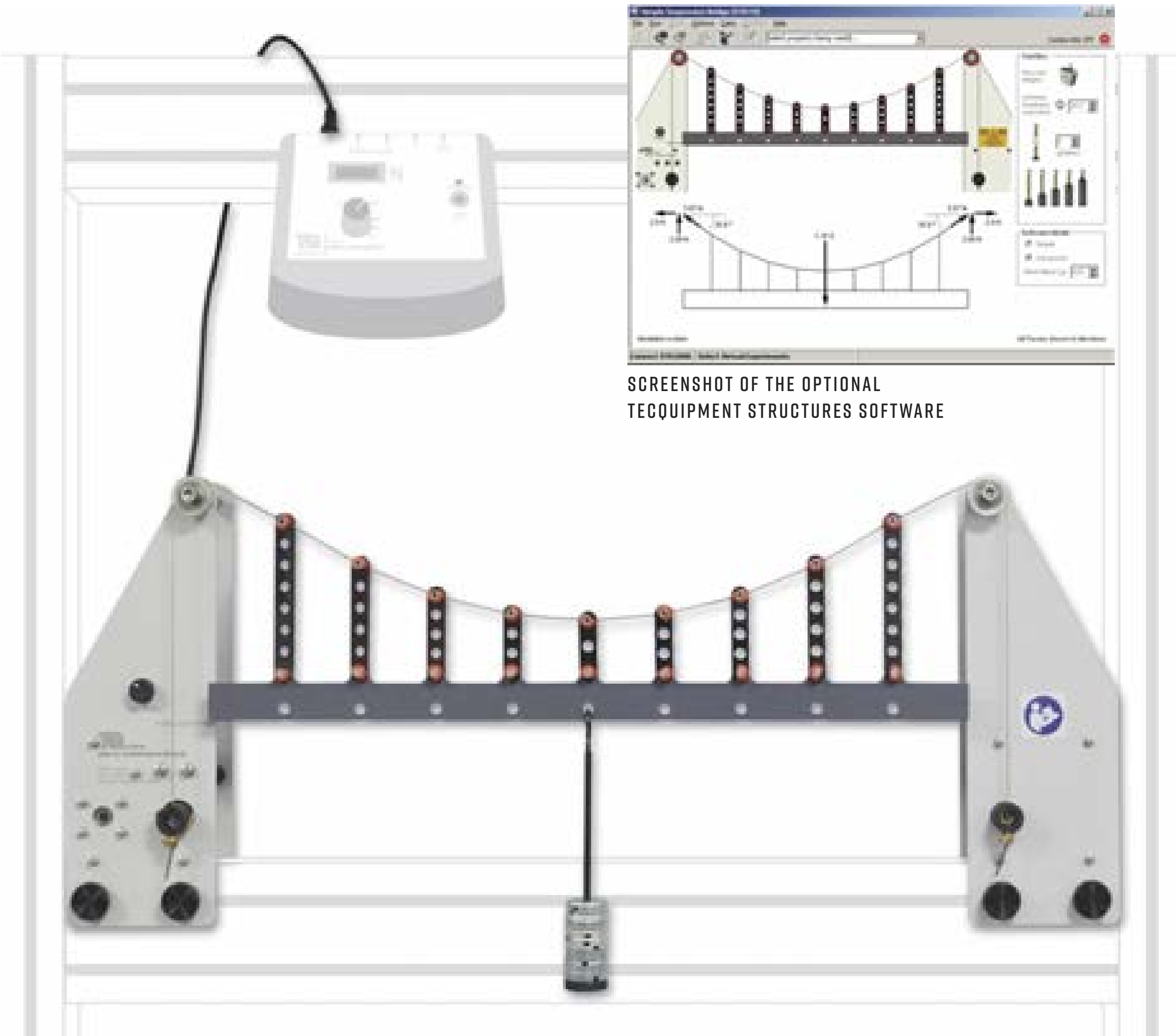
> "We are pleased with the TecQuipment set we have in our laboratory. It gives students a valuable chance to revisit the theory related to the material and structural behaviour studied in their mechanics of material and structural analyses courses." Commented Dr Ghada Karaki, Assistant Professor at the Department of Civil Engineering, Faculty of Engineering and Technology, Birzeit University.

Since the 1980s, when Birzeit University purchased fluid mechanics, material testing, aerodynamics and theory of machines products from TecQuipment that are still in use, they have continued to call upon the company for thermodynamics, fluid mechanics, structures, materials testing and theory of machines equipment.

SIMPLE SUSPENSION BRIDGE

STR19

For the study of characteristics of a simple suspension bridge.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

- Demonstration of the characteristics of a simple suspension bridge
- Examination of the relationship between applied loads and the suspension cable tension
- Observation of the stability of the structure
- Comparison of behaviour to simplified cable theory

Students use masses on weight hangers to apply various loads to a rigid deck, joined to a parabolic cable via hangers. A load cell measures the cable tension.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

ALTERNATIVE PRODUCTS:

- Suspension Cable Demonstration (STF2) 182

TECQUIPMENT USER GUIDES

Each piece of apparatus is accompanied by a comprehensive user guide which includes:

- Assembly instructions
- Use and maintenance instructions
- Associated theory

> "Every time we look at the quality of the materials you have used to build these apparatuses, and the user-friendliness of your software, we thank you and wished other companies would learn from you."
>
> PROFESSOR KHOSROWJERDI
> WESTERN NEW ENGLAND UNIVERSITY

THEORY INCLUDED

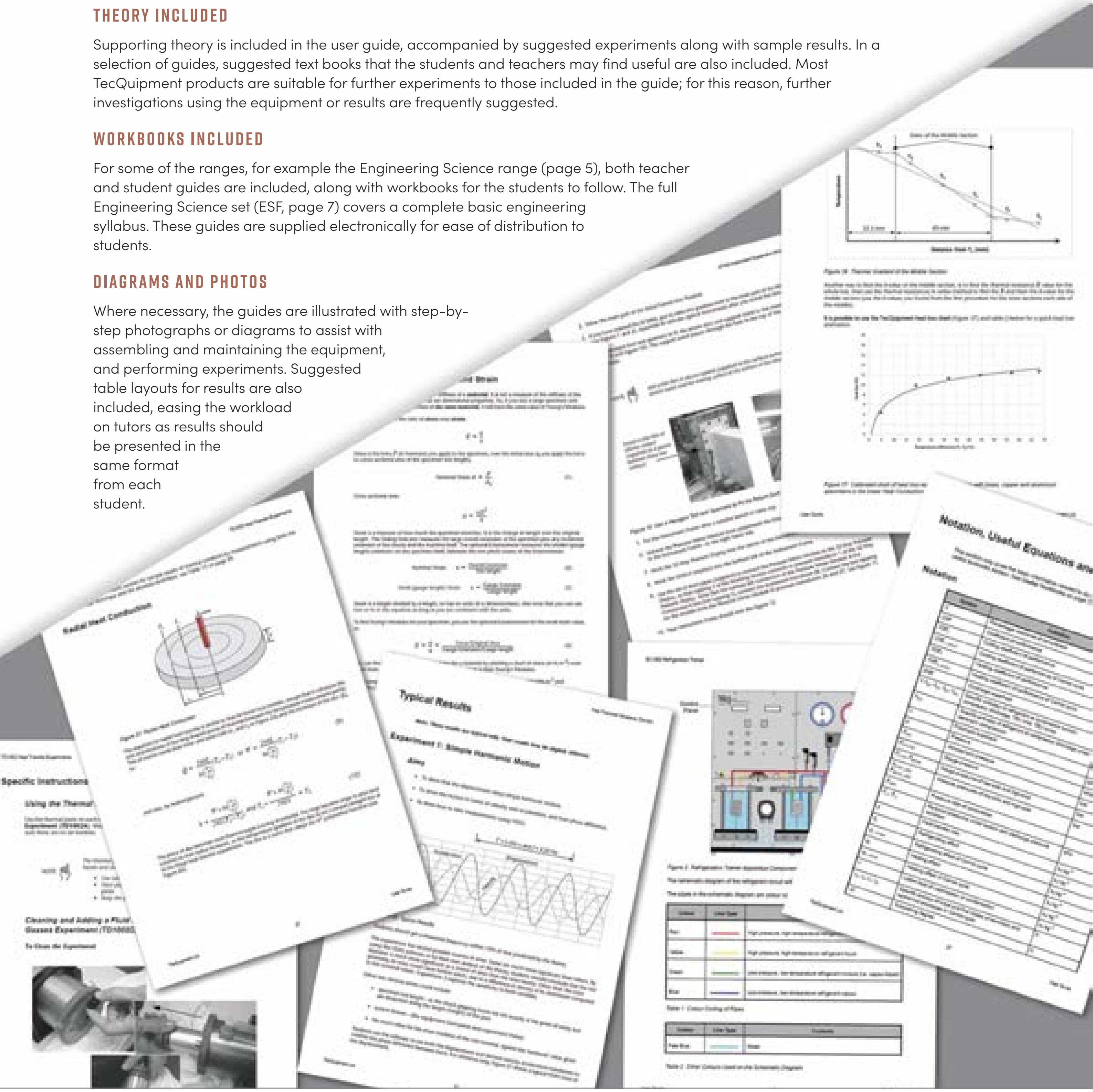
Supporting theory is included in the user guide, accompanied by suggested experiments along with sample results. In a selection of guides, suggested text books that the students and teachers may find useful are also included. Most TecQuipment products are suitable for further experiments to those included in the guide; for this reason, further investigations using the equipment or results are frequently suggested.

WORKBOOKS INCLUDED

For some of the ranges, for example the Engineering Science range (page 5), both teacher and student guides are included, along with workbooks for the students to follow. The full Engineering Science set (ESF, page 7) covers a complete basic engineering syllabus. These guides are supplied electronically for ease of distribution to students.

DIAGRAMS AND PHOTOS

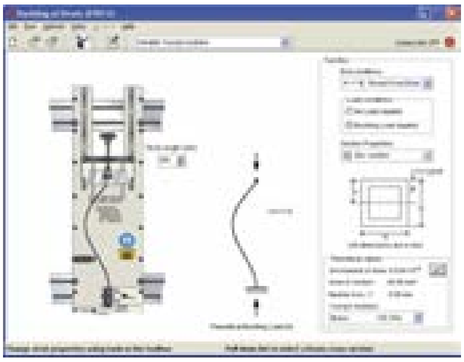
Where necessary, the guides are illustrated with step-by-step photographs or diagrams to assist with assembling and maintaining the equipment, and performing experiments. Suggested table layouts for results are also included, easing the workload on tutors as results should be presented in the same format from each student.



EULER BUCKLING OF A COLUMN

STR12

For the study of buckling of slender columns and relationships between length, end-fixing conditions and buckling load.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

- Euler buckling loads
- Relationship between strut length and collapse load
- Relationship between various end-fixing conditions and collapse load
- Nature of deflection and deflected shapes with various end-fixing conditions

Students compress aluminium columns (struts) using a screw mechanism. The equipment uses chucks to hold the struts and allows different end-fixing conditions. A load cell measures the load applied to the strut.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

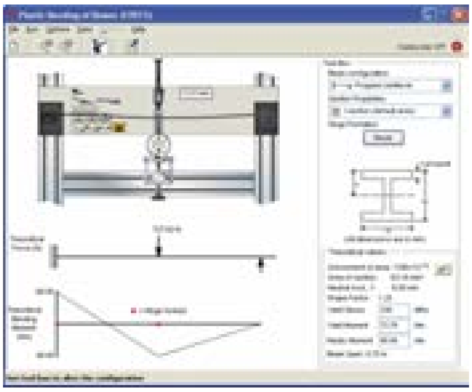
ALTERNATIVE PRODUCTS:

- Euler Strut Buckling Apparatus (SM1005) 177

PLASTIC BENDING OF BEAMS

STR15

Introduces students to plastic theory and limit state design.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

- Relationship between load and deflection for beams loaded to the plastic condition
- Introduction to form factor
- Introduction to limit state design
- Relationship between maximum loading and plastic hinge formation for a simply supported beam, a propped cantilever and a fixed beam

Students fix a specimen beam in chucks at both ends of a backboard. The chucks can either clamp the beam (encastré fixing), or hold it on a knife-edge. The students then load the beam using a screw mechanism and electronic load cell. Deflection of the structure is measured by a digital indicator.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

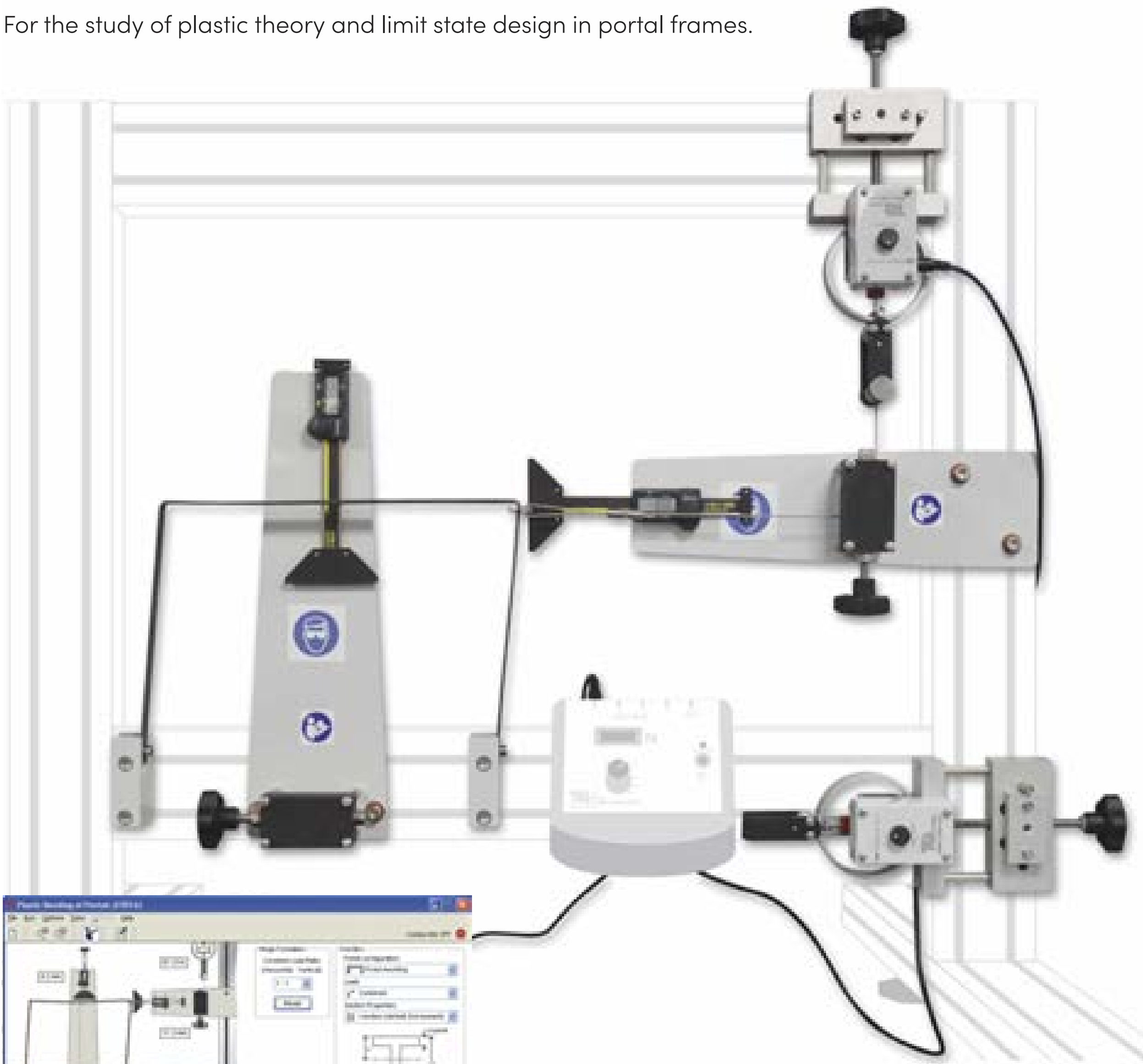
ALTERNATIVE PRODUCTS:

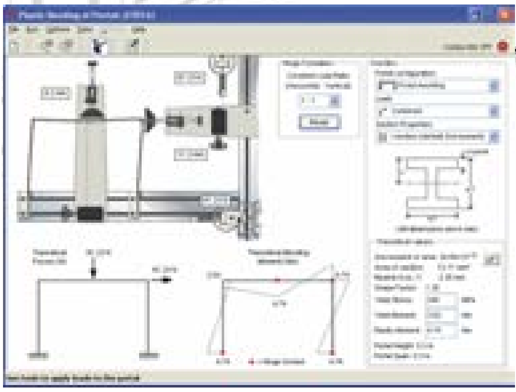
- Beam and Leaf Spring (SM1000g) 165

PLASTIC BENDING OF PORTALS

STR16

For the study of plastic theory and limit state design in portal frames.





SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

Students fix a specimen portal frame (two uprights with a cross-beam at the top) to the bottom cross-piece of a test frame. The test frame also holds horizontal and vertical screw mechanisms, with electronic load cells for loading the portal frame. Deflection is measured by two digital indicators.

LEARNING OUTCOMES:

- Relationship between load and deflection for portal frames loaded to the plastic condition
- Introduction to limit state design
- Relationship between maximum loading and plastic hinge formation in portal frames loaded vertically from the centre, horizontally from one corner, and equally from both positions
- Interaction between horizontal and vertical loading in terms of plastic hinge position and mode of collapse

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

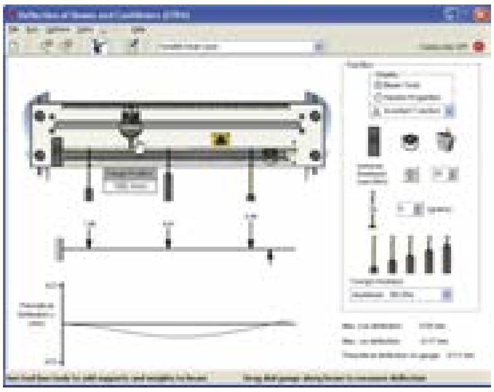
OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

DEFLECTION OF BEAMS AND CANTILEVERS

STR4

For the study of beam deflection under different loads and fixing conditions, and demonstration of Young's modulus.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

EXAMINATION OF:

- Beam deflections
- General bending formulae
- Beam end rotations
- Elastic modulus (Young's modulus) for various materials

TYPICAL CONDITIONS ARE:

- Cantilever
- Propped cantilever
- Encastré beam
- Simply supported beam

The experiment hardware consists of a backboard that fixes to the Structures Test Frame (STR1, available separately). Test beams fit onto the backboard using a rigid clamp and knife-edge supports. Students apply loads at any position using hangers holding various masses. Mounted on a trammel, a digital deflection indicator traverses the beam to measure beam deflection.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

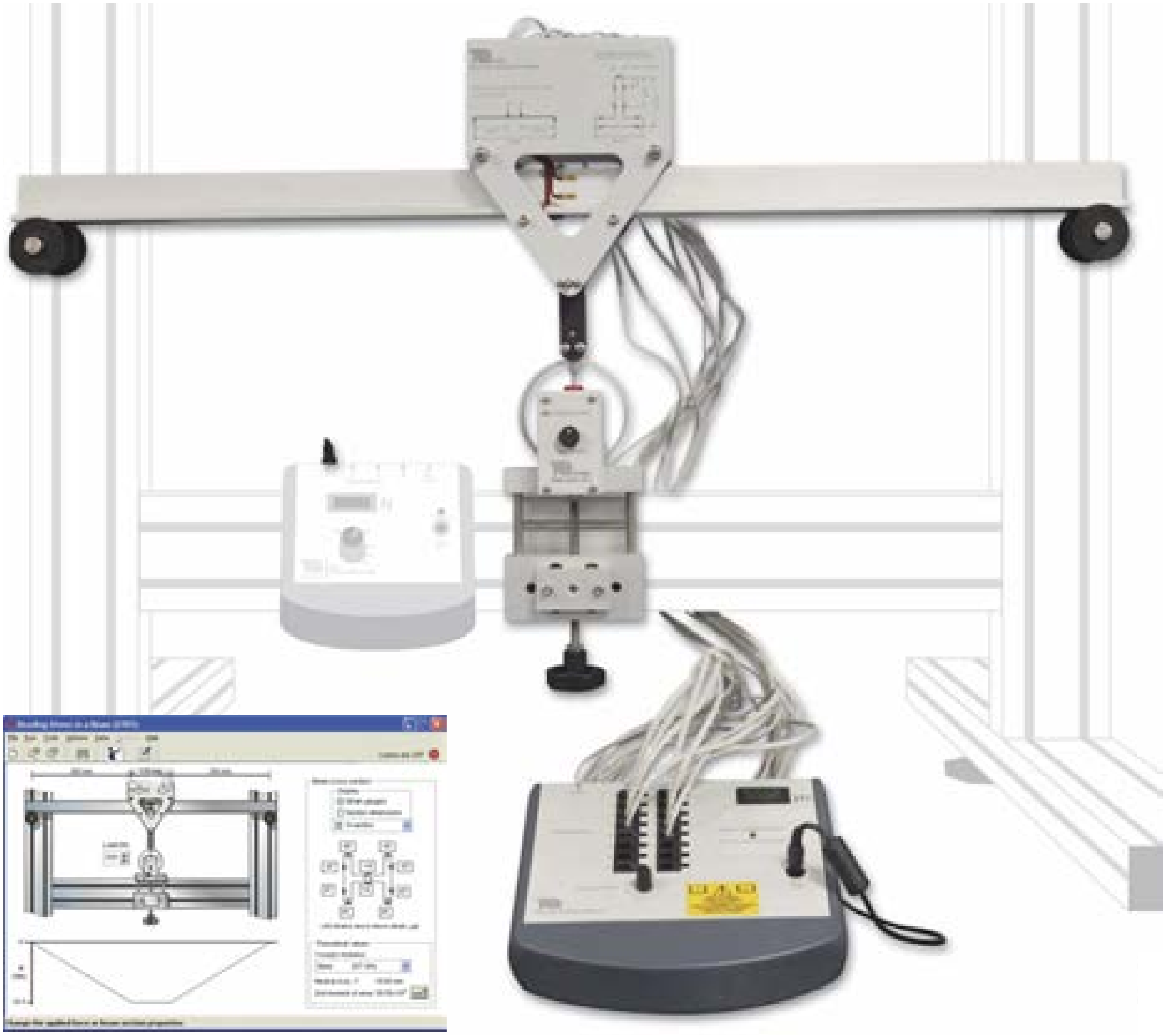
ALTERNATIVE PRODUCTS:

- Deflection of Beams and Cantilevers Kit (ES4) 11
- Stiffness – Bending and Torsion (TE16) 152
- Beam and Leaf Spring (SM1000g) 165
- Beam Apparatus (SM1004) 175
- Continuous and Indeterminate Beams (STR13) 204

BENDING STRESS IN A BEAM

STR5

For the study of stress distribution across the section of a beam.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

Study of:

- Second moment of area
- Converting strains to stresses
- Strain gauges
- The neutral axis
- The bending equation

The experiment hardware is a T-beam that fits onto a Structures Test Frame (STR1, available separately). Students adjust a load cell that bends the beam and, when connected to the optional Digital Force Display (STR1a, available separately), it measures the bending force (load). Strain gauges and a digital strain bridge measure the strains in the beam. Dummy strain gauges compensate for temperature variation and balance the strain bridges.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

CONTINUOUS AND INDETERMINATE BEAMS

STR13

Versatile equipment for a wide variety of beam experiments, from simple cases to complex problems.

SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

- Reactions of a simply supported beam
- Reactions of a two-span continuous beam
- Reactions and fixing moments of a fixed beam and a propped cantilever
- Reaction and fixing moment of a propped cantilever with a sinking support
- Relationship between load and deflection for beams and cantilevers

This equipment allows many possible experiment configurations, using a stiff (rigid) beam or a significantly more flexible beam.

Students rest a beam on up to three 'piers'. The piers are movable, so students can arrange them in many different positions under the beam. Students use masses on weight hangers to load the beam. Each pier has a load cell to measure the reaction force. A flexible beam can also be attached to measure deflection or fixing moment.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

ALTERNATIVE PRODUCTS:

- Deflection of Beams and Cantilevers Kit (ES4) 11
- Stiffness – Bending and Torsion (TE16) 152
- Beam and Leaf Spring (SM1000g) 165
- Beam Apparatus (SM1004) 175
- Deflection of Beams and Cantilevers (STR4) 202

LOOK AT THE MATERIALS TESTING RANGE

THE MATERIALS TESTING AND PROPERTIES RANGE ALSO EXTENDS INTO THE AREA OF STRUCTURES AND STRUCTURAL ELEMENTS AND INCLUDES THE FOLLOWING FREE-STANDING PRODUCTS:

UNSYMMETRICAL CANTILEVER APPARATUS (SM1003) – **PAGE 174**

Examines and displays bending of an unsymmetrical cantilever.

BEAM APPARATUS (SM1004) – **PAGE 175**

Examines the deflection and forces on different types of beams for a wide range of supports and loads.

EULER STRUT BUCKLING APPARATS (SM1005)

EULER STRUT BUCKLING APPARATUS (SM1005) – **PAGE 177**

Tests different types of struts and demonstrates how they deflect under load.

VDAS®

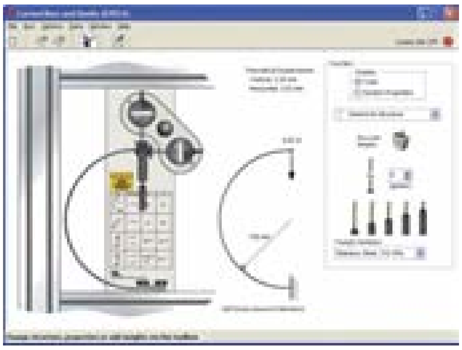
The above equipment is compatible with TecQuipment's Versatile Data Acquisition System (VDAS®). This gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer – **PAGE 299**

SM1003 VDAS® SCREENSHOT

CURVED BARS AND DAVITS

STR14

For students to investigate two common curved structures and two common davit structures.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

Investigation of the relationship between load, horizontal deflection and vertical deflection for:

- Curved davit
- Angled davit
- Semicircle structure
- Quarter-circle structure

Included with the experiment module are four different structures. Loads are then applied to the structure using masses on hangers. Deflection of the structure is measured by two digital indicators.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

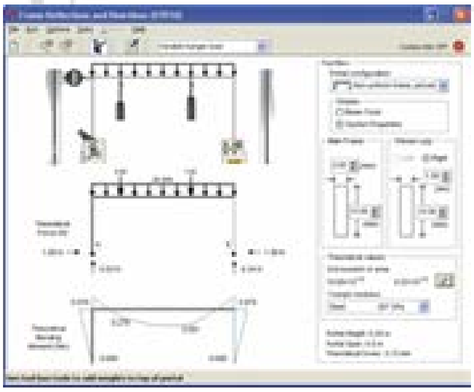
OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

FRAME DEFLECTIONS AND REACTIONS

STR18

For the study of rectangular portals subjected to vertical loads.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

Study and comparison of load, horizontal reactions, fixing moments, sway and shear forces in a:

- rectangular portal with a uniform section; and
- rectangular portal with a non-uniform section

The hardware includes two rectangular portal frames with the same dimensions. However, one of the frames has a constant second moment of area, while the other has one leg with a smaller second moment of area. Load is applied using variable masses whilst deflection is measured by a digital indicator.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

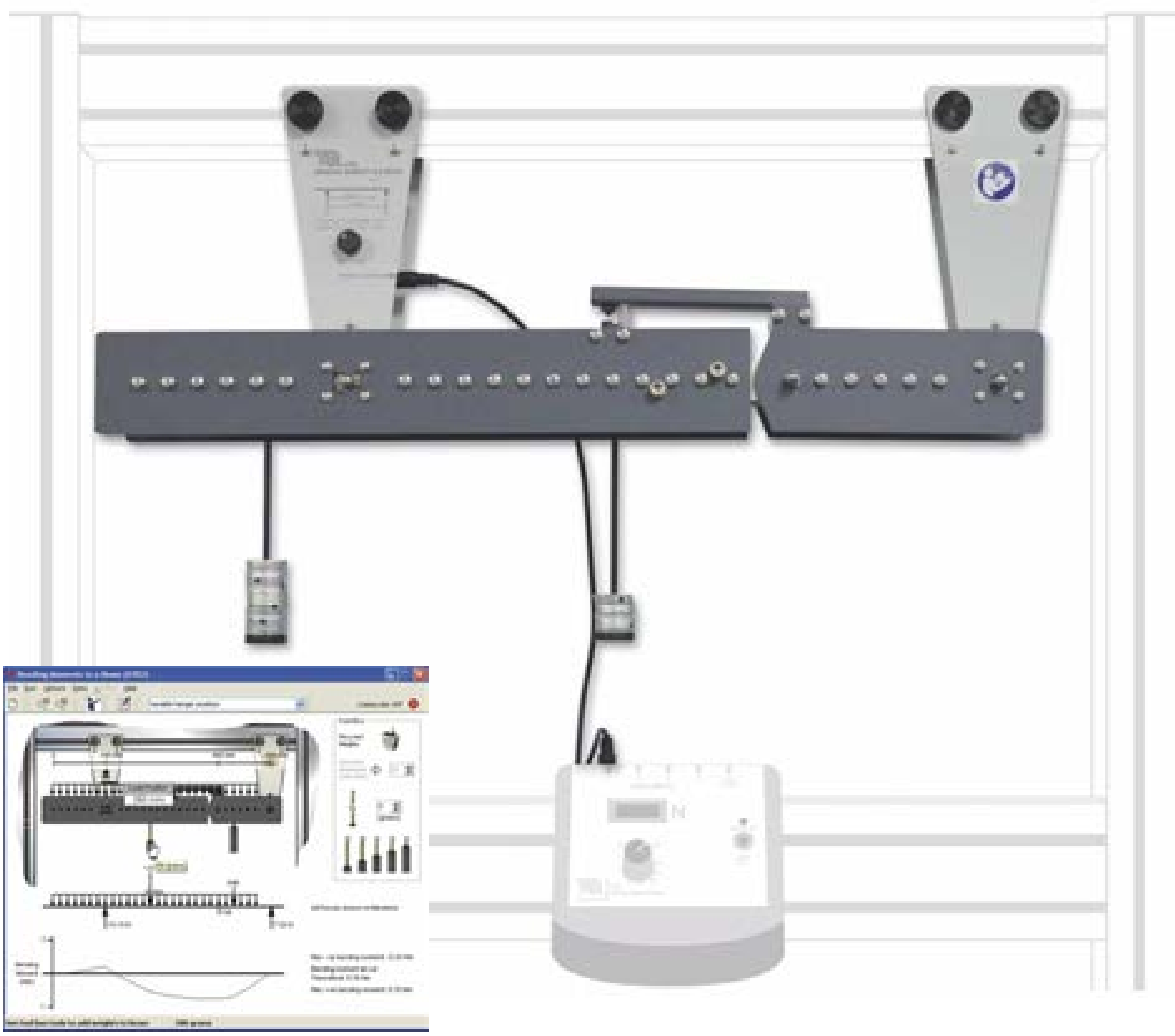
ALTERNATIVE PRODUCTS:

- Bending Moments in a Portal Frame (STR20) 210

BENDING MOMENTS IN A BEAM

STR2

Illustrates and proves the basic theory of bending moments in a beam.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

- Bending moment variation at the point of loading
- Variation of bending moment away from the point of loading
- Examination of various other loading cases, including loads traversing the beam

The experiment hardware is a simply supported beam 'cut' by a pivot. Students apply loads at set positions using hangers holding various masses. To stop the beam collapsing, a moment arm bridges the 'cut' onto a load cell, thus reacting to (and measuring) the bending moment force.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

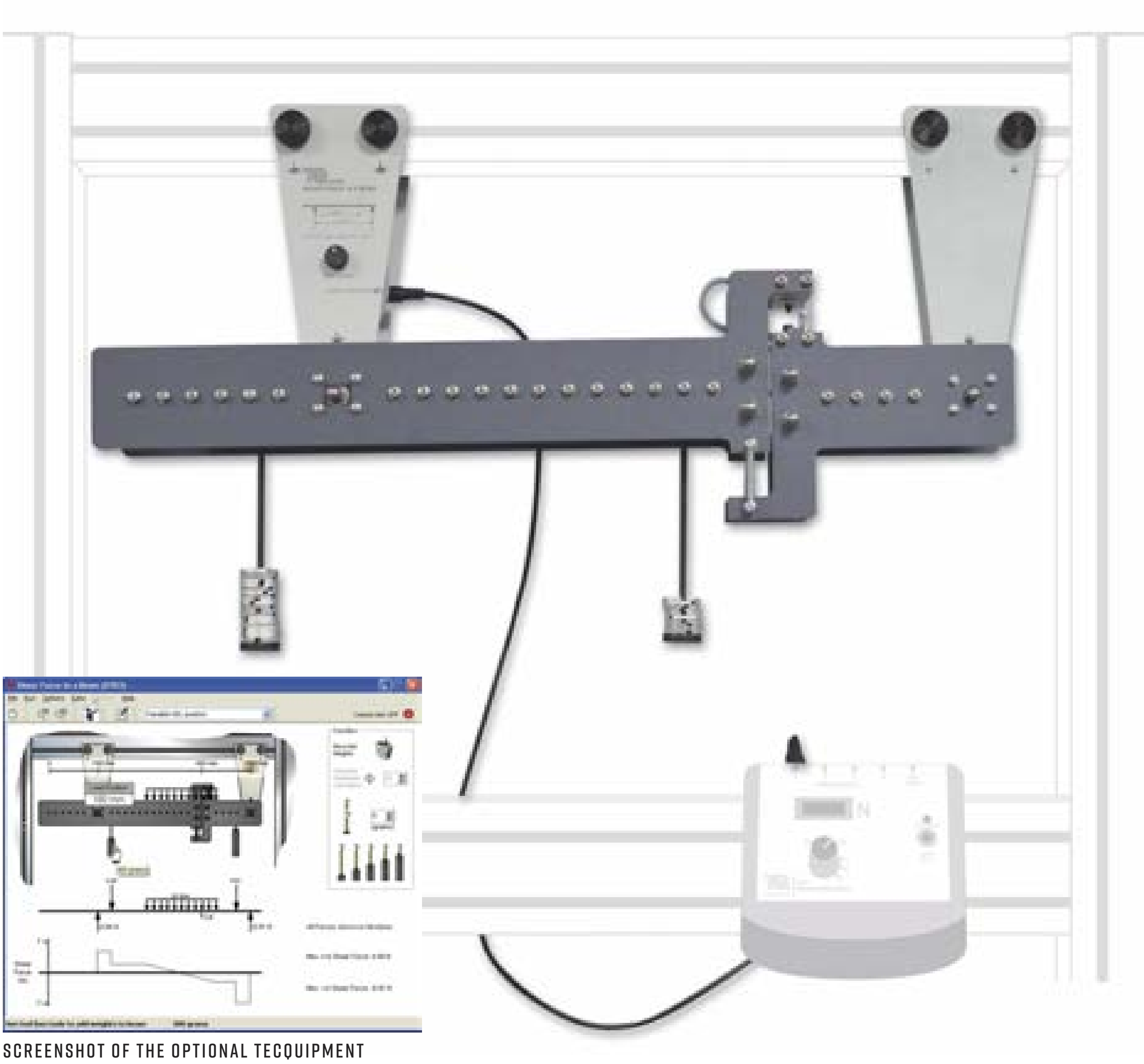
OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

SHEAR FORCE IN A BEAM

STR3

Illustrates and proves the basic theory of shear force in a beam.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

- Shear force variation with an increasing point load
- Variation of shear force for various loading conditions
- Examination of various other loading cases and their effect on shear force, including loads traversing the beam

The experiment hardware is a simply supported beam with a 'cut'. A mechanism bridges the cut, which stops the beam collapsing and allows movement in the shear direction only. Students apply loads at set positions using hangers holding various masses. The load cell measures shear force at the 'cut'.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

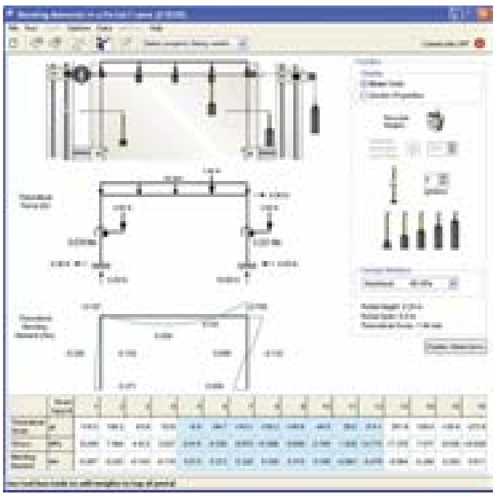
OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

BENDING MOMENTS IN A PORTAL FRAME

STR20

For the study of bending moments and sway in portal frames.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

Students use masses on weight hangers to apply various loads to a portal frame. The portal has three members: a horizontal beam and two vertical members or 'legs' joined at two upper corners. All members are of the same material and have the same flexural rigidity, i.e. value. Deflection is measured by a digital indicator.

LEARNING OUTCOMES:

- Strain gauge linearity
- Using strain measurement to find the bending moment
- Bending moments and sway for vertical and horizontal loads
- Bending moments for internal and external moments on vertical members
- Comparison of ideal and non-ideal structures

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

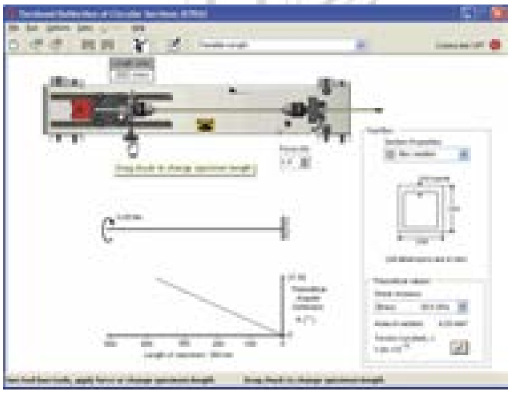
ALTERNATIVE PRODUCTS:

- Frame Deflections and Reactions (STR18) 207

TORSION OF CIRCULAR SECTIONS

STR6

For the study of torque and deflection in different materials with circular section.



SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

Study of:

- The relationship between specimen length, torque and angular deflection
- The behaviour of specimens of different materials and sections
- General torsion theory
- Shear modulus
- Polar moment of inertia

The experiment module examines the behaviour in the elastic region of solid and tubular-section specimens. Two chucks on a backboard hold a test specimen. A mechanism on one chuck applies torque manually to the specimen. A protractor scale on this chuck measures angular movement. A load cell on the other chuck measures torque.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

ESSENTIAL ANCILLARIES:

- Digital Force Display (STR1a) 189

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

ALTERNATIVE PRODUCTS:

- Torsion of Circular Sections Kit (ES5) 12
- Additional Torsion Testing Kit (TE16b) 152
- Torsion Testing Machine – 30 Nm (SM1001) 158

UNSYMMETRICAL BENDING AND SHEAR CENTRE

STR7

For the study of vertical and horizontal deflection of different unsymmetrical (asymmetric) sections.

SCREENSHOT OF THE OPTIONAL TECQUIPMENT STRUCTURES SOFTWARE

LEARNING OUTCOMES:

Study of:

- Horizontal and vertical deflection of different unsymmetrical sections under various loads and at various angles
- Relationship between the vertical and horizontal deflections and the principal moments of area of each section
- Shear centre of various unsymmetrical sections

The experiment module examines the vertical and horizontal deflection of different unsymmetrical sections at various angles and loads. Two multi-way chucks hold a test specimen vertically. One chuck has an indexing system for rotating the beam in set increments. This changes the angle of loading. The other chuck and a weight hanger applies a variable load. Two digital deflection indicators measure deflection in the x and y directions. An interchangeable plate allows students to find the shear centre of the specimen.

ESSENTIAL BASE UNIT:

- Structures Test Frame (STR1) 188

RECOMMENDED ANCILLARIES:

- Structures Software (STRS) for virtual experiments 190

OR

- Automatic Data Acquisition Unit (STR2000) for automatic data acquisition and virtual experiments 189

ALTERNATIVE PRODUCTS:

- Unsymmetrical Cantilever Apparatus (SM1003) 174

THEORY OF MACHINES

"

We saw the things required for training and everything was in good shape and we could see that there was high quality assurance for material testing and production. We were impressed and happy that whatever TecQuipment provided was good quality and, as customers, we're very satisfied.

MAK'OMONDI LUCAS OWINO
HEAD OF TRAINING, EAST AFRICA SCHOOL OF AVIATION

THEORY OF MACHINES

The Theory of Machines range offers teaching equipment for the basics of machine engineering, such as motion, to more advanced studies of free and forced vibration, friction in bearings, geared systems and governors.

SAFE YET HIGHLY VISUAL

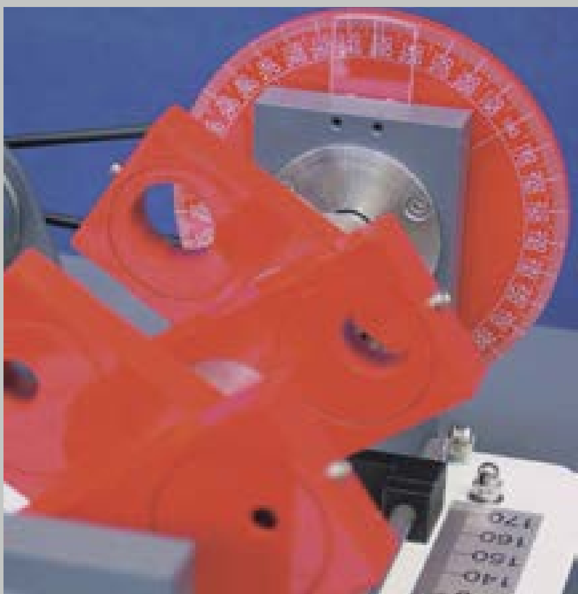
Due to the amount of fast moving parts in this range, extra safety features have been incorporated. Interlocked guards prevent accidents, while care has been taken in the design process not to compromise the visibility.

KEY FEATURES AND BENEFITS:

BASIC TO ADVANCED TEACHING: To suit all your laboratory needs.

SAFETY BY DESIGN: Interlocked guards where required prevent accidents.

AUTOMATIC DATA ACQUISITION: Fast moving equipment often requires multiple fast measurements, making data acquisition a powerful tool.

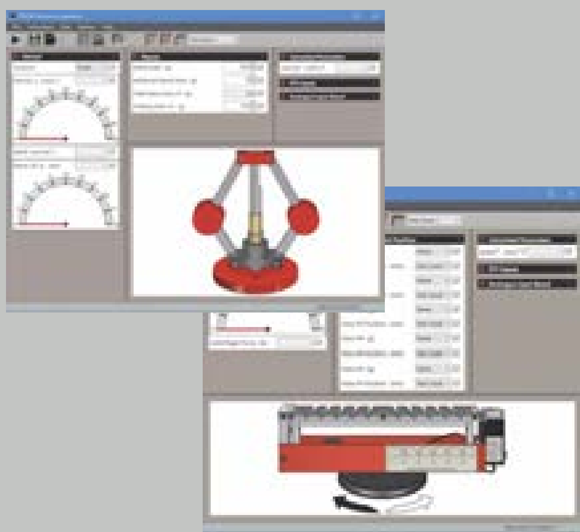


ENGINEERING SCIENCE

The Engineering Science range also includes products that demonstrate some of the fundamental principles of simple machines, such as pulleys and gears – **SEE PAGE 5.**

AUTOMATIC DATA ACQUISITION VDAS®

Look at the products in this range that work with TecQuipment's unique Versatile Data Acquisition System (VDAS®) – **SEE PAGE 299**.

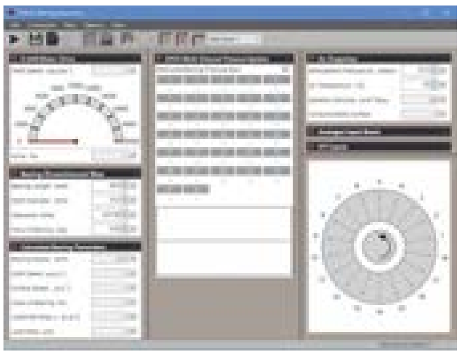


AIR BEARING APPARATUS

VDAS® TE96

A self-contained air bearing apparatus to demonstrate the performance of self-acting, gas-lubricated journal bearings, including the phenomenon of half-speed whirl.

- Demonstrates the performance of a self-acting, gas (air)-lubricated journal bearing
- Self-contained and bench-mounted – includes all instrumentation needed for tests
- Variable bearing load and speed, for a range of tests
- Includes a multi-channel digital pressure display
- Demonstrates the onset of bearing 'whirl'



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

The main part has a variable-speed motor that turns a belt drive. The belt drive turns a precision bearing shaft. The shaft has a high-quality surface finish and spins inside a vertically loaded bush. A hand-operated load control and load cell allow the user to apply and measure the load on the bearing bush. The bush has pressure tappings equally spaced around its circumference. The tappings connect to a multichannel digital pressure display unit.

LEARNING OUTCOMES:

- Demonstrate how a vertical load affects the pressure distribution around an air-lubricated journal bearing
- Demonstrate how bearing speed, and therefore compressibility number, affects the pressure distribution in the bearing, and how this compares with theory
- Demonstrate the onset of 'whirl'

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

ALTERNATIVE PRODUCTS:

- Michell Pad Apparatus (TE99) 217
- Journal Bearing Demonstration (TM25) 218

HERTZIAN CONTACT APPARATUS

TE98

Self-contained unit that allows a practical examination of Hertz's theories of contact between materials.

- Compact, self-contained unit – needs no electricity or external services
- Uses flexible material to produce magnified and easily viewed results
- Controllable hydraulic pressure system with gauge for repeatable results
- Variable relative contact angles and pressures for a range of experiments

LEARNING OUTCOMES:

- The effect of varied pressure with constant angle
- The effect of varied angle (different relative curvature) with constant pressure

The apparatus has two pads with curved contact surfaces. The upper pad (made of a transparent plastic material) has a compound radius. The lower pad (made of an opaque flexible material) has a simple radius. A hand-operated hydraulic pump and cylinder force the two pads together. Students may rotate the lower pad – a pointer shows the angle of rotation. This allows a study of the effect of different relative curvatures.

DOCUMENTS INCLUDED – EVERYTHING YOU NEED

A comprehensive pack of documents is supplied with all experiments, including:

- **USER MANUAL:** How to use the product, along with instructions on experiment set-up and supporting enginering principles for guided learning.
- **PACKING CONTENTS LIST:** All the parts that make up the complete product.
- **TEST CERTIFICATE:** Your peace of mind that the product has been thoroughly tested before dispatch.

MICHELL PAD APPARATUS

TE99

Demonstrates the pressure distribution across the film of oil in a Michell tilting pad slider bearing. Helps to prove Reynold's equation for pressure gradient in fluid film.

- Proven design, based on a machine created by Imperial College London
- Accurately mimics a Michell tilting pad, fluid-lubricated slider bearing
- Fully adjustable pad (tilt) angle
- Includes oil and a viscometer

The bench-mounting unit has an aluminium plate (pad) mounted above a continuous loop flat belt. The belt runs in an oil reservoir to provide a continuous supply of oil under the pad. This creates a pressurised film of oil between the pad and the belt. A set of 13 graduated tubes show the oil pressure across and along the film under the pad.

ALTERNATIVE PRODUCTS:

- Air Bearing Apparatus (TE96) 215
- Journal Bearing Demonstration (TM25) 218

LEARNING OUTCOMES:

Study of:

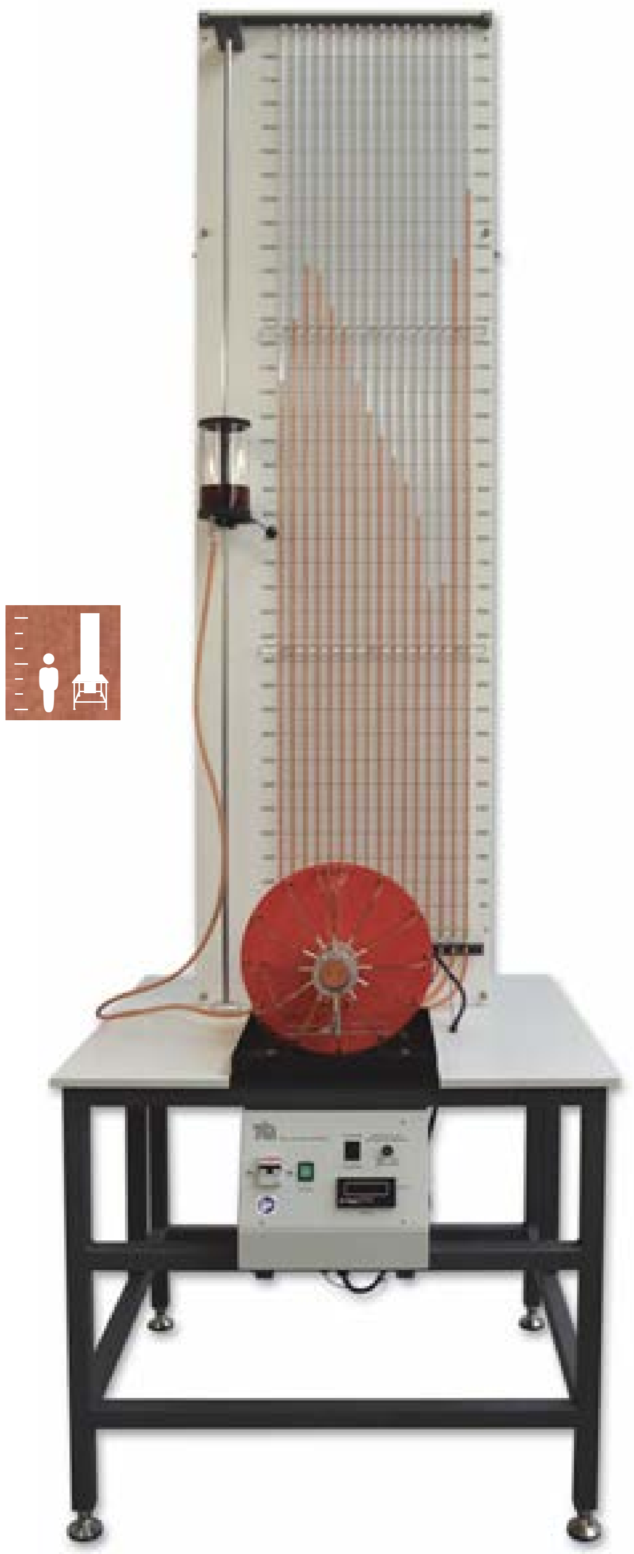
- Pressure distributions in a tilting pad bearing
- Influence of sliding speed and viscosity on the pressure distribution in the bearing, and comparison with calculations based on Reynold's equation
- Relationship between pressure and the film thickness at the trailing edge of the pad

JOURNAL BEARING DEMONSTRATION

TM25

Demonstrates the pressures around a journal bearing at different speeds.

- Acrylic bearing allows clear observation of oil film at all times
- Pressure profiles, along and around the bearing, continuously monitored on large manometer panel
- Theoretical pressure profiles (Sommerfeld analysis) may be tested and compared with practical results
- Provides striking demonstration of self-excited vibrations (half-speed whirl)
- Fully adjustable speed, direction and loads



LEARNING OUTCOMES:

SIMPLE DEMONSTRATIONS:

- Observation of oil wedge (film thickness) and hence eccentricity variations for different speeds and loads
- Observation of the pressure profiles at these conditions
- Observation of the critical bearing whirl

EXPERIMENTS:

- Measuring pressure profiles for chosen conditions and plotting the Cartesian and polar pressure curves
- Measuring pressure profiles for chosen conditions and plotting the theoretical Sommerfeld curve
- Measuring shaft speed and journal speed at the critical whirl

All tests may be conducted for either direction of rotation of the shaft.

An adjustable reservoir supplies oil to a low-pressure region at both ends of the bearing. The bearing contains 12 equi-spaced pressure tappings around its circumference, and four additional ones along its topside and on a vertical radial plane. All are connected by light and flexible plastic tubes to the rear manometer panel, to clearly show the pressure head of oil at all 16 points at all times. Students load the bearing by attaching weights (included) to arms connected to the bearing.

RECOMMENDED ANCILLARIES:

- Stroboscope (ST1) 303

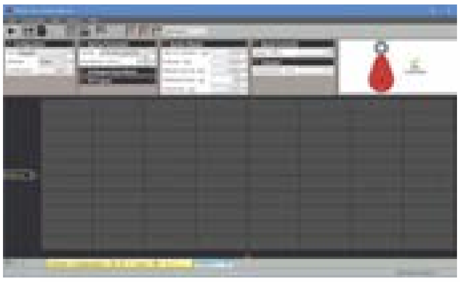
ALTERNATIVE PRODUCTS:

- Air Bearing Apparatus (TE96) 215
- Michell Pad Apparatus (TE99) 217

CAM ANALYSIS MACHINE

VDAS® TM1021

Studies the dynamic behaviour of different cams and followers and their 'bounce' speed.



SCREENSHOT OF THE VDAS® SOFTWARE

- Illustrates cam and follower separation or 'cam bounce' under safe and controlled conditions
- Fully interlocked for safety
- Highly visual and audible – perfect for demonstrations
- Works with TecQuipment's VDAS® to capture data and show live traces (on a computer screen) of the follower movement – even at bounce

LEARNING OUTCOMES:

- Comparing actual results with theory for profiles of follower displacement, acceleration and velocity
- Cam bounce speeds for different cam and follower combinations, and comparison of speeds to those predicted by simplified theory
- How spring rate, preload and follower mass affect cam bounce speed

The main part of the product has a precision-machined heavy steel base which holds a high-torque, direct-drive variable-speed motor. The motor shaft connects through a coupling to the main shaft which then passes into the cam test area. Self-aligning heavy-duty bearings support the shaft which has a substantial flywheel. The flywheel reduces speed variations as the torque demand changes during the cam rotation cycle. The cam under test fits to the end of the main shaft, accurately mounted both axially and radially to ensure repeatability. The follower fits to the bottom of a vertical shaft running in low-friction linear bearings.

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – bench-mounted version (VDAS-B) 299

NOTE: This equipment needs the latest VDAS® and will not work with early versions of VDAS®. Contact TecQuipment or the local agent if unsure.

ALTERNATIVE PRODUCTS:

- Cam and Crank and Toggle Kit (ES12) 23

ENGAGING STUDENTS THROUGH COMPETITIONS

For academics looking to find new ways of motivating students with the practical elements of their courses, TecQuipment is introducing student competitions. This is achieved by working with academics to create custom competitions that integrate into the syllabus.

COMPETITION EXAMPLE

First-year Mechanical Engineering students at Nottingham Trent University were set a new challenge in their thermo-fluids module to help them prepare for the real world of work at the end of their degree. The students were required to design a new experiment, using one of TecQuipment's fluid mechanics products, to investigate a fluid phenomenon of their choosing.

To enter, students submitted a video of the team demonstrating the experiment and discussing the outcomes, which was judged live by a panel. Winners received a trophy and prize money provided by TecQuipment.

Email MARKETING@TECQUIPMENT.COM to discuss competition options.

SIMON WOODS PRESENTS 'A CAREER IN ENGINEERING' AT NOTTINGHAM TRENT UNIVERSITY TO FIRST-YEAR ENGINEERING STUDENTS

FLUID MECHANICS LABORATORY AT NOTTINGHAM TRENT UNIVERSITY

WHIRLING OF SHAFTS AND CRITICAL SPEED

TM1001

Demonstrates 'whirling' in different horizontal shafts with a variety of fixings (end conditions), loaded and unloaded.

- Demonstrates first and second mode whirl speeds and how to predict them
- Extra bearings and weights (included) give a choice of free-free, fixed-free and fixed-fixed end conditions and experiments with loaded shafts and eccentric loading
- Supplied with different shafts to study how length and diameter affects whirling
- Optional stroboscope to 'freeze' the image of the shaft to see its shape clearly

LEARNING OUTCOMES:

- Basic whirling demonstration
- The effect of shaft length and diameter
- The effect of end conditions (fixings)
- Loaded shaft (one and two masses)
- Eccentric loading

A variable-speed motor turns the horizontal test shaft. Two bearings hold the shaft – one bearing at the 'driven end' and the other bearing at the 'tail end' of the shaft. The tail end bearing slides in its housing to allow the shaft length to change as it 'whirls'. Similar to a beam on two simple knife-edge supports, both bearings allow free angular shaft movement (free ends condition). Also supplied with the equipment are extra bearings that restrict angular movement when fitted, to give 'fixed ends'.

RECOMMENDED ANCILLARIES:

- Stroboscope (ST1) 303

GEARED SYSTEMS

VDAS® TM1018

A set of products for dynamic and static experiments on geared and other drive systems.

FEATURES:		BENEFITS:
Fully equipped bench-mounted base unit for tests on several different drive units	→	Saves space and reduces costs
Includes gear drive unit, with optional belt, chain and helical gear drive systems	→	Offers comparative tests of different designs
Optional test stand (TM1018a)	→	For additional tests in static efficiency and inertia
Easy set-up – all drive units can be removed and fitted in minutes	→	Maximises experiment time
Works with VDAS®	→	Quick and reliable tests with data capture

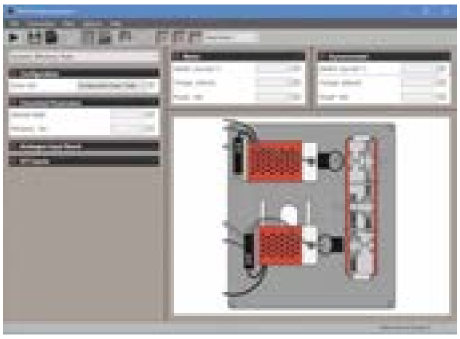
LEARNING OUTCOMES:

DYNAMIC:

- Simple and compound gear trains
- Mechanical advantage, velocity ratio and dynamic efficiencies of gear trains
- Mechanical advantage, velocity ratio and dynamic efficiencies of optional drive systems (chain, belt and helical gears)
- Appreciation of the different characteristics of drive systems
- Chain and belt drive tension, including different methods of application

ACCELERATION AND STATIC:

- Mechanical advantage, velocity ratio and static efficiencies of gear drives
- Mass moment of inertia of a flywheel by experiment and calculation
- Mass moment of inertia of geared drive systems by experiment and calculation



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

In the base unit's upper level, the student fits their choice of drive unit. A variable-speed, low-voltage motor provides the shaft input turning force (effort) to the drive. A dynamometer provides the output braking force (load) to the drive. The dynamometer uses electromagnetic braking and a hysteresis effect to provide a variable load at a constant torque, irrespective of the speed. Sensors on the motor and dynamometer measure their shaft speed, torque and therefore power in and out at the drive. Fans provide air cooling for both the motor and dynamometer. Flexible couplings with collets connect the drive unit to the motor and dynamometer for quick and accurate alignment.

OPTIONAL TEST STAND TM1018A

The Acceleration and Static Test Stand (TM1018a) gives extra experiments in measuring angular acceleration and static efficiency.

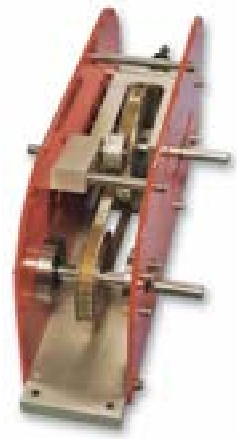
RECOMMENDED ANCILLARIES:

- Acceleration and Static Test Stand (TM1018a) 223
- Toothed Belt Drive (TM1018b) 223
- Round Belt Drive (TM1018c) 223
- Chain Drive (TM1018d) 223
- Helical Gear Drive (TM1018e) 223
- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

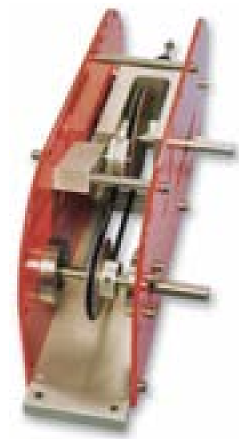
OPTIONAL DRIVE UNITS

TOOTHED BELT DRIVE TM1018B
ROUND BELT DRIVE TM1018C
CHAIN DRIVE TM1018D
HELICAL GEAR DRIVE TM1018E

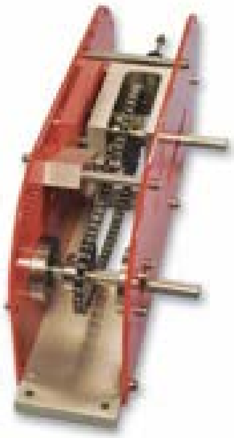
The optional drive units work with the TM1018 base unit for dynamic tests on performance, allowing comparison with the gear drive. For extended experiments, the optional drives each include three different methods of adjusting their tension to demonstrate how this affects performance.



TOOTHED BELT DRIVE
TM1018B



ROUND BELT DRIVE
TM1018C



CHAIN DRIVE
TM1018D

HELICAL GEAR DRIVE
TM1018E

ALTERNATIVE PRODUCTS:

- Drive Systems Kit (ES11) 20
- Gear Trains Kit (ES13) 21
- Potential and Kinetic Energy Kit (ES9) (for the optional test stand TM1018a) 17

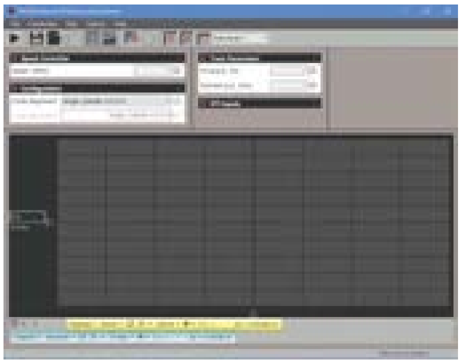
BALANCE OF RECIPROCATING MASSES

VDAS® TM1022

A model four-cylinder engine that demonstrates the primary and secondary forces and moments when balancing reciprocating masses.

- Includes a control and instrumentation unit to process the force and moment signals – also has an electronic drive control to adjust and display the engine speed accurately
- Simulates one, two and four-cylinder engines
- Variable crank angle settings and additional piston masses – for a range of tests
- Works with VDAS® to show dynamic force and moment waveforms for popular engine arrangements and compare them with theory

A cantilever holds a model four-cylinder engine. The model engine has a crankshaft, connecting rods, bushes (as big-end bearings), pistons and a cylinder block. A separate control and instrumentation unit (included) controls a motor that turns the engine crankshaft. The crankshaft has adjustable sections. Students can rotate each section relative to the others to change the crank angles.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

- Primary and secondary forces and moments in popular engine configurations – one, two and four-cylinder
- Primary and secondary forces and moments for different crank settings
- The effect of adding additional mass to one or more pistons for any chosen crank setting
- Comparing calculated forces and moments with actual results

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ALTERNATIVE PRODUCTS:

- Static and Dynamic Balancing (TM1002) 225

STATIC AND DYNAMIC BALANCING

TM1002

For experiments in balancing a rotating mass system, statically and dynamically.

- Interlocked transparent dome allows students to observe the masses rotating
- Demonstrates balancing a horizontal shaft with two, three or four rotating masses
- Independent analysis of static and dynamic balancing
- Includes four removeable rotating masses (balance blocks) with different inserts for a range of moments
- Protractor, horizontal scale and sliding indicator to help accurately position the rotating masses

LEARNING OUTCOMES:

- Demonstration of simple static and dynamic balancing of two, three and four rotating masses
- Dynamic balancing of rotating mass systems by calculation and vector diagrams (triangle and polygon)

The test assembly includes a balanced steel shaft mounted horizontally on low-friction bearings. The equipment includes a set of four rotating masses (balance blocks). The balance blocks fix in any horizontal position and relative angle on the shaft. Each block contains a different (and removable) circular insert, allowing students to create four blocks of different mass and moment. Without the inserts, the blocks become four identical masses for simple balancing tests.

ALTERNATIVE PRODUCTS:

- Balance of Reciprocating Masses (TM1022) 224

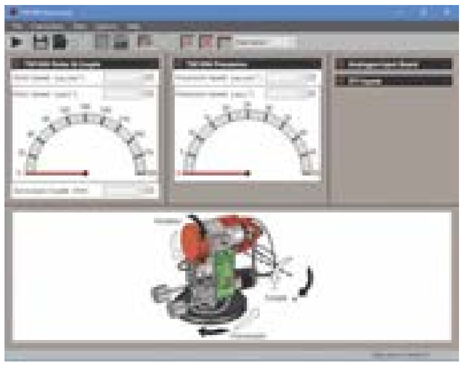
GYROSCOPE

VDAS® TM1004

For experiments in gyroscopic couple and velocities of rotor and precession.

- Direct measurement of gyroscopic tilting force, couple and velocities (speeds) shown on digital displays
- Interlocked, transparent dome allows students to observe the gyroscope spinning in safety
- Works in both clockwise and anticlockwise directions for a full range of tests
- Unique multifunction controls for coarse and fine adjustment of velocity and direction

The rotor of an electric motor shares a horizontally supported shaft with a flywheel, forming the gyroscope. A second electric motor turns a belt that turns a turntable under the gyroscope, causing precession about a vertical axis. Both motors work in clockwise and anticlockwise rotation and with variable velocity.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

- Direction of gyroscopic couple (in relation to precession and rotor spin directions).
- Magnitude of gyroscopic couple (in relation to precession and rotor spin velocities).

RECOMMENDED ANCILLARIES:

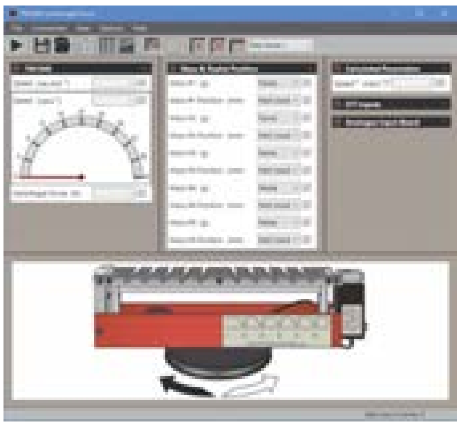
- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

CENTRIFUGAL FORCE

VDAS® TM1005

For experiments in centrifugal force and angular velocity.

- Demonstrates the relationship between centrifugal force, mass of a rotating body, its distance from the axis, and its angular velocity
- Balanced arm mechanism for accurate readings
- Interlocked, transparent dome allows students to see the mechanism rotating in safety
- Includes a set of weights for different experiments



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

Finding the relationship between centrifugal force, the mass of a rotating body, its distance from the axis of rotation (radial position) and the speed of rotation.

A base unit supports a mechanism that rotates under a clear dome. An electric motor turns a belt that turns a turntable under the mechanism. The motor works in clockwise and anticlockwise direction and with variable velocity. A sensor measures the rotational velocity of the mechanism.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ALTERNATIVE PRODUCTS:

- Centrifugal Force Kit (ES16) 22

CORIOLIS FORCE NEW

TM1017

For demonstrations and experiments in Coriolis force.

- Clearly demonstrates the Coriolis force deflecting a jet of water within a rotating reference system
- Adjustable speed and direction of rotation
- Adjustable pump rate
- Local LCD display

A bench-top base unit supporting a rotating arm on which a transparent water tank and counterbalance are mounted. The water tank houses a submersible pump which produces a jet of water. The jet of water is observed to deflect when the arm rotates. The deflection is due to the Coriolis force, a fictitious force which appears to act on objects moving within a frame of reference that is rotating.

Dials and a digital display on the base unit allow students to adjust the speed and direction of rotation, as well as the pump rate.

FULL SPECIFICATION DATASHEETS

Datasheets contain full specifications such as size, weight, noise output, fluid capacity, voltage requirements etc. Download from each individual product webpage.

TECQUIPMENT.COM (search product)

LEARNING OUTCOMES:

- Understanding of fictitious forces
- Visualisation of the Coriolis force effect
- Verification of the relationship between Coriolis force, the speed and direction of rotation and the velocity of objects moving within the rotating reference frame

GOVERNORS

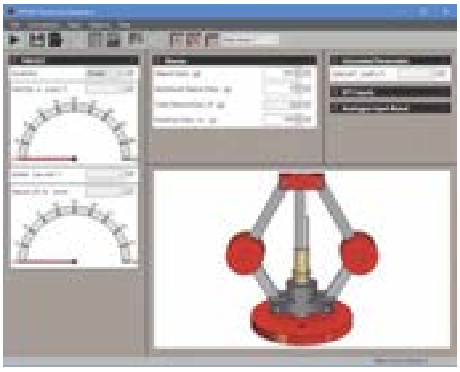
VDAS® TM1027

Demonstrates how different governors work, including Hartnell, Porter and Proell governors.

HARTNELL GOVERNOR SHOWN FITTED

PORTER GOVERNOR

PROELL GOVERNOR



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Includes three easy-to-fit governors: Hartnell, Porter and Proell
- Interlocked, transparent dome allows students to observe the governors rotating in safety
- Includes additional weights to change the mass of the Porter and Proell governor sleeves
- Supplied with different springs and rotating masses for the Hartnell governor

A base unit contains a variable-speed motor. The motor turns each of three different governors: Proell, Porter and Hartnell.

NOTE: Only one governor can be tested at a time.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

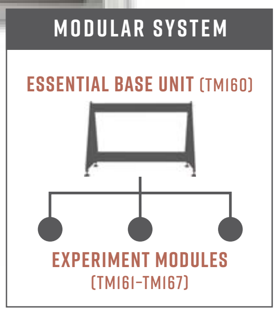
LEARNING OUTCOMES:

- Finding characteristic curves of governor speed against sleeve lift
- Comparison of governor types in terms of sensitivity, stability and effort
- On the Porter and Proell governors, the effects of varying centre sleeve mass
- On the Hartnell governor, the effects of varying:
  - arm length
  - spring rate
  - spring compression
  - rotating mass
- Demonstration of the isochronous condition (Hartnell governor)

FREE VIBRATIONS TEST FRAME

TM160

Sturdy frame for use with TecQuipment's Free Vibrations experiment modules.



FEATURES:		BENEFITS:
Rigid and lightweight construction	→	Ensures repeatability of results and long service life, yet light enough to move around the laboratory
Supplied with all the tools needed for assembly	→	Quick and easy set-up time – optimises experiment time during laboratory sessions
Includes a storage tray for safe storage of any tools and smaller parts of the optional experiments	→	Reduces risk of losing components – greater longevity

For use with TecQuipment's Free Vibrations experiments, the test frame fits on any standard desk or bench top. Students, teachers or lecturers fit the parts of their free vibrations experiments to the test frame to study or demonstrate a free vibrations topic.

AVAILABLE EXPERIMENT MODULES:

SHOWN WITH ONE OF THE AVAILABLE EXPERIMENT MODULES

SIMPLE AND COMPOUND PENDULUMS

TM161

Studies simple harmonic motion and the factors that affect the period of oscillation of pendulums.

- Back panels with referenced scales and sliding indicators for accurate positioning of pendulum parts
- The simple pendulum has unique quick-change spheres and adjustable cord length – no tools required
- Includes simple, compound and Kater's pendulums for a range of experiments
- Quick and easy assembly
- Contains all parts needed for the experiments – including a stopwatch and basic tools

This product is part of a range that explores free vibrations in simple 'one degree of freedom' systems and introduces students to key scientific terms such as:

- Simple harmonic motion (SHM) and period of oscillation
- Mass moment of inertia
- Radius of gyration
- Routh's rule

LEARNING OUTCOMES:

- Cord length and period of a simple pendulum
- Mass and period of a simple pendulum
- Using a simple pendulum to find the acceleration due to gravity
- Centre of gravity and period of a compound pendulum
- How an adjustable mass affects the period of a compound pendulum
- Using a Kater's pendulum to find the acceleration due to gravity

ESSENTIAL BASE UNIT:

- Free Vibrations Test Frame (TM160) 230

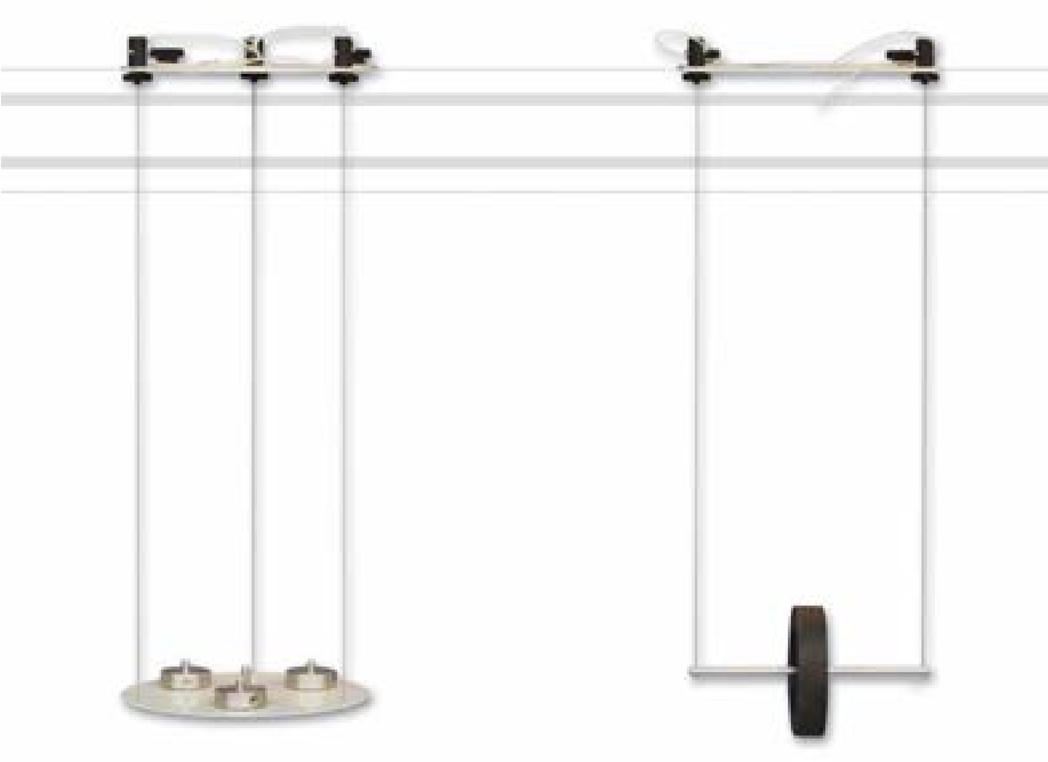
ALTERNATIVE PRODUCTS:

- Simple Harmonic Motion Kit (ES7) 15

FILAR PENDULUMS

TM162

Studies simple harmonic motion and the factors that affect the period of oscillation of bifilar and trifilar pendulums.



- Flexible and modular – fits onto the test frame (TM160) for experiments and laboratory demonstrations
- Different pendulum designs, lengths, mass and inertia – for a range of experiments
- Quick and easy assembly
- Contains all parts needed for the experiments – including an 'example machine element', stopwatch, steel rule and basic tools

This product is part of a range that explores free vibrations in simple 'one degree of freedom' systems and introduces students to key scientific terms such as:

- Simple harmonic motion (SHM) and period of oscillation
- Mass moment of inertia
- Radius of gyration
- Axis of rotation
- Parallel axis theorem

ESSENTIAL BASE UNIT:

- Free Vibrations Test Frame (TM160) 230

ALTERNATIVE PRODUCTS:

- Simple Harmonic Motion Kit (ES7) 15

LEARNING OUTCOMES:

- Cord length and period of bifilar and trifilar pendulums
- Cord (support) positions and period of bifilar and trifilar pendulums
- Mass and period of bifilar and trifilar pendulums
- Position of mass on bifilar and trifilar pendulums
- Finding moment of inertia of an 'example machine part' in two different axes

SHOWN WITH THE TEST FRAME (TM160)

VIBRATION

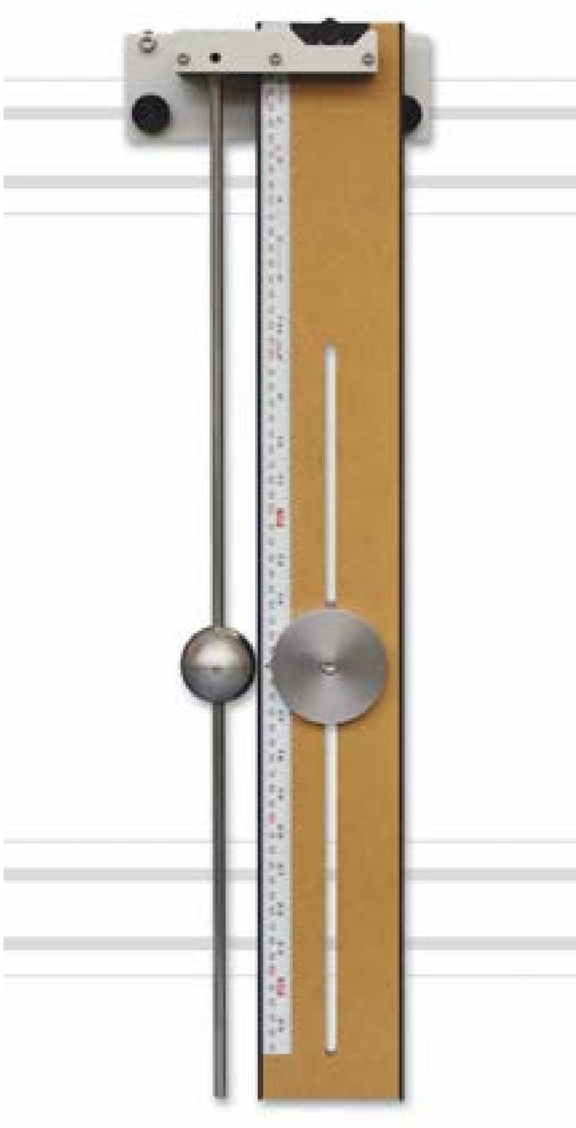
THEORY OF MACHINES

CENTRE OF PERCUSSION

TM163

Illustrates how to calculate and find a compound centre of percussion pendulums.

- Flexible and modular – fits onto the test frame (TM160) for experiments and laboratory demonstrations
- Realistic scale – for highly visual and accurate experiments in complete safety
- Quick and easy assembly
- Contains all parts needed for the experiments – including a stopwatch and basic tools



LEARNING OUTCOMES:

- Centre of gravity, period of oscillation and radius of gyration of a compound pendulum
- Centre of percussion of a compound pendulum

This product is part of a range that explores free vibrations in simple 'one degree of freedom' systems and introduces students to key scientific terms such as:

- Simple harmonic motion (SHM) and period of oscillation
- Radius of gyration
- Centre of gravity
- Centre of percussion (CoP) and the 'sweet spot'
- Impact reactions

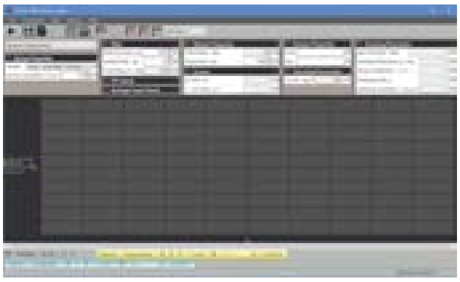
ESSENTIAL BASE UNIT:

SHOWN WITH THE TEST FRAME (TM160)

FREE VIBRATIONS OF A MASS-SPRING SYSTEM

VDAS® TM164

Uses simple harmonic motion theory to demonstrate how to calculate the frequency of oscillation in simple mass-spring systems; demonstrates Hooke's law.



SCREENSHOT OF THE VDAS® SOFTWARE

SHOWN FITTED WITH THE OPTIONAL DAMPER KIT (TM164A)

- Flexible and modular – fits onto the test frame (TM160) for experiments and laboratory demonstrations
- Optional dashpot for extra experiments in oscillation damping
- Non-contacting measurement sensors for negligible damping
- Additional acceleration sensor for comparison with software-derived waveform
- Works with TecQuipment's Versatile Data Acquisition System (VDAS®) for real-time display of the mass-spring oscillations

LEARNING OUTCOMES:

- Spring extension and force (spring constant) and Hooke's law
- Frequency of oscillation, spring constant and varying mass
- Phase difference between displacement and its derivatives
- Comparison of measured and derived acceleration
- Oscillation damping and coefficient – needs optional Damper Kit (TM164a)

This product is part of a range that explores free vibrations in simple 'one degree of freedom' systems and introduces students to key scientific terms such as:

- Simple harmonic motion (SHM) and frequency of oscillation
- Spring constant and Hooke's law
- Oscillation damping
- Phase difference between displacement and its derivatives

ESSENTIAL BASE UNIT:

- Free Vibrations Test Frame (TM160) 230

RECOMMENDED ANCILLARIES:

- 2 x Damper Kit (TM164a)

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – bench-mounted version (VDAS-B) 299

NOTE: This equipment needs the latest VDAS® and will not work with early versions of VDAS®. Contact TecQuipment or the local agent if unsure.

ALTERNATIVE PRODUCTS:

- Free and Forced Vibrations (TM1016) 239

FREE TORSIONAL VIBRATIONS

VDAS® TM165

Demonstrates the oscillatory motion of a disc attached to a slender rod.

SCREENSHOT OF THE VDAS® SOFTWARE

SHOWN FITTED WITH THE OPTIONAL DAMPER KIT (TM165A)

- Uses the rotational movement of a disc suspended from a circular rod for a highly visual and intuitive display of simple harmonic motion
- Optional Damper Kit (TM165a) for extra experiments in oscillation damping
- Includes a selection of specimen rods and an additional inertia ring for a range of experiments
- Non-contacting displacement sensor to see and measure oscillatory motion with negligible damping effect
- Works with TecQuipment's VDAS® for real-time display of the displacement waveform and its derivatives

This product is part of a range that explores free vibrations in simple 'one degree of freedom' systems and introduces students to key scientific terms such as:

- Simple harmonic motion (SHM)
- Frequency of oscillation
- Shear modulus
- Polar moment of area
- Mass moment of inertia
- Phase difference between displacement and its derivatives

LEARNING OUTCOMES:

- Rod diameter and frequency of oscillation
- Rod length and frequency of oscillation
- Inertia and frequency of oscillation
- Phase difference between displacement and its derivatives
- Damped torsional oscillations – needs optional Damper Kit (TM165a)

ESSENTIAL BASE UNIT:

- Free Vibrations Test Frame (TM160) 230

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – bench-mounted version (VDAS-B) 299

NOTE: This equipment needs the latest VDAS® and will not work with early versions of VDAS®. Contact TecQuipment or the local agent if unsure.

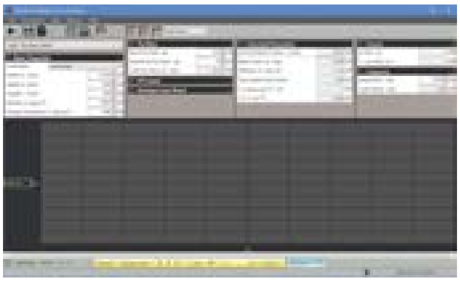
RECOMMENDED ANCILLARIES:

- Damper Kit (TM165a)

FREE VIBRATIONS OF A CANTILEVER

VDAS® TM166

Uses fundamental theory and Rayleigh's approximation to calculate the frequency of oscillation of a cantilever. Also utilises Dunkerley's method to predict the 'beam only' frequency.



SCREENSHOT OF THE VDAS® SOFTWARE

- Quick and easy assembly
- Mounts both vertically and horizontally for alternative analysis
- Includes a plain cantilever and a weighted cantilever with 'tip mass' for a range of experiments
- Non-contacting displacement sensor to see and measure oscillatory motion with negligible damping effect

This product is part of a range that explores free vibrations in simple 'one degree of freedom' systems and introduces students to key scientific terms such as:

- Simple harmonic motion (SHM) and frequency of oscillation
- Beam stiffness
- Rayleigh's method
- Dunkerley's method
- Second moment of area
- Phase difference between displacement and its derivatives

LEARNING OUTCOMES:

- Predicting oscillation frequency using Rayleigh's method and the simplified method assuming that the beam is 'light'
- Phase difference between displacement and its derivatives
- Horizontal cantilever length and frequency of oscillation
- Using Dunkerley's method to predict the 'beam only' frequency
- Comparison of vertical and horizontal cantilevers

ESSENTIAL BASE UNIT:

- Free Vibrations Test Frame (TM160) 230

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – bench-mounted version (VDAS-B) 299

NOTE: This equipment needs the latest VDAS® and will not work with early versions of VDAS®. Contact TecQuipment or the local agent if unsure.

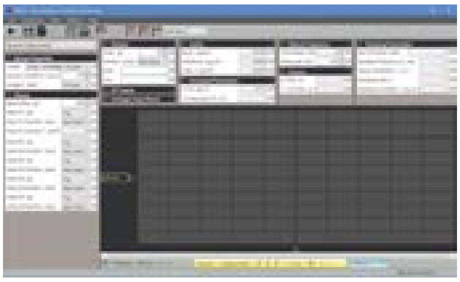
ALTERNATIVE PRODUCTS:

- Free and Forced Vibrations (TM1016) 239

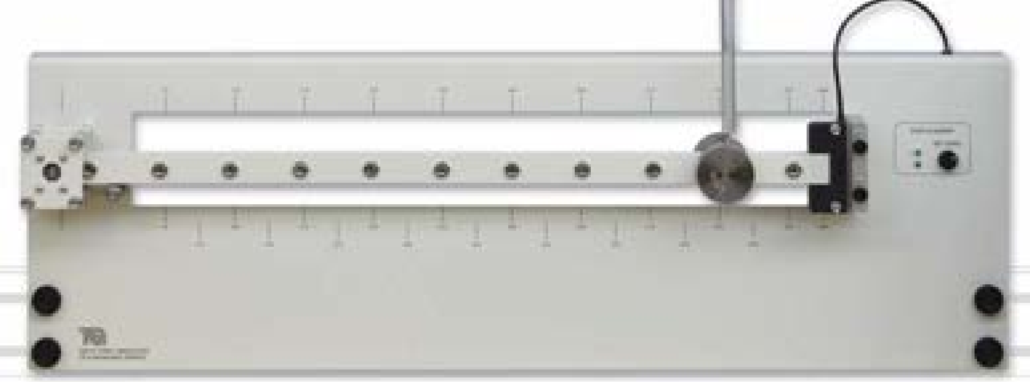
FREE VIBRATIONS OF A BEAM AND SPRING

VDAS® TM167

Demonstrates the oscillatory motion of a rigid beam, pivoted at one end and suspended by a spring at the other.



SCREENSHOT OF THE VDAS® SOFTWARE



- Uses a pivoted beam with spring for a highly visual display of simple harmonic motion
- Integral scales to save time and for convenient use
- Optional Damper Kit (TM167a) for extra experiments in oscillation damping using safe, easily-available fluids
- Non-contacting displacement sensor to see and measure oscillatory motion with negligible damping effect

SHOWN FITTED WITH THE OPTIONAL DAMPER KIT (TM167A)

LEARNING OUTCOMES:

- Spring extension and force (spring constant), and Hooke's law
- Phase difference between displacement and its derivatives
- Frequency of oscillation and varying mass moment of inertia by varying mass value
- Frequency of oscillation and spring constant
- Frequency of oscillation and varying mass moment of inertia by varying mass position
- Oscillation damping and coefficient – needs optional Damper Kit (TM167a)

This product is part of a range that explores free vibrations in simple 'one degree of freedom' systems and It introduces students to key scientific terms such as:

- Simple harmonic motion (SHM) and frequency of oscillation
- Moment of inertia
- Oscillation damping
- Spring constant and Hooke's law
- Phase difference between displacement and its derivatives

CONTINUED ON NEXT PAGE

FREE VIBRATIONS OF A BEAM AND SPRING (TM167) CONTINUED FROM PREVIOUS PAGE

SHOWN FITTED TO THE TEST FRAME (TM160) AND CONNECTED TO VDAS®

ESSENTIAL BASE UNIT:

- Free Vibrations Test Frame (TM160) 230

RECOMMENDED ANCILLARIES:

- Damper Kit (TM167a) 237

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – bench-mounted version (VDAS-B) 299

NOTE: This equipment needs the latest VDAS® and will not work with early versions of VDAS®. Contact TecQuipment or the agent if unsure.

ALTERNATIVE PRODUCTS:

- Free and Forced Vibrations (TM1016) 239

UNIVERSAL VIBRATIONS APPARATUS

VDAS® TM16S

This package includes all products from the Vibration section of TecQuipment's Theory of Machines range (TM160–TM167 and TM1016). It offers multiple experiments in both free and forced vibrations, and includes our Versatile Data Acquisition System (VDAS®).

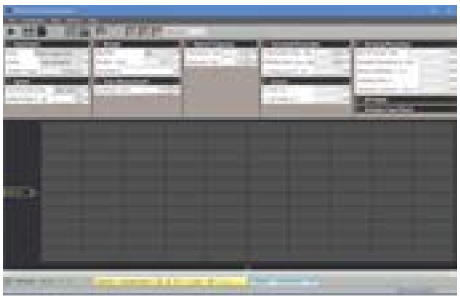
Products included in the package:

- Free and Forced Vibrations (TM1016)
- Free Vibrations Test Frame (TM160)
- Simple and Compound Pendulums (TM161)
- Filar Pendulums (TM162)
- Centre of Percussion (TM163)
- Free Vibrations of a Mass-Spring System (TM164)
- 2 x Damper Kit (TM164a)
- Free Torsional Vibrations (TM165)
- 1 x Damper Kit (TM165a)
- Free Vibrations of a Cantilever (TM166)
- Free Vibrations of a Beam and Spring (TM167)
- 2 x Damper Kit (TM167a)
- 2 x Versatile Data Acquisition System (VDAS-B)

FREE AND FORCED VIBRATIONS

VDAS® TM1016

Investigates the free and forced vibrations of a rigid beam with a spring, and a simply supported beam. Demonstrates Rayleigh's approximation and Dunkerley's method.



SCREENSHOT OF THE VDAS® SOFTWARE

FEATURES:		BENEFITS:
Two different vibration systems in one self-contained unit: a 'rigid' beam with a spring and a pinned-pinned (simply supported) 'flexible' beam	→	Increased experimental scope with minimal set up time
Non-contacting displacement sensor	→	Frictionless measurement of displacement – minimises influence on experiment results
High-quality servomotor 'exciter' – for forced vibrations at a constant speed	→	Minimises cyclical variations – enhances accuracy and repeatability
Offset mass position sensor	→	Demonstrates the phase relationship between applied force and displacement
Built-in accelerometer for comparison of derived and measured acceleration waveforms	→	High level functions deepen students' understanding
Works with TecQuipment's VDAS® for real-time display of the vibrations	→	Advanced software eliminates need for additional expensive oscilloscope

CONTINUED ON NEXT PAGE

LEARNING OUTCOMES:

- Free and forced vibrations of a rigid beam and spring
- Free and forced vibrations of a flexible pinned–pinned (simply supported) beam
- Using Rayleigh's approximation to predict vibration frequency
- Frequency of oscillation and varying mass
- Finding the 'beam only' frequency using Dunkerley's method
- Phase difference between displacement, its derivatives and measured acceleration
- Damped free and forced oscillations and damping coefficient
- Phase relationship between the applied force and beam position for different damping values
- Demonstration of a two-degree of freedom (2DoF) system
- Demonstration of an undamped vibration absorber

A bench-top unit to demonstrate free and forced vibrations of two mass-beam systems:

1. A 'rigid' beam with a pivot at one end and a spring at the other – the spring provides the elasticity.
2. A 'flexible' pinned-pinned beam with a pivot at one end and a roller pivot at the other – the beam itself provides the elasticity.

ESSENTIAL ANCILLARIES:

- Versatile Data Acquisition System – bench-mounted version (VDAS-B) 299

NOTE: This equipment needs the latest VDAS® and will not work with early versions of VDAS®. Contact TecQuipment or the local agent if unsure.

ALTERNATIVE PRODUCTS:

- Free Vibrations of a Mass-Spring System (TM164) 234
- Free Vibrations of a Cantilever (TM166) 236
- Free Vibrations of a Beam and Spring (TM167) 237

SHOWN CONNECTED TO VDAS®

THERMODYNAMICS

> BAE Systems Defence Information, Training and Services have recently used TecQuipment to support training activities in the Kingdom of Saudi Arabia through the procurement of two gas turbine trainers. Throughout the procurement, manufacturing and installation period TecQuipment have performed well and supported extra requirements such as product safety justification reports. The experience and expertise of their commissioning engineer was first class and in-country activities went well.

N CHERRY
TRAINING PROCUREMENT WARTON, BAE SYSTEMS (OPERATIONS) LIMITED

THERMODYNAMICS

The Thermodynamics range offers teaching equipment for the illustration of the basic principles of thermodynamics through to complex theories. Students can learn using practical experiments about the behaviour of gases, heat transfer and thermal conductivity, conduction, convection and heat exchange. They can get hands-on to prove theories such as the Antoine equation, Seebeck effect, Lenz and Thomson effects, Carnot cycle and reversible Carnot cycle, Stefan Boltzmann law, Kirchhoff's law and Lambert's direction law.

SAFE, PRACTICAL AND REALISTIC

As thermodynamics experiments can often take many hours, the range has been designed to reduce the experiment time to a practical and realistic level, with safety as the key aspect.

AUTOMATIC DATA ACQUISITION VDAS®

Look at the products in this range that work with TecQuipment's unique Versatile Data Acquisition System (VDAS®) – **SEE PAGE 299**.

KEY FEATURES AND BENEFITS:

SAFE AND PRACTICAL DESIGN: Reduced experiment times.

BROAD RANGE OF PRODUCTS: From basic principles to gas turbines.

AUTOMATIC DATA ACQUISITION: Thermodynamics experiments need several minutes of constant monitoring to achieve thermal equilibrium, making automatic data acquisition a useful tool.

MODULAR FLUID POWER

The Modular Fluid Power range includes products that can be analysed in terms of thermodynamic performance, such as compressors – **SEE PAGES 134-148**.

IDEAL GASES – BOYLE'S LAW

VDAS® TD1000

Demonstrates the relationship between pressure and volume of an ideal gas at a fixed temperature.

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- A self-contained bench-top experiment – no power supply needed
- Highly visual experiment using a 'liquid piston' for reliability and accurate, repeatable results
- Includes a thermocouple and digital display to help maintain constant temperature and demonstrate how compression and decompression of a gas can affect its temperature
- Supplied with hand-operated pumps to compress or decompress the gas (air) above and below atmospheric pressure

LEARNING OUTCOMES:

- Demonstrations of gas temperature change during compression and decompression
- Proving Boyle's law by experiment

The bench-mounted equipment includes a backplate that holds two clear-walled cylinders containing oil (supplied). Students use hand-operated pumps (supplied) to increase or decrease the pressure in the left-hand cylinder (the reservoir) which moves a 'liquid piston' of oil in the right-hand cylinder (the test cylinder). This piston compresses or decompresses a trapped column of air in the test cylinder.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ALTERNATIVE PRODUCTS:

- Ideal Gases – Gay-Lussac's Law (TD1001) 244
- Expansion of Perfect Gas (TD1004) 245

IDEAL GASES – GAY-LUSSAC'S LAW

VDAS® TD1001

Demonstrates the relationship between pressure and temperature of a fixed volume of ideal gas.

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Demonstrates Gay-Lussac's law relating pressure and temperature of an ideal gas (air)
- Simple and safe – needs no tools
- Uses low pressures and a thermally-insulated heater
- Includes thermocouples and a pressure sensor connected to a digital display
- Electronic controller to accurately regulate temperature

The bench-mounted equipment includes a backplate that holds a low-pressure vessel. The vessel holds a fixed volume of air surrounded by an insulated heater, controlled by an electronic temperature controller.

LEARNING OUTCOMES :

- Demonstrates change of pressure of a fixed volume of gas during heating
- Proving Gay-Lussac's law by experiment
- The principle of a vapour pressure thermometer

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

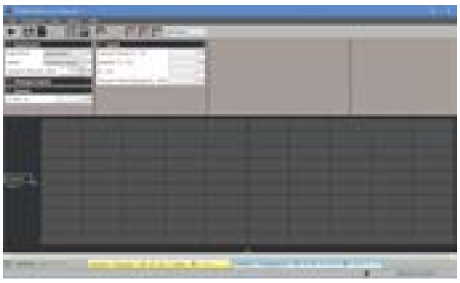
ALTERNATIVE PRODUCTS:

- Ideal Gases – Boyle's Law (TD1000) 243
- Expansion of Perfect Gas (TD1004) 245

EXPANSION OF A PERFECT GAS

VDAS® TD1004

Bench-top apparatus to demonstrate the behaviour and expansion processes of a perfect gas.



SCREENSHOT OF THE VDAS® SOFTWARE

LEARNING OUTCOMES:

- The non-flow energy equation
- Clément Desormes experiment
- The behaviour of a perfect gas and its describing equations
- Adiabatic reversible process (isentropic expansion)
- Constant volume process
- Constant internal energy process
- Polytropic process

- A self-contained bench-top experiment, for convenient use in a laboratory
- Highly visual experiment with accurate and repeatable results
- Simple and safe to use – needs no tools
- Supplied with an electric pump for easy compression and decompression of the gas (air)
- VDAS® connectivity included featuring data acquisition via USB

The apparatus consists of two frame-mounted, interconnected transparent and rigid vessels, with one vessel equipped for operation under pressure and the second vessel under vacuum.

ALTERNATIVE PRODUCTS:

- Ideal Gases – Boyle's Law (TD1000) 243
- Ideal Gases – Gay-Lussac's Law (TD1001) 244

FILMWISE AND DROPWISE CONDENSATION AND BOILING

VDAS® TE78

Demonstrates heat transfer during different boiling and condensing processes.

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Has a glass vessel so students can see what is happening
- Demonstrates nucleate, film and sub-cooled boiling
- Demonstrates condensation on different surface finishes
- Demonstrates filmwise and dropwise condensation

LEARNING OUTCOMES:

- Boiling heat transfer
- Condensing heat transfer

Heating and condensing takes place inside a partially filled glass vessel. A heater coil heats the water. For boiling heat transfer experiments, students adjust the current in a resistant wire heater element in the water. The temperature of the wire reaches significantly higher than 100°C.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

DOWNLOAD POSTERS, SOFTWARE AND CATALOGUES

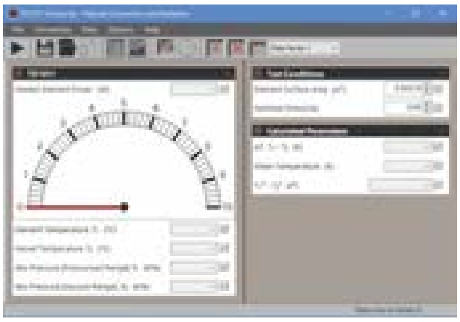
TecQuipment offers a wide range of digital content such as posters, brochures, catalogues, charts and software on the website.

TECQUIPMENT.COM/DOWNLOADS

EMISSIVITY – NATURAL CONVECTION AND RADIATION

VDAS® TD1011

Demonstrates to students how different types of heat can transfer over a range of pressures; helps them understand the Stefan Boltzman constant.



SCREENSHOT OF THE VDAS® SOFTWARE

- Helps students to understand natural 'free' convection, radiation, emissivity and the Stefan Boltzman equation
- Includes a pressure vessel to allow tests above and below atmospheric pressure
- All instruments and vacuum pump included
- Test results are accurate enough to allow extrapolation down to a complete vacuum
- VDAS® connectivity included featuring data acquisition via USB

A small heated element hangs in the centre of a pressure vessel. The heater has a matt black surface. Attached to its surface is a thermocouple to measure the temperature. The vessel's inside is also black, and it has a thermocouple fitted to its wall to measure the temperature in the vessel. The vessel may be charged with compressed air up to 1 bar (gauge) or evacuated down to approximately 5 Pa (absolute). Students can extrapolate the results down to a total vacuum (no convection). This allows them to isolate the heat transfer by radiation.

ALTERNATIVE PRODUCTS:

- Free and Forced Convection (TD1005) 255
- Radiant Transfer Experiments (TD1003) 262

LEARNING OUTCOMES:

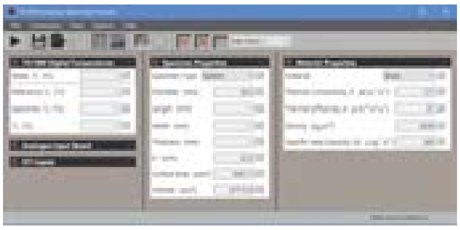
- Determination of emissivity
- Verification of the Stefan Boltzmann constant

UNSTEADY STATE HEAT TRANSFER

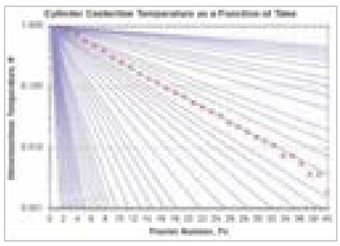
VDAS® TD1009

Measures unsteady state heat transfer to bodies of different shape and thermal conductivity.

TEST SHAPES



SCREENSHOT OF THE VDAS® SOFTWARE



HEISLER CHART CREATED BY THE VDAS® SOFTWARE

- Includes TecQuipment's Versatile Data Acquisition System (VDAS®)
- Includes a set of different solid shapes of different materials – for multiple experiments
- Simple to use – needs no tools
- Water temperature controller for consistent results
- Clear digital displays of all readings – a computer is not required to operate or take readings from the equipment

LEARNING OUTCOMES:

- Transient temperature changes with sudden immersion (unsteady state)
- How shape and surface area affect heat transfer
- How materials of different thermal conductivity affect heat transfer

A sturdy, bench-mounting frame contains a hot water vessel and instrumentation. The test shapes are of different dimensions and material to give different heat transfer areas and thermal conductivities. This gives multiple experiments in heat transfer.

FORCED CONVECTION HEAT TRANSFER

TD1

Demonstrates forced convection in pipes and heat transfer theory. Demonstrates the derivation of the value of Nusselt number, determination of the Stanton number and determination of the validity of the Reynolds analogy for air.

- Constant-speed fan with variable flow-control valve for better flow control
- Heater interlock for safety
- Includes Pitot tube traverse for velocity profile measurements, and traversing thermocouple to measure temperature distribution across the test pipe
- Includes thermocouples along the test pipe to measure heat transfer

LEARNING OUTCOMES:

- Derivation of the value of Nusselt number (Nu) and comparison with empirical formula
- Calculation of the local heat transfer coefficient (h)
- Determination of the Stanton number (St)
- Calculation of the friction factor (f) and comparison with experimental value
- Determination of the validity of the Reynolds analogy for air

The fan runs at a constant speed and draws air through a control valve. The air then moves into a u-shaped pipe. An orifice plate in the pipe connects to a manometer on the instrumentation panel to measure the air flow rate. A larger manometer on the instrument panel measures the fan pressure drop. The u-shaped pipe connects to a smaller diameter insulated and electrically heated copper 'test pipe'. Students control the power input to the test pipe heater using a variable transformer, while noting the power using instrumentation on the panel. The test pipe discharges to atmosphere.

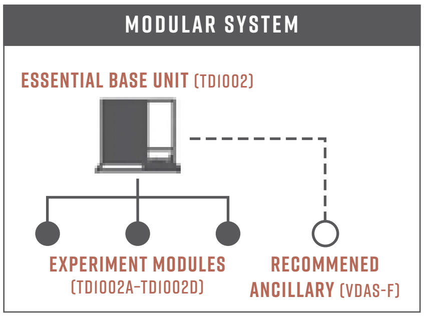
ALTERNATIVE PRODUCTS:

- Cross-Flow Heat Exchanger (TE93) 261
- Free and Forced Convection (TD1005) 255
- Water-to-Air Heat Exchanger (TD1007) 263

HEAT TRANSFER EXPERIMENTS BASE UNIT

VDAS® TD1002

Base unit for a range of optional experiments that study different methods of heat transfer.



FEATURES:		BENEFITS:
A self-contained bench-top base unit with four optional experiments	→	Modular approach reduces total laboratory costs
Foolproof fittings allow students to change and connect the optional experiments quickly and easily (needs no tools)	→	Simple and safe to use – self-sealing connectors prevents spillage of water
Clear digital displays of all readings	→	No computer needed to operate it or take readings – simplified approach enhances student learning
The experiments each have a bedplate with a clear schematic diagram to show students how they connect, and the measuring point positions	→	Maximises teaching effectiveness – simple to set up and students can easily understand the experiment

The Heat Transfer Experiments Base Unit (TD1002) is the core of the TD1002 range. It provides cold water and heater power to the optional experiments and all the instruments needed to measure their performance.

AVAILABLE EXPERIMENT MODULES:

- Linear Heat Conduction Experiment (TD1002a MkII) 251
- Radial Heat Conduction Experiment (TD1002b) 252
- Extended Surface Heat Transfer Experiment (TD1002c) 253
- Conductivity of Liquids and Gases Experiment (TD1002d) 254

RECOMMENDED ANCILLARIES:

- VDAS-F (frame-mounted version of the Versatile Data Acquisition System) 299

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

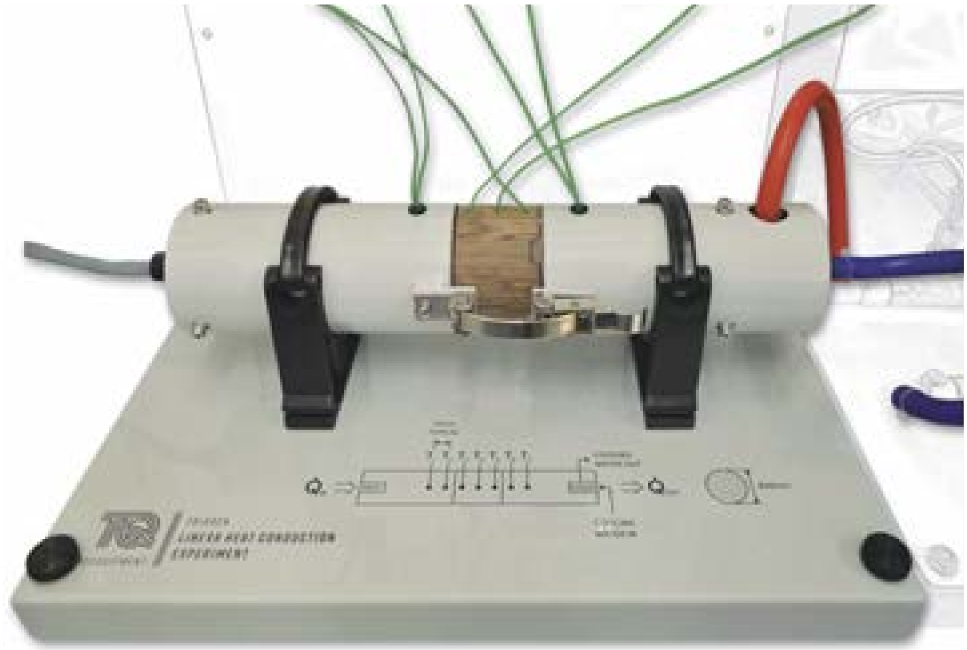
ALTERNATIVE PRODUCTS:

- Free and Forced Convection (TD1005) 255
- Radiant Transfer Experiments (TD1003) 262

LINEAR HEAT CONDUCTION EXPERIMENT

TD1002A MKII

Introduces students to the principles of linear heat conduction and thermal conductivity.



- One of four optional experiments for the Heat Transfer Experiments Base Unit (TD1002)
- Fits quickly and easily onto the base unit – water connections have self-sealing quick connectors (need no tools)
- Demonstrates the principles of linear heat conduction along a rod of uniform diameter
- Clear schematic printed on the baseplate aids student understanding

This experiment has a solid brass bar of circular cross-section, made in two sections with an interchangeable middle section. It mounts on a base plate with a clear schematic of the experiment layout.

ESSENTIAL BASE UNIT:

- Heat Transfer Experiments Base Unit (TD1002) 250

LEARNING OUTCOMES:

- Demonstration and calculations of linear heat conduction
- Calculation of the thermal conductivity (k value)
- Demonstration of the effectiveness of thermal paste
- Demonstration and calculations of thermal resistances (R value) in series
- Demonstration of ‘thermal lag’

RADIAL HEAT CONDUCTION EXPERIMENT

TD1002B

Introduces students to the principle of radial heat conduction and thermal conductivity.

- One of four optional experiments for the Heat Transfer Experiments Base Unit (TD1002)
- Fits quickly and easily onto the base unit – water connections have self-sealing quick connectors (need no tools)
- Demonstrates the principles of radial heat conduction around a disc of uniform diameter
- Clear schematic printed on the baseplate aids student understanding

LEARNING OUTCOMES:

- Demonstration and calculations of radial heat conduction
- Calculation of the thermal conductivity (k value)

This experiment has a solid brass disc with an electric heater (heat source) at its centre and a circular cross-section cooling tube (heat sink) around its circumference. It mounts on a base plate with a clear schematic of the experiment layout.

ESSENTIAL BASE UNIT:

- Heat Transfer Experiments Base Unit (TD1002) 250

EXTENDED SURFACE HEAT CONDUCTION EXPERIMENT

TD1002C

Demonstrates an example of conduction combined with losses due to radiation and convection.

- One of four optional experiments for the Heat Transfer Experiments base unit (TD1002)
- Fits quickly and easily onto the base unit – water connections have self-sealing quick connectors (need no tools)
- Demonstrates how a long thin rod conducts heat along it and how heat is lost due to radiation and convection
- Clear schematic printed on the baseplate aids student understanding

LEARNING OUTCOMES:

- To demonstrate how heat transfers from the surface of a solid bar or rod
- To demonstrate the temperatures on, and heat flow through the solid bar to its surroundings

This experiment has a thin solid bar with an electric heater (heat source) at one end. It mounts on a base plate with a clear schematic of the experiment layout.

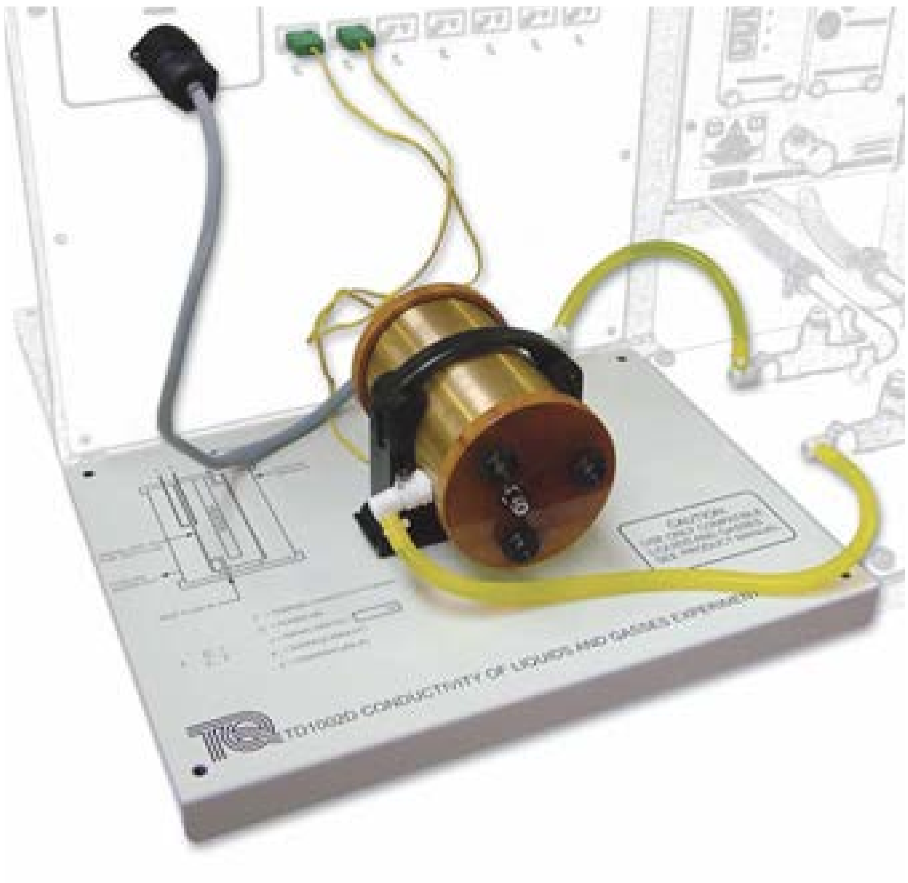
ESSENTIAL BASE UNIT:

- Heat Transfer Experiments Base Unit (TD1002) 250

CONDUCTIVITY OF LIQUIDS AND GASES EXPERIMENT

TD1002D

Allows students to test various fluids to find their thermal conductivity.



- One of four optional experiments for the Heat Transfer Experiments base unit (TD1002)
- Fits quickly and easily onto the base unit – water connections have self-sealing quick connectors (need no tools)
- Allows students to measure the thermal conductivity of various compatible liquids and gases
- Clear schematic printed on the baseplate aids student understanding

LEARNING OUTCOMES:

- Calibration of the unit using air as the known medium
- Finding the thermal conductivity (*k*) of various liquids and gases and comparing them to typical published values

This experiment has three concentric cylinders. The inner cylinder contains an electric heater (the heat source). The test liquid or gas forms a second, thin cylinder around the heat source. The third cylinder, cooled by water, surrounds them both to make a heat sink. The whole assembly is mounted on a base plate with a clear schematic of the experiment layout.

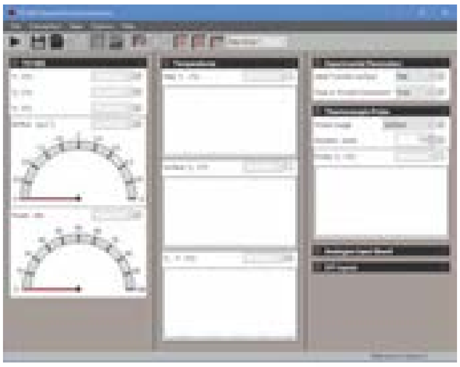
ESSENTIAL BASE UNIT:

- Heat Transfer Experiments Base Unit (TD1002) 250

FREE AND FORCED CONVECTION

VDAS® TD1005

Illustrates free and forced convection from different heat transfer surfaces.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Includes three of the most common heat transfer surfaces – flat plate, pinned and finned
- Thermocouples and a sensitive anemometer measure temperatures and air velocity – shown on a digital display
- Additional hand-held thermocouple probe included to measure temperatures along the length of the pins and fins of two heat transfer surfaces
- Variable-speed fan and variable-power heat source for a range of tests

The bench-top equipment includes a vertical duct that holds the chosen heat transfer surface and all instruments needed. TecQuipment include three different common heat transfer surfaces with the equipment.

LEARNING OUTCOMES:

- Comparing free and forced convection for different surfaces
- Comparison of free convection from vertical and horizontal (finned) surfaces
- Comparison of heat transfer surface efficiency
- Comparing the coefficient of heat transfer and Nusselt number for forced and free convection
- Temperature distribution along finned and pinned surfaces

RECOMMENDED ANCILLARIES:

- Bench-mounted version of the Versatile Data Acquisition System (VDAS-B) 299

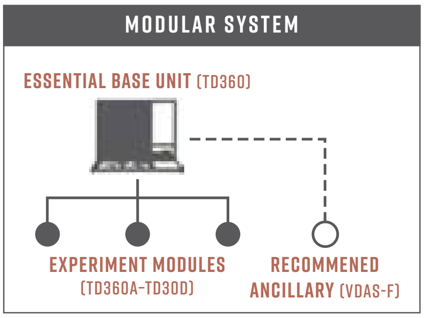
ALTERNATIVE PRODUCTS:

- Forced Convection Heat Transfer (TD1) 249
- Heat Transfer Experiments (TD1002) 250
- Emissivity – Natural Convection and Radiation (TD1011) 247
- Cross-Flow Heat Exchanger (TE93) 261
- Water-to-Air Heat Exchanger (TD1007) 263

BENCH-TOP HEAT EXCHANGERS SERVICE MODULE

VDAS® TD360

Examines and compares small-scale heat exchangers to help students understand how they work.



FEATURES:	BENEFITS:
A bench-top service module with optional small-scale demonstration heat exchangers – designed for teaching	Efficient use of valuable laboratory space
Optional heat exchangers include most common types used in industry (tubular, plate, shell and tube, and a jacketed vessel with coil and stirrer)	Qualitative and quantitative comparison of main heat exchanger designs
All optional heat exchangers have the same nominal heat transfer area and wall thickness	Allows students to compare them directly
Foolproof fittings allow students to change and connect the optional experiments quickly and easily (needs no tools)	Simple and safe to use – self-sealing connectors prevents spillage of water
Heat-exchangers each have a bedplate with a clear schematic diagram to help students understand how to connect it	Easy to set up and operate – maximises students' practical time

The Bench-top Heat Exchangers Service Module (TD360) is the core of the bench-top heat exchangers range. It provides hot and cold water to the heat exchangers and all the instruments needed to measure their performance.

AVAILABLE EXPERIMENT MODULES:

RECOMMENDED ANCILLARIES:

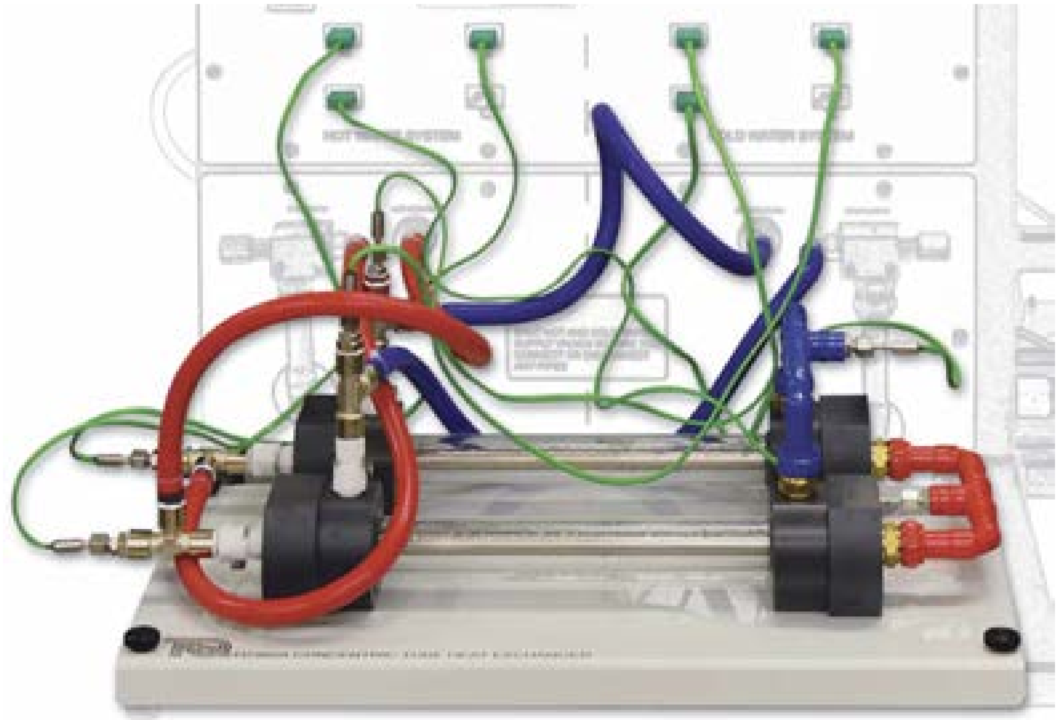
SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

ALTERNATIVE PRODUCTS:

CONCENTRIC TUBE HEAT EXCHANGER

TD360A

Illustrates how a simple concentric shell and tube heat exchanger works.



- One of a set of optional heat exchangers for use with TecQuipment's TD360 Service Module
- Simple and safe to use – foolproof fittings allow students to change and connect the heat exchanger quickly and easily (needs no tools)
- Clear outside casing, so students can see its construction
- Bedplate with a clear schematic diagram to help students understand how to connect the heat exchanger

LEARNING OUTCOMES:

- Demonstration of heat transfer from one fluid to another through a solid wall
- Energy balance and efficiency calculations
- Demonstration of parallel-flow and counter-flow operation of heat exchangers
- Measurement of the heat transfer coefficient, and the effect of fluid flow rates and the driving force (temperature differential) upon it
- Introduction to the logarithmic mean temperature difference in heat exchangers
- Comparison of different types of heat exchanger in terms of performance, size and relative cost (only if two or more optional heat exchangers have been bought)

This is the simplest of the optional heat exchangers. It has two tubes, one inside the other. One tube carries hot fluid, the other carries cold fluid.

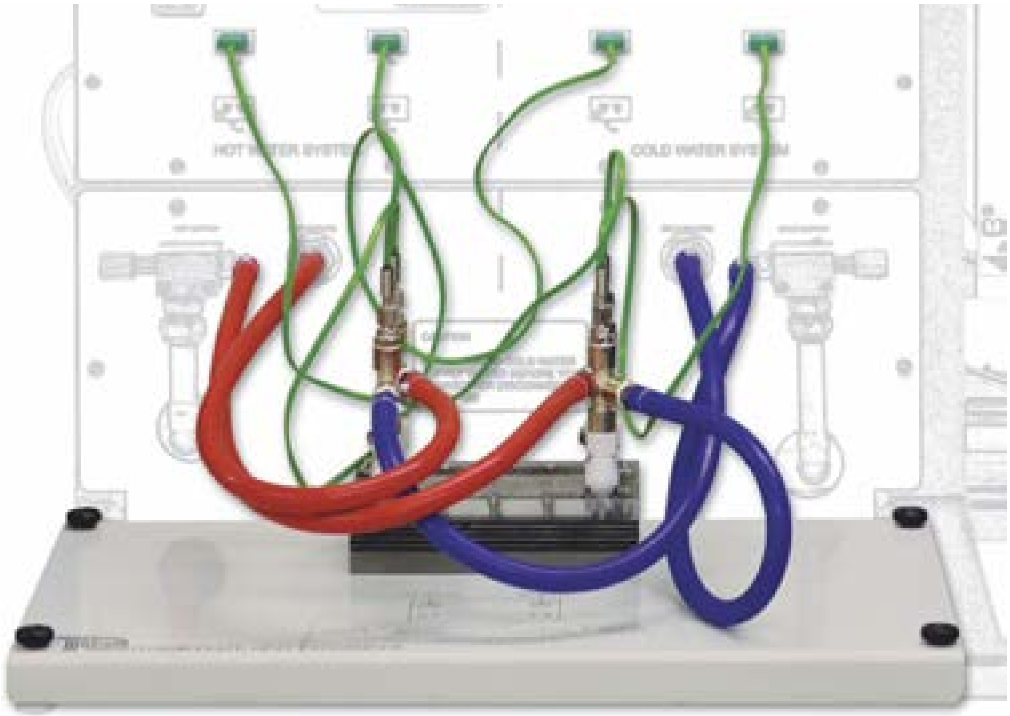
ESSENTIAL BASE UNIT:

- Service Module (TD360) 256

PLATE HEAT EXCHANGER

TD360B

Illustrates how a compact plate heat exchanger works.



- One of a set of optional heat exchangers for use with TecQuipment's TD360 Service Module
- Simple and safe to use – foolproof fittings allow students to change and connect the heat exchanger quickly and easily (needs no tools)
- Clear outside casing, so students can see its construction
- Bedplate with a clear schematic diagram to help students understand how to connect the heat exchanger

LEARNING OUTCOMES:

- Demonstration of heat transfer from one fluid to another through a solid wall
- Energy balance and efficiency calculations
- Demonstration of parallel-flow and counter-flow operation of heat exchangers
- Measurement of the heat transfer coefficient, and the effect of fluid flow rates and the driving force (temperature differential) upon it
- Introduction to the logarithmic mean temperature difference in heat exchangers
- Comparison of different types of heat exchanger in terms of performance, size and relative cost (only if two or more optional heat exchangers have been bought)

This heat exchanger is a set of metal plates separated by spacers (gaskets). The plates and gaskets have holes that make the hot and cold flow run on alternate sides of the plates, thereby transferring heat.

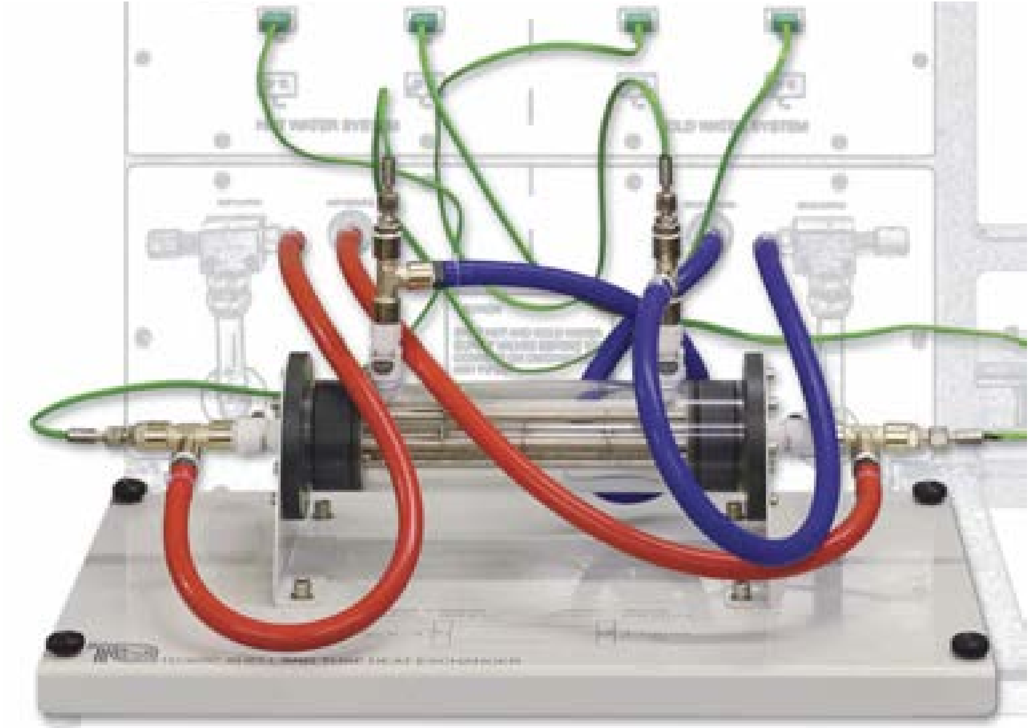
ESSENTIAL BASE UNIT:

- Service Module (TD360) 256

SHELL AND TUBE HEAT EXCHANGER

TD360C

Illustrates how a compact shell and tube bundle heat exchanger works.



- One of a set of optional heat exchangers for use with TecQuipment's TD360 Service Module
- Simple and safe to use – foolproof fittings allow students to change and connect the heat exchanger quickly and easily (needs no tools)
- Clear outside casing, so students can see its construction
- Bedplate with a clear schematic diagram to help students understand how to connect the heat exchanger

LEARNING OUTCOMES:

- Demonstration of heat transfer from one fluid to another through a solid wall
- Energy balance and efficiency calculations.
- Demonstration of parallel-flow and counter-flow operation of heat exchangers
- Measurement of the heat transfer coefficient, and the effect of fluid flow rates and the driving force (temperature differential) upon it
- Introduction to the logarithmic mean temperature difference in heat exchangers
- Comparison of different types of heat exchanger in terms of performance, size and relative cost (only if two or more optional heat exchangers have been bought)

This heat exchanger is one of the most common types used in industry. This is because it is compact, but can work at higher pressures than other designs. It is a large tube (shell) which surrounds several smaller tubes (a bundle).

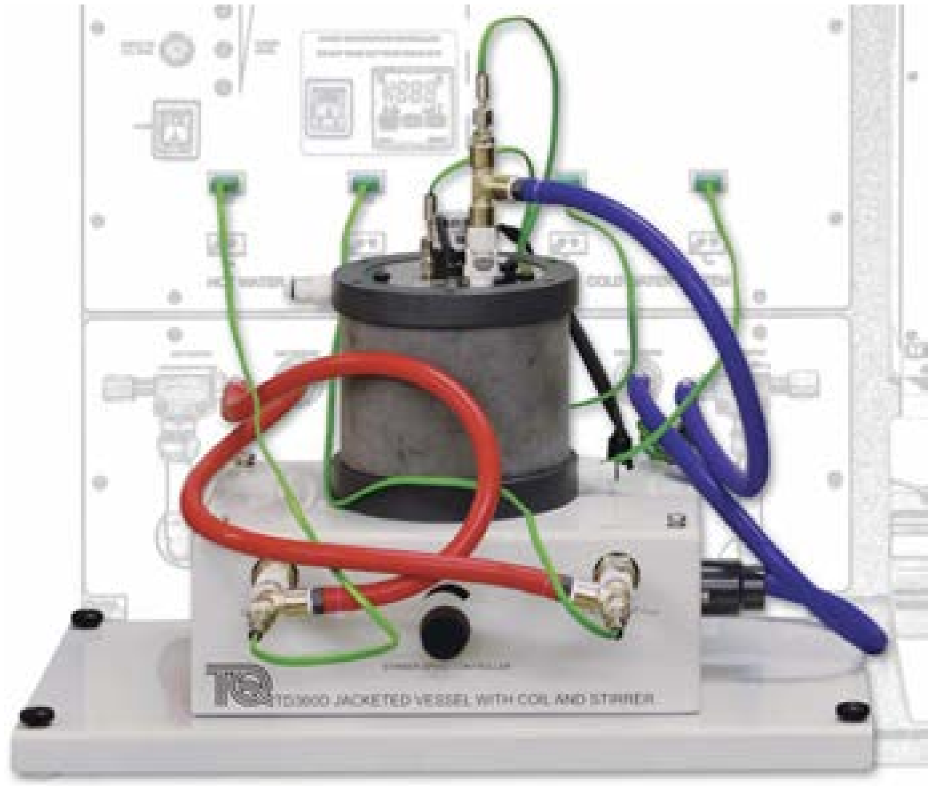
ESSENTIAL BASE UNIT:

- Service Module (TD360) 256

JACKETED VESSEL WITH COIL AND STIRRER

TD360D

Illustrates how a 'jacketed vessel' heat exchanger works and how stirring affects heat transfer.



- One of a set of optional heat exchangers for use with TecQuipment's TD360 Service Module
- Simple and safe to use – foolproof fittings allow students to change and connect the heat exchanger quickly and easily (needs no tools)
- Clear top cover, so students can see its construction
- Jacketed vessel with internal coil and stirrer for batch or continuous heating tests

LEARNING OUTCOMES:

- Demonstration of heat transfer from one fluid to another through a solid wall
- Introduction to the logarithmic mean temperature difference in heat exchangers
- Comparison of different types of heat exchanger in terms of performance, size and relative cost (only if two or more optional heat exchangers have been bought)
- Flow-through and batch heating, with or without stirring, using a heating jacket or a coil

This heat exchanger mimics those used in the process industry. It can demonstrate heat transfer by using the outer skin (or 'jacket') of the vessel, or by a coil inside the vessel. Students can set a continuous feed to the vessel for heating, or you set a fixed batch for heating.

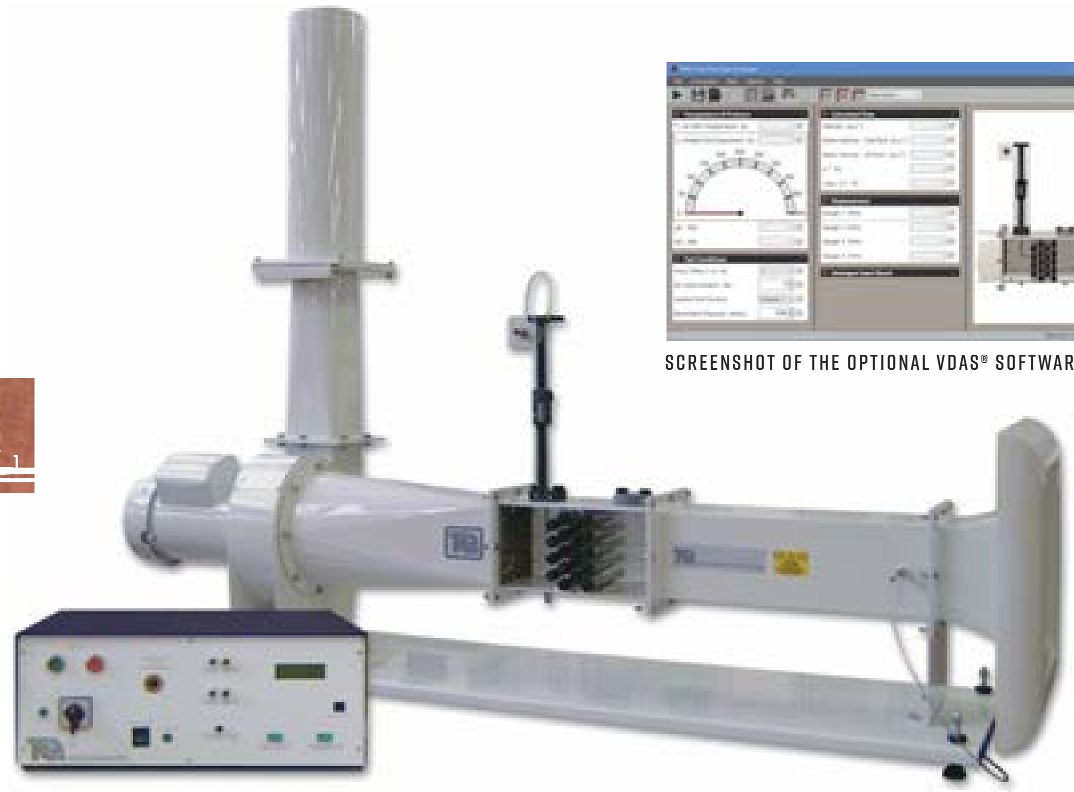
ESSENTIAL BASE UNIT:

- Service Module (TD360) 256

CROSS-FLOW HEAT EXCHANGER

VDAS® TE93

For studies into the principles and performance of heat exchangers.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- For full understanding of heat exchange by forced convection and measurement of heat transfer
- Consists of a wind tunnel with fully controllable air flow and heat exchanger rod matrix
- Separate pre-heated element with built-in thermocouple can take the place of any heat exchanger rod
- Instrumentation unit also includes controlled heat source to pre-heat element

The TE93 is a horizontal wind tunnel with a contraction cone, a working section, a diffuser, a constant-speed fan, and an exhaust with silencer. A variable slide valve controls the air flow. The working section includes a series of rods arranged in a matrix and at right-angles to the direction of air flow. To do experiments, students can remove any one of these rods and replace it with a cylindrical copper element. The copper element is of known thermal capacity and includes a built-in thermocouple. Students insert the element, which has been pre-heated to a specific temperature, into the working section at a known air velocity. They measure the time taken for the temperature to drop and determine the heat transfer rate.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

LEARNING OUTCOMES:

Typical experiments include:

- Determining the pressure losses created by the heat exchange rods and creating a chart of pressure drop against upstream pressure
- Calculating the inlet velocity and the mean velocity through the rods
- Determining the rate at which the heated rod cools down, within a bank of rods and by itself
- Plotting 'cooling curves' and using them to find the coefficient of heat transfer (h) for the heated rod at various positions in the heat exchanger
- Determining the velocity distribution (profile) downstream of the rods
- Converting results into dimensionless values (typically using Nusselt, Prandtl and Reynolds equations)
- Comparing results and producing heat transfer coefficient curves

ALTERNATIVE PRODUCTS:

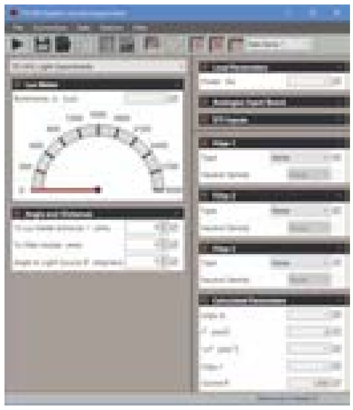
- Forced Convection Heat Transfer (TD1) 249
- Bench-top Heat Exchangers (TD360) 256
- Free and Forced Convection (TD1005) 255
- Water-to-Air Heat Exchanger (TD1007) 263

RADIANT TRANSFER EXPERIMENTS

VDAS® TD1003

Demonstrates the laws of radiant transfer from heat and light sources.

- Uses a safe, low-voltage heat source and thermopile (heat flux sensor) for radiant heat transfer experiments
- Includes plates of different heat absorption properties and apertures for extra experiments in heat transfer
- Uses a safe, low-voltage 'integrating sphere' light source and lux meter (light meter) for light transfer experiments
- Includes different optical filters for extra experiments in light transfer



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

HEAT:

- Inverse square law (or Lambert's distance law/area law) – demonstrating that radiation is inversely proportional to distance squared
- Stefan Boltzmann's law – demonstrating the relationship between radiation and source temperature
- Kirchhoff's law – demonstrating that a body with good emissivity also has good absorptivity
- Area factor – demonstrating that radiation transfer depends on the exposed area of the radiant source

LIGHT:

- Inverse square law (or Lambert's distance law/area law) – demonstrating radiation is inversely proportional to distance squared
- Lambert's direction law (or cosine law) – demonstrating that radiation is proportional to the cosine of the angle between the emitter and the receiver
- Transmittance and absorbance – demonstrating that optical filters can reduce light intensity

The equipment has two parts: an aluminium experiment frame and a control box. The frame holds all the experiment parts and allows the user to slide the parts along easily for experiments of transfer over distances. The control box contains the electrical controls and displays of the measured readings.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ALTERNATIVE PRODUCTS:

- Heat Transfer Experiments (TD1002) 250
- Emissivity – Natural Convection and Radiation (TD1011) 247

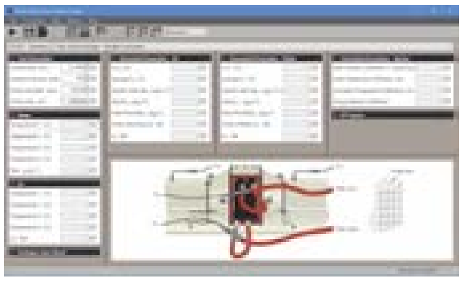
WATER-TO-AIR HEAT EXCHANGER

VDAS® TD1007

Illustrates how cross-flow water-to-air heat exchangers work.

16-TUBE HEAT EXCHANGER (TD1007A)

FINNED HEAT EXCHANGER (TD1007B)



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

FEATURES:		BENEFITS:
Includes one heat exchanger as standard	→	Complete experiment 'out of the box'
Two additional heat exchangers available for extended experiments	→	Allows quantitative comparison of different designs of heat exchanger
Heat exchangers have transparent sides and schematic diagrams	→	Enhanced learning capabilities – helps students understand how they work and how to connect them
Foolproof fittings allow students to change and connect the optional experiments quickly and easily (needs no tools)	→	Simple and safe to use – self-sealing connectors prevents spillage of water

CONTINUED ON NEXT PAGE

LEARNING OUTCOMES:

- Heat transfer between fluids through a solid wall
- Energy balance and efficiency
- Finding the heat transfer coefficient and log mean temperature difference (LMTD)
- Effect of water temperature (the 'driving force')
- Comparison of heat exchangers of different construction and heat transfer area (needs optional heat exchangers, TD1007a and TD1007b)

Many thermodynamic applications use water-to-air heat exchangers. Examples include using circulated water to heat or cool air in an HVAC installation, or to cool hot water using a flow of air, as in the radiator of a combustion engine.

The TecQuipment Water-to-Air Heat Exchanger mirrors air heating and water cooling applications. It fits on a bench top and includes a hot water supply, a cooling air duct and all instruments needed for tests on cross-flow heat exchangers. The heat output of the design produces good results, without greatly affecting the temperature of a reasonably-sized classroom or laboratory.

RECOMMENDED ANCILLARIES:

- 16-Tube Heat Exchanger (TD1007a) 263
- 16-Tube Finned Heat Exchanger (TD1007b) 263
- VDAS-F (frame-mounted version of the Versatile Data Acquisition System) 299

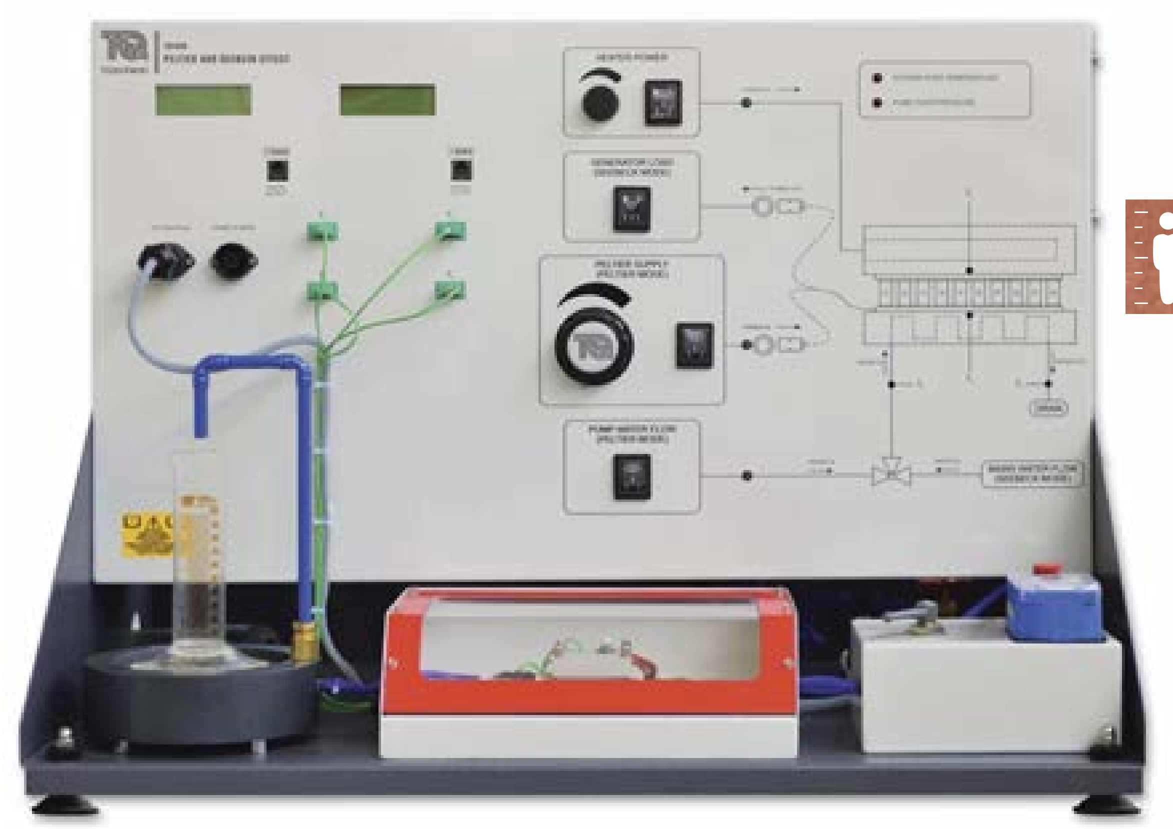
ALTERNATIVE PRODUCTS:

- Bench-Top Heat Exchangers (TD360) 256
- Cross-Flow Heat Exchanger (TE93) 261
- Free and Forced Convection (TD1005) 255
- Forced Convection Heat Transfer (TD1) 249

PELTIER AND SEEBECK EFFECT

VDAS® TD1008

Examines the performance of a thermoelectric device when connected for Peltier or Seebeck tests as a heat pump or generator.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Connects for both Peltier or Seebeck tests – giving a full set of experiments
- Schematic diagram and transparent guard to help students understand the device construction and allow simple demonstrations
- A switchable load, variable heat source and device power supply for multiple test conditions
- Clear, multiline digital displays of all readings – a computer is not required to operate it or collect data

LEARNING OUTCOMES:

- Seebeck coefficient and the performance of a thermoelectric generator (TEG)
- Peltier heat pump tests and the performance of a thermoelectric cooler (TEC)
- Coefficient of performance (CoP) and energy balance
- Comparisons of manufacturers' data, theoretical performance and results from experiments
- Observation of the Lenz and Thomson effects
- Simple cooling demonstrations (determined by local conditions)

The TD1008 can be connected in a choice of two modes:

- Heat to electricity for power generation when used in Seebeck mode – often used for thermoelectric generation and given the acronym 'TEG'.
- As an electrically powered heat pump when used in Peltier mode. Often used in thermoelectric cooling and given the acronym 'TEC'.

RECOMMENDED ANCILLARIES:

- VDAS-B (bench-mounted version of the Versatile Data Acquisition System) 299

TEMPERATURE MEASUREMENT AND CALIBRATION

VDAS® TD400

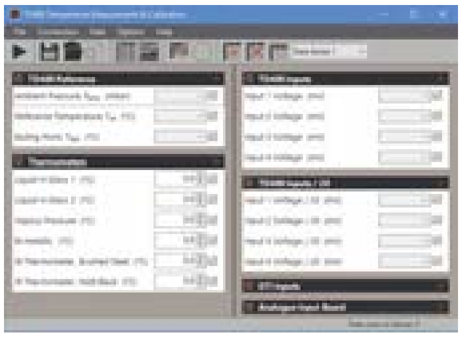
Studies the accuracy, linearity and important characteristics of popular temperature measuring devices.

- Uses a platinum resistance thermometer as a reference to accurately calibrate the other devices
- Demonstrates how electrical resistance devices and thermocouples work, their characteristics and how to connect them correctly to reduce measurement errors
- Hand-held digital thermometer for thermal infrared measurements
- Built-in water heater tank with protective guard and drain tap for safe experiments
- Built-in pressure sensor (barometer) with display of local water boiling temperature

The Temperature Measurement and Calibration apparatus fits on a desk or bench top. It includes eight different temperature measurement devices and demonstrates their characteristics and how to calibrate them against a standard.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

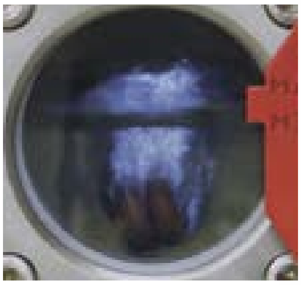
LEARNING OUTCOMES:

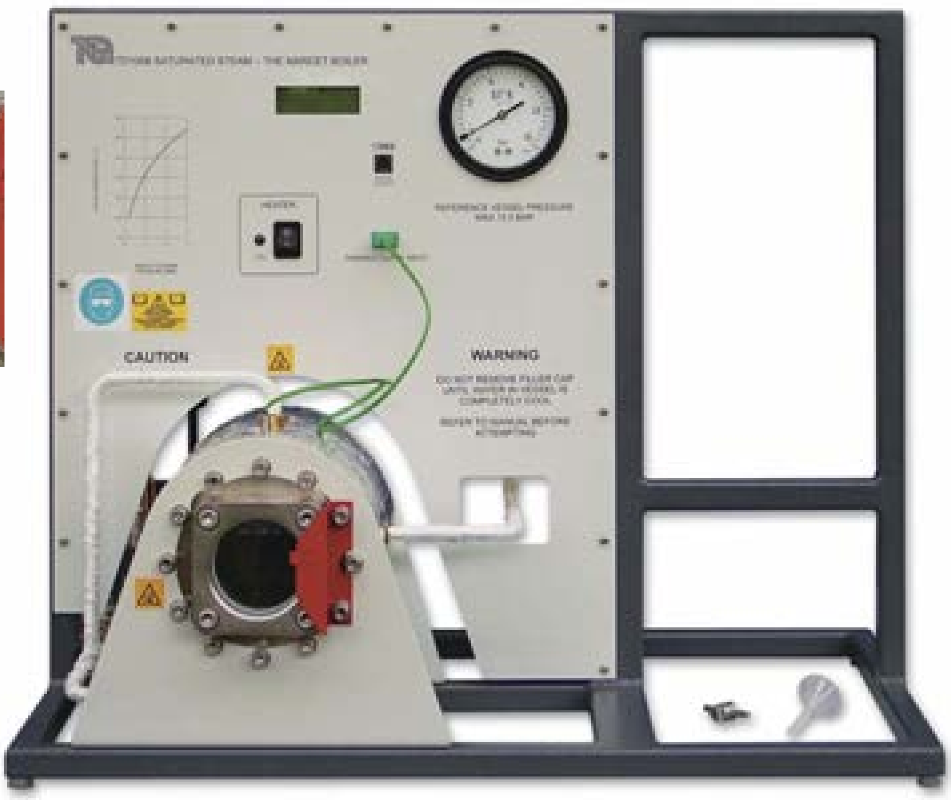
- Simulation of two, three and four-wire connection of a platinum resistance thermometer (PRT)
- Constant current and voltage sources
- Calibration and linearity of temperature measurement devices and temperature lag
- Thermal infrared temperature measurement on surfaces of different emissivity
- Thermocouples in series, parallel and the Seebeck effect
- Resistance in thermocouple circuits

SATURATED STEAM – THE MARCET BOILER

VDAS® TD1006

Illustrates the pressure and temperature relationship for saturated steam.

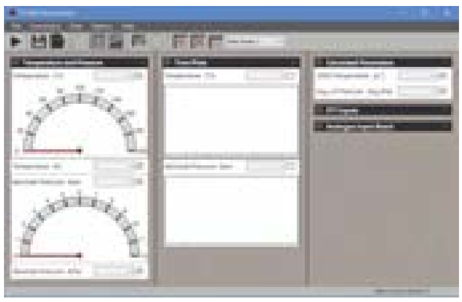




- Proves the Antoine equation for saturated steam
- Vessel (boiler) has viewing window to see the boiling process and the water level
- Simple and safe to use – includes temperature cut-out switches and a pressure-relief valve
- Electronic sensors measure boiler temperature and pressure – shown on a digital display in both SI and traditional units (including absolute values)

LEARNING OUTCOMES:

- Variation of saturated steam pressure with temperature
- Confirmation of the Antoine equation



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

The Marcet boiler is a simple experiment to demonstrate the relationship between pressure and temperature for saturated (wet) steam for comparison with published results.

The apparatus consists of a rigid frame containing an insulated pressure vessel (boiler) and an instrumentation and control unit. The frame also has extra space for the optional VDAS® interface.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

ALTERNATIVE PRODUCTS:

- Thermal Power Plant with Steam Engine Trainer (TD1050) 283

TWO-STAGE COMPRESSOR TEST SET

GT103

Illustrates how single and two-stage compressors work, and the thermodynamic properties.

- Works as single-stage, two-stage or two-stage intercooled compressor
- Independently controlled compressor units, both with variable-speed dynamometer drives
- Clear, fully-instrumented control panel with mimic diagram
- Completely fail-safe operation – interlocks and pressure-relief valves prevent misuse

This test set has two independently-controlled, motor-driven compressors, intercooler and air receiver. It works as a single-stage, two-stage or two-stage compressor with intercooler. All controls and instrumentation are on an easy-to-operate mimic panel.

RECOMMENDED ANCILLARIES:

- Pressure Indicator (GT103a)

NOTE: A computer with a spare USB socket is required to setup and analyse the pressure indicator results.

ALTERNATIVE PRODUCTS:

- Reciprocating Compressor Module (MFP104) 143

LEARNING OUTCOMES:

A range of experiments and tests based on:

- Volumetric, mechanical and isothermal efficiency
- Indicated work done
- Motor output power (compressor shaft power)
- Pressure ratio
- Temperature ratio
- Inlet dryness calculations
- P-V indicator diagram (needs optional pressure indicator)
- Effect of inter-stage cooling on compressor total power requirements and effect on cycle temperatures
- Effect of two-stage compression and inter-stage pressure on power requirements

ENGINES

"

For a number of years we have procured laboratory-based teaching resources from TecQuipment. Operation of this equipment, coupled with the robust build quality, provides our students with a clear understanding of the intrinsic features behind thermo-fluids and mechanical principles. This instills confidence for a safe, hands-on experience demonstrating these principles in practice. Furthermore, the build quality of TecQuipment products also gives assurance that the investment made satisfies our ongoing teaching needs well into the future.

GRAHAM PREECE
FACULTY OF COMPUTING, ENGINEERING AND SCIENCES, STAFFORDSHIRE UNIVERSITY

ROLLS-ROYCE BR710 ENGINE

ENGINES

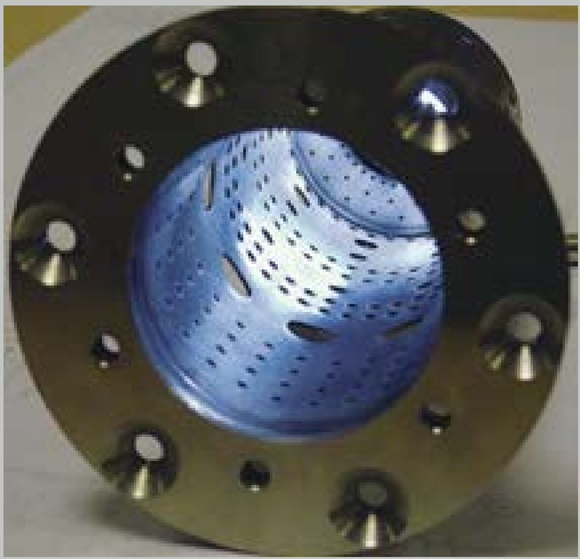
The Engines range offers teaching equipment for a wide variety of engine-specific theory. It covers internal combustion engines, starting with simple four-stroke engines, through to gas turbines/turbojets, along with a steam engine trainer.

The range meets entry level requirements for the general teaching of mechanical engineering, through to addressing the more advanced theories required for final-year students, enabling them to meet the learning objectives required for specific industries, such as aerospace, automotive and power.

KEY FEATURES AND BENEFITS:

MODULAR: Entry level packages with further options available.

DESIGNED FOR SAFETY: Suitable for all university student levels.



ENGINES

AUTOMATIC DATA ACQUISITION

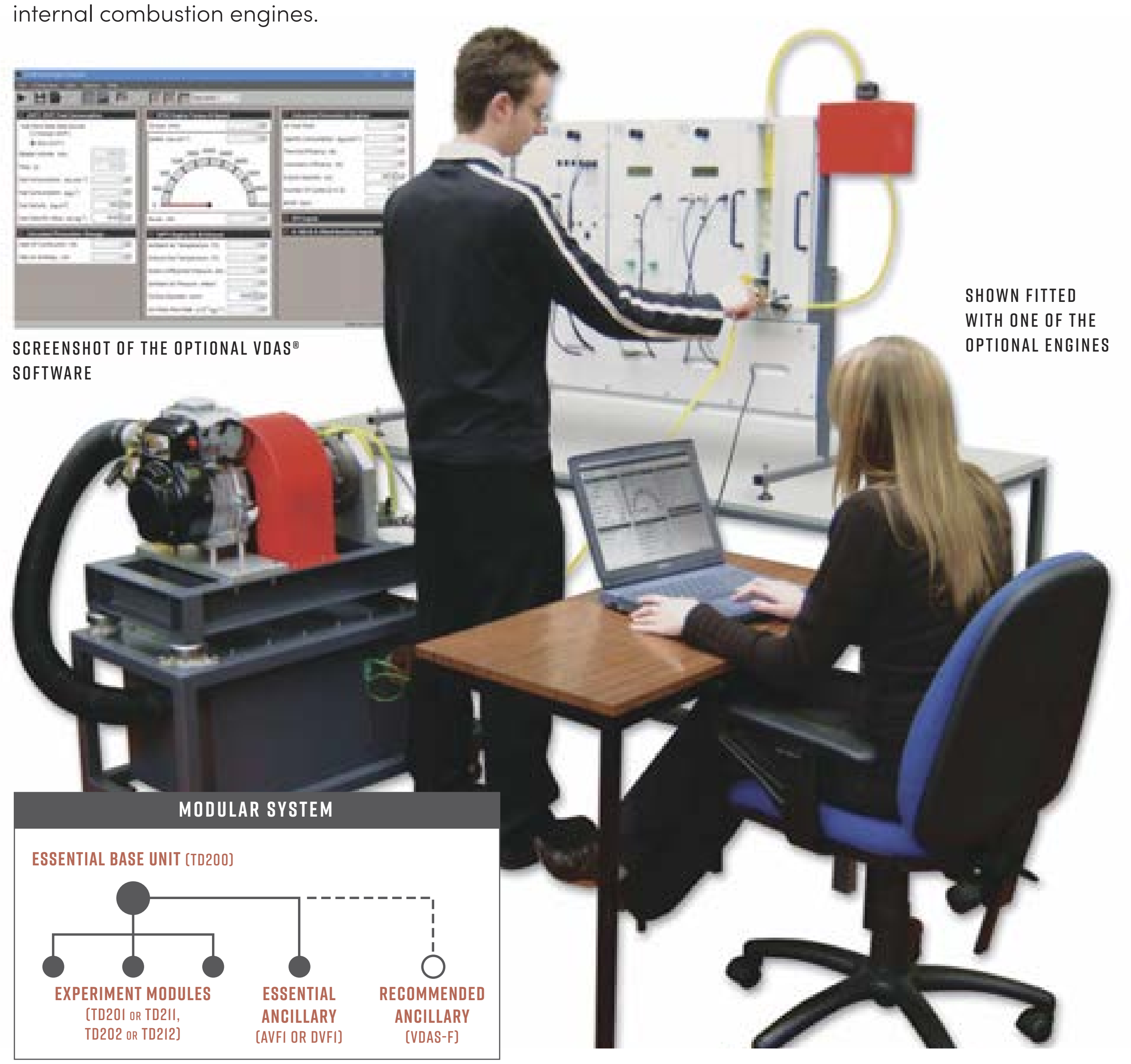
VDAS® Look at the products in this range that work with TecQuipment's unique Versatile Data Acquisition System (VDAS®) – **SEE PAGE 299.**

ADA TecQuipment's gas turbine products work with our unique Gas Turbine software.

SMALL ENGINE TEST SET

VDAS® TD200

Versatile engine test bed and instrumentation for investigations into the fundamental features of internal combustion engines.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

SHOWN FITTED WITH ONE OF THE OPTIONAL ENGINES

MODULAR SYSTEM

ESSENTIAL BASE UNIT (TD200)

EXPERIMENT MODULES (TD201 OR TD211, TD202 OR TD212)

ESSENTIAL ANCILLARY (AVFI OR DVFI)

RECOMMENDED ANCILLARY (VDAS-F)

FEATURES:		BENEFITS:
Fully equipped test set that supports a choice of internal combustion engines	→	Saves space and reduces costs
Optional petrol and diesel engines	→	Allows comparative tests of different engines
Several engine and instrument options	→	Expands the range of studies
Separate instruments and test bed	→	Avoids transmission of vibration to give accurate, repeatable results
Robust, simple hydraulic dynamometer	→	Reliability and long life
Easy set-up – it takes minutes to remove and fit an engine	→	Maximises experiment time
Works with VDAS®	→	Quick and reliable tests with data capture

CONTINUED ON NEXT PAGE

LEARNING OUTCOMES:

A comprehensive range of investigations into the features of single-cylinder, four-stroke petrol and diesel engines including:

- Torque, speed and power relationship
- Brake mean effective pressure
- Engine performance curves
- Air and fuel consumption
- Volumetric and thermal efficiencies
- Willans line for a diesel engine

By using the recommended ancillaries and engine choices, students can investigate more features including:

- Plotting p-θ and p-V diagrams
- Engine cycle analysis
- Indicated mean effective pressure
- Indicated power
- Comparison of brake and indicated mean effective pressures
- Mechanical efficiency of the engine

The bed sits on a trolley for portability. It includes a robust, precision-machined, trunnion-mounted hydraulic dynamometer. The dynamometer applies load according to the flow rate and level of water in the casing. An accurate needle valve controls the flow rate and level. An electronic load cell measures torque. The engines (available separately) are supplied pre-mounted on a sturdy precision base plate. When the engine is initially mounted onto the test bed or exchanged with an alternative engine, dowels and slots locate the engine quickly, accurately and reliably. To enable students to measure air flow, an air-box and orifice plate are located underneath the engine bed on the trolley.

AVAILABLE EXPERIMENT MODULES:

- Four-Stroke Petrol Engine (TD201 or TD211) 272 /274
- Four-Stroke Diesel Engine (TD202 or TD212) 273 /275

ESSENTIAL ANCILLARIES:

- Manual Volumetric Fuel Gauge (AVF1) or 281
- Automatic Volumetric Fuel Gauge with Digital Read-Out (DVF1) 281

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

ALTERNATIVE PRODUCTS:

- Regenerative Engine Test Set (TD300) 276

FOUR-STROKE PETROL ENGINE

TD201

A four-stroke, single-cylinder petrol engine for use with TecQuipment's Small Engine Test Set (TD200).

- High-quality yet cost-effective engine specially modified for educational use
- Wide range of investigations possible
- Quickly and accurately mounts on the test bed
- Includes colour-coded fuel tank with quick-release couplings

FOUR-STROKE DIESEL ENGINE

TD202

A four-stroke, single-cylinder diesel engine for use with TecQuipment's Small Engine Test Set (TD200).

- High-quality yet cost-effective engine specially modified for educational use
- Wide range of investigations possible
- Quickly and accurately mounts on the test bed
- Includes colour-coded fuel tank with quick-release couplings

LEARNING OUTCOMES:

When used with TecQuipment's Small Engine Test Set (TD200), investigations into the performance and characteristics of a four-stroke diesel engine, including:

- Torque, speed and power relationship
- Brake mean effective pressure
- Engine performance curves
- Air and fuel consumption
- Volumetric and thermal efficiencies
- Willans line

Adapted specially for education, the engine is mounted on a sturdy precision bed plate. The bed plate has dowels and slots which align and locate it accurately with the dynamometer test set. This minimises the time spent replacing one engine with another. In addition, each engine includes a colour-coded fuel tank with self-sealing couplings. The couplings ensure the engine can be connected and disconnected quickly and efficiently, with minimum loss or spillage of fuel. This engine starts using a simple pull cord, however, TecQuipment can supply an electric start version (TD202ES).

ESSENTIAL BASE UNIT:

- Small Engine Test Set (TD200) 271

ALTERNATIVE PRODUCTS:

- Four-Stroke Petrol Engine (TD201) 272
- Modified Four-Stroke Petrol Engine (TD211) 274
- Modified Four-Stroke Diesel Engine (TD212) 275
- Four-Stroke Petrol Engine (TD301) 278
- Four-Stroke Diesel Engine (TD302) 279

LEARNING OUTCOMES:

When used with TecQuipment's Small Engine Test Set (TD200), investigations into the performance and characteristics of a four-stroke petrol engine, including:

- Torque, speed and power relationship
- Brake mean effective pressure
- Engine performance curves
- Air and fuel consumption
- Volumetric and thermal efficiencies

Adapted specially for education, the engine includes an exhaust thermocouple, a half-coupling to link to the test set dynamometer and all essential hoses and fittings. In addition, each engine includes a colour-coded fuel tank with self-sealing couplings. The couplings ensure the engine can be connected and disconnected quickly and efficiently, with minimum loss or spillage of fuel. This engine starts using a simple pull cord, however, TecQuipment can supply an electric start version (TD201ES).

ESSENTIAL BASE UNIT:

- Small Engine Test Set (TD200) 271

ALTERNATIVE PRODUCTS:

- Four-Stroke Diesel Engine (TD202) 273
- Modified Four-Stroke Petrol Engine (TD211) 274
- Modified Four-Stroke Diesel Engine (TD212) 275
- Four-Stroke Petrol Engine (TD301) 278
- Four-Stroke Diesel Engine (TD302) 279

MODIFIED FOUR-STROKE PETROL ENGINE

TD211

A four-stroke, single-cylinder petrol engine with modified cylinder head and crank, for use with TecQuipment's Small Engine Test Set (TD200).

- Modified for use with optional Pressure (ECA101) and Crank Angle (ECA102) Transducers and Engine Cycle Analyser (ECA100)
- Wide range of investigations possible
- Quickly and accurately mounts on the test bed
- Includes colour-coded fuel tank with quick-release couplings

LEARNING OUTCOMES:

When used with TecQuipment's Small Engine Test Set (TD200), investigations into the performance and characteristics of a four-stroke petrol engine, including:

- Torque, speed and power relationship
- Brake mean effective pressure
- Engine performance curves
- Air and fuel consumption
- Volumetric and thermal efficiencies

When used with TecQuipment's Small Engine Test Set (TD200), Cylinder Head Pressure Transducer (ECA101), Crank Angle Encoder (ECA102) and Engine Cycle Analyser (ECA100), students can investigate further features including:

- Plotting p-θ and p-V diagrams
- Engine cycle analysis
- Indicated mean effective pressure
- Indicated power
- Comparison of brake and indicated mean effective pressures
- Mechanical efficiency of the engine

Adapted specially for education, the engine includes an exhaust thermocouple, a half-coupling to link to the test set dynamometer and all essential hoses and fittings. In addition, each engine includes a colour-coded fuel tank with self-sealing couplings. The engine has a modified cylinder head and crank. These allow use with the Cylinder Head Pressure Transducer (ECA101, available separately) and the Crank Angle Encoder (EA102, available separately). These can then connect to the Engine Cycle Analyser (ECA100, available separately) to extend the range of experiments possible. The engine is mounted on a sturdy precision bedplate. The bedplate has dowels and slots which align and locate it accurately with the dynamometer test set. This engine starts using a simple pull cord, however, TecQuipment can supply an electric start version (TD211ES).

ESSENTIAL BASE UNIT:

- Small Engine Test Set (TD200) 271

RECOMMENDED ANCILLARIES:

- Engine Cycle Analyser (ECA100) 282
- Cylinder Head Pressure Transducer (ECA101) 282
- Crank Angle Encoder (ECA102) 282

ALTERNATIVE PRODUCTS:

- Four-Stroke Petrol Engine (TD201) 272
- Four-Stroke Diesel Engine (TD202) 273
- Modified Four-Stroke Diesel Engine (TD212) 275
- Four-Stroke Petrol Engine (TD301) 278
- Four-Stroke Diesel Engine (TD302) 279

MODIFIED FOUR-STROKE DIESEL ENGINE

TD212

A four-stroke, single-cylinder diesel engine with modified cylinder head and crank, for use with TecQuipment's Small Engine Test Set (TD200).

- Modified for use with optional Pressure (ECA101) and Crank Angle (ECA102) Transducers and Engine Cycle Analyser (ECA100)
- Wide range of investigations possible
- Quickly and accurately mounts on the test bed
- Includes colour-coded fuel tank with quick-release couplings

LEARNING OUTCOMES:

When used with TecQuipment's Small Engine Test Set (TD200), investigations into the performance and characteristics of a four-stroke diesel engine, including:

- Torque, speed and power relationship
- Brake mean effective pressure
- Engine performance curves
- Air and fuel consumption
- Volumetric and thermal efficiencies
- Willans line

When used with TecQuipment's Small Engine Test Set (TD200), Cylinder Head Pressure Transducer (ECA101), Crank Angle Encoder (ECA102) and Engine Cycle Analyser (ECA100), students can investigate further features including:

- Plotting p-θ and p-V diagrams
- Engine cycle analysis
- Indicated mean effective pressure
- Indicated power
- Comparison of brake and indicated mean effective pressures
- Mechanical efficiency of the engine

Adapted specially for education, the engine includes an exhaust thermocouple, a half-coupling to link to the test bed dynamometer and all essential hoses and fittings. In addition, each engine includes a colour-coded fuel tank with self-sealing couplings. The engine has a modified cylinder head and crank. These allow use with the Cylinder Head Pressure Transducer (ECA101, available separately) and the Crank Angle Encoder (EA102, available separately). These can then connect to the Engine Cycle Analyser (ECA100, available separately) to extend the range of experiments possible. The engine is mounted on a sturdy precision bed plate. The bed plate has dowels and slots which align and locate it accurately with the dynamometer test set. This engine starts using a simple pull cord, however, TecQuipment can supply an electric start version (TD212ES).

ESSENTIAL BASE UNIT:

- Small Engine Test Set (TD200) 271

RECOMMENDED ANCILLARIES:

- Engine Cycle Analyser (ECA100) 282
- Cylinder Head Pressure Transducer (ECA101) 282
- Crank Angle Encoder (ECA102) 282

ALTERNATIVE PRODUCTS:

- Four-Stroke Petrol Engine (TD201) 272
- Four-Stroke Diesel Engine (TD202) 273
- Modified Four-Stroke Petrol Engine (TD211) 274
- Four-Stroke Petrol Engine (TD301) 278
- Four-Stroke Diesel Engine (TD302) 279

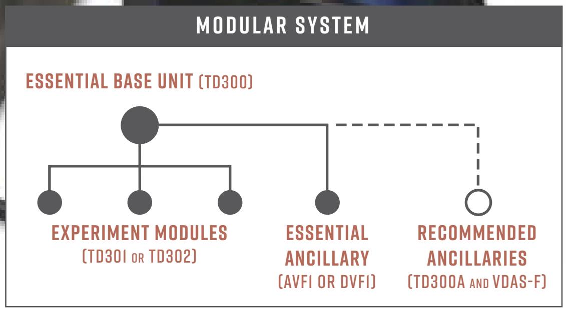
REGENERATIVE ENGINE TEST SET

VDAS® TD300

Versatile engine test bed with instrumentation for comprehensive investigations into the features and operating characteristics of internal combustion engines.

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

SHOWN FITTED WITH ONE OF THE OPTIONAL ENGINES



FEATURES:		BENEFITS:
Fully equipped test set that supports a choice of internal combustion engines	→	Saves space and reduces costs
Optional petrol and diesel engines	→	Allows comparative tests of different engines
Several engine and instrument options	→	Expands the range of studies
Separate instruments and test bed	→	Avoids transmission of vibration to give accurate, repeatable results
Precision four-quadrant drive to start and load the engines	→	Accurate loading with no need for pull-cord starting
Easy set-up – engines can be removed and fitted in minutes	→	Maximises experiment time
Works with VDAS®	→	Quick and reliable tests with data capture

LEARNING OUTCOMES:

A comprehensive range of investigations into the features of single-cylinder, four-stroke petrol and diesel engines including:

- Torque, speed and power relationship
- Brake mean effective pressure
- Engine performance curves
- Air and fuel consumption
- Volumetric and thermal efficiencies

By using the recommended ancillaries and engine choices, students can investigate more features including:

- Plotting p-θ and p-V diagrams
- Engine cycle analysis
- Indicated mean effective pressure
- Indicated power
- Comparison of brake and indicated mean effective pressures
- Mechanical efficiency of the engine

The bed is held on anti-vibration mounts. It includes a robust trunnion-mounted DC machine. An electronic load cell connected to the machine measures the driving torque of the test engine. The engines (available separately) are supplied pre-mounted on a sturdy precision base plate. When the engine is initially mounted onto the test bed or exchanged with an alternative engine, dowels and slots locate the engine quickly, accurately and reliably. Each engine includes a colour-coded fuel tank with self-sealing couplings. The couplings ensure the engines can be connected and disconnected quickly and efficiently, with minimum loss or spillage of fuel. For convenience and safety, the fuel tank can be removed for filling or for storage in a fuel locker when not in use. Removing the fuel tank also prevents unauthorised use of the equipment.

AVAILABLE EXPERIMENT MODULES:

- Four-stroke petrol engine (TD301) 278
- Four-stroke diesel engine (TD302) 279

ESSENTIAL ANCILLARIES:

- Manual Volumetric Fuel Gauge (AVF1) 281

OR

- Automatic Volumetric Fuel Gauge with Digital Read-out (DVF1) 281

RECOMMENDED ANCILLARIES:

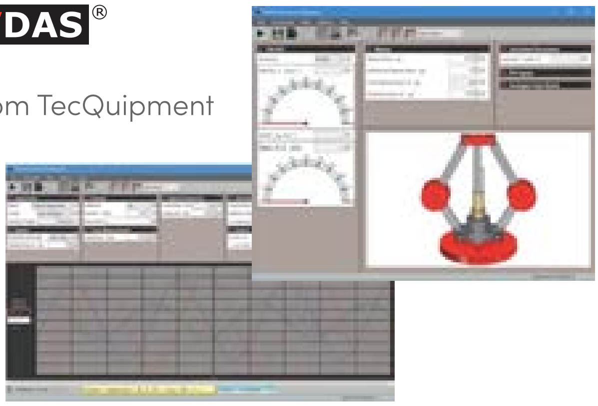
- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299
- Exhaust Gas Calorimeter (TD300a) 280

ALTERNATIVE PRODUCTS:

- Small Engine Test Set (TD200) 271

CAPTURE THE POWER OF VDAS®

...the Versatile Data Acquisition System from TecQuipment



Our Versatile Data Acquisition System (VDAS®) is a highly effective way of collecting and using data from experiments using TecQuipment's educational teaching equipment.

LOOK AT THE BENEFITS...

VERSATILE – can be used across a wide range of TecQuipment products

DATA – transforms raw data instantly which easily exports or creates sophisticated graphs and tables

ACQUISITION – USB connectivity, multiple-source real-time data capture

SYSTEM – an expandable modular approach providing easy-to-use digital plug-and-play technology

LABVIEW

All TecQuipment products compatible with VDAS® have the capability to interface with a LabVIEW environment.

Visit **TECQUIPMENT.COM** for more information.

FOUR-STROKE PETROL ENGINE

TD301

A four-stroke, single-cylinder petrol engine with modified cylinder head and crank, for use with TecQuipment's Regenerative Engine Test Set (TD300).

- Modified for use with optional Pressure (ECA101) and Crank Angle (ECA102) Transducers and Engine Cycle Analyser (ECA100)
- Quickly and accurately mounts on the test bed
- Includes colour-coded fuel tank with quick-release couplings

LEARNING OUTCOMES:

When used with TecQuipment's Regenerative Engine Test Set (TD300), investigations into the performance and characteristics of a four-stroke petrol engine, including:

- Torque, speed and power relationship
- Brake mean effective pressure
- Engine performance curves
- Air and fuel consumption
- Volumetric and thermal efficiencies

When used with TecQuipment's Regenerative Engine Test Set (TD300), Cylinder Head Pressure Transducer (ECA101), Crank Angle Encoder (ECA102) and Engine Cycle Analyser (ECA100), students can investigate further features including:

- Plotting p-θ and p-V diagrams
- The thermodynamic cycle of an internal combustion engine
- Indicated mean effective pressure
- Indicated power
- Comparison of brake and indicated mean effective pressures
- Mechanical efficiency of the engine

Adapted specially for education, the engine includes an exhaust thermocouple, a half-coupling to link to the test set dynamometer and all essential hoses and fittings. In addition, each engine includes a colour-coded fuel tank with self-sealing couplings. The engine has a modified cylinder head and crank. These allow use with the Cylinder Head Pressure Transducer (ECA101, available separately) and the Crank Angle Encoder (ECA102, available separately). These can then connect to the Engine Cycle Analyser (ECA100, available separately) to extend the range of experiments possible. The engine is mounted on a sturdy precision bed plate. The bed plate has dowels and slots which align and locate it accurately with the dynamometer test set.

ESSENTIAL BASE UNIT:

- Regenerative Engine Test Set (TD300) 276

RECOMMENDED ANCILLARIES:

- Engine Cycle Analyser (ECA100) 282
- Cylinder Head Pressure Transducer (ECA101) 282
- Crank Angle Encoder (ECA102) 282

ALTERNATIVE PRODUCTS:

- Four-Stroke Petrol Engine (TD201) 272
- Four-Stroke Diesel Engine (TD202) 273
- Modified Four-Stroke Petrol Engine (TD211) 274
- Modified Four-Stroke Diesel Engine (TD212) 275
- Four-Stroke Diesel Engine (TD302) 279

FOUR-STROKE DIESEL ENGINE

TD302

A four-stroke, single-cylinder diesel engine with modified cylinder head and crank, for use with TecQuipment's Regenerative Engine Test Set (TD300).

- Modified for use with optional Pressure (ECA101) and Crank Angle (ECA102) Transducers and Engine Cycle Analyser (ECA100)
- Quickly and accurately mounts on the test bed
- Includes colour-coded fuel tank with quick-release couplings

LEARNING OUTCOMES:

When used with TecQuipment's Regenerative Engine Test Set (TD300), investigations into the performance and characteristics of a four-stroke diesel engine, including:

- Torque, speed and power relationship
- Brake mean effective pressure
- Engine performance curves
- Air and fuel consumption
- Volumetric and thermal efficiencies

When used with TecQuipment's Regenerative Engine Test Set (TD300), Cylinder Head Pressure Transducer (ECA101), Crank Angle Encoder (ECA102) and Engine Cycle Analyser (ECA100) students can investigate further features including:

- Plotting p-θ and p-V diagrams
- The thermodynamic cycle of an internal combustion engine
- Indicated mean effective pressure
- Indicated power
- Comparison of brake and indicated mean effective pressures
- Mechanical efficiency of the engine

Adapted specially for education, the engine includes an exhaust thermocouple, a halfcoupling to link to the test bed dynamometer, and all essential hoses and fittings. In addition, each engine includes a colour-coded fuel tank with self-sealing couplings. The engine has a modified cylinder head and crank. These allow use with the Cylinder Head Pressure Transducer (ECA101, available separately) and the Crank Angle Encoder (ECA102, available separately). These can then connect to the Engine Cycle Analyser (ECA100, available separately) to extend the range of experiments possible. The engine is mounted on a sturdy precision bed plate. The bed plate has dowels and slots which align and locate it accurately with the dynamometer test set.

ESSENTIAL BASE UNIT:

- Regenerative Engine Test Set (TD300) 276

RECOMMENDED ANCILLARIES:

- Engine Cycle Analyser (ECA100) 282
- Cylinder Head Pressure Transducer (ECA101) 282
- Crank Angle Encoder (ECA102) 282

ALTERNATIVE PRODUCTS:

- Four-Stroke Petrol Engine (TD201) 272
- Four-Stroke Diesel Engine (TD202) 273
- Modified Four-Stroke Petrol Engine (TD211) 274
- Modified Four-Stroke Diesel Engine (TD212) 275
- Four-Stroke Petrol Engine (TD301) 278

EXHAUST GAS CALORIMETER

VDAS® TD300A

For use with TecQuipment's Regenerative Engine Test Set (TD300) to measure the heat content of engine exhaust gases.

- Safely and effectively measures the heat content of TecQuipment's test engine exhaust gases
- Specially designed for educational use
- Uses electronic transducers and a digital display for ease of use and accuracy
- Separate instrumentation unit conveniently mounts on test set console frame

LEARNING OUTCOMES:

When used with TecQuipment's Regenerative Engine Test Set (TD300), the Exhaust Gas Calorimeter enables students to assess the heat lost to exhaust in the energy balance for single-cylinder, four-stroke petrol (TD301) and diesel (TD302) engines.

The heat exchanger is mounted on a sturdy base plate. Exhaust gases from the test engine mounted on the test set flow through the tubes. A jacket of constantly flowing cooling water surrounds the tubes, and the heat content of the gases is assessed by measuring the cooling water flow rate and the inlet and outlet temperatures. A hand-operated valve, which mounts on the control console of the test set, controls the flow of cooling water through the heat-exchanger jacket. Thermocouples measure the temperature of gas and water at the inlet and outlet. A turbine flow meter measures the flow rate. For safety, the heat exchanger also includes a pressure-relief valve in case insufficient cooling water is flowing.

ANCILLARY FOR:

- Regenerative Engine Test Set (TD300) 276

MANUAL VOLUMETRIC FUEL GAUGE

AVF1

Convenient and accurate fuel gauge for use with TecQuipment Engine Test Sets (TD200 and TD300 series).

- Volumetric fuel gauge for use with TecQuipment's Small Engine Test Set (TD200) and Regenerative Engine Test Set (TD300) and engines
- Convenient and accurate measurement of fuel consumption
- Easy to install and use
- Self-sealing couplings enable quick and efficient connection and disconnection of fuel lines with minimum loss or spillage of fuel

The fuel gauge consists of a precision-calibrated two-bulb pipette and control valves. It mounts on the instrumentation frame of the test set and connects between the fuel tank and the engine under test.

ANCILLARY FOR:

- Small Engine Test Set (TD200) 271
- Regenerative Engine Test Set (TD300) 276

ESSENTIAL ANCILLARIES:

- Stopwatch (SW1) 28

AUTOMATIC VOLUMETRIC FUEL GAUGE WITH DIGITAL READ-OUT

VDAS® DVF1

Automatic fuel gauge for use with TecQuipment's Engine Test Sets (TD200 and TD300 series).

- Accurately and automatically calculates fuel consumption
- Directly displays fuel consumption on digital read-out
- Can cycle continuously or run once only
- Self-sealing couplings enable quick and efficient connection and disconnection of fuel lines with minimum loss or spillage of fuel

The gauge accurately calculates fuel consumption and displays it directly on a digital read-out.

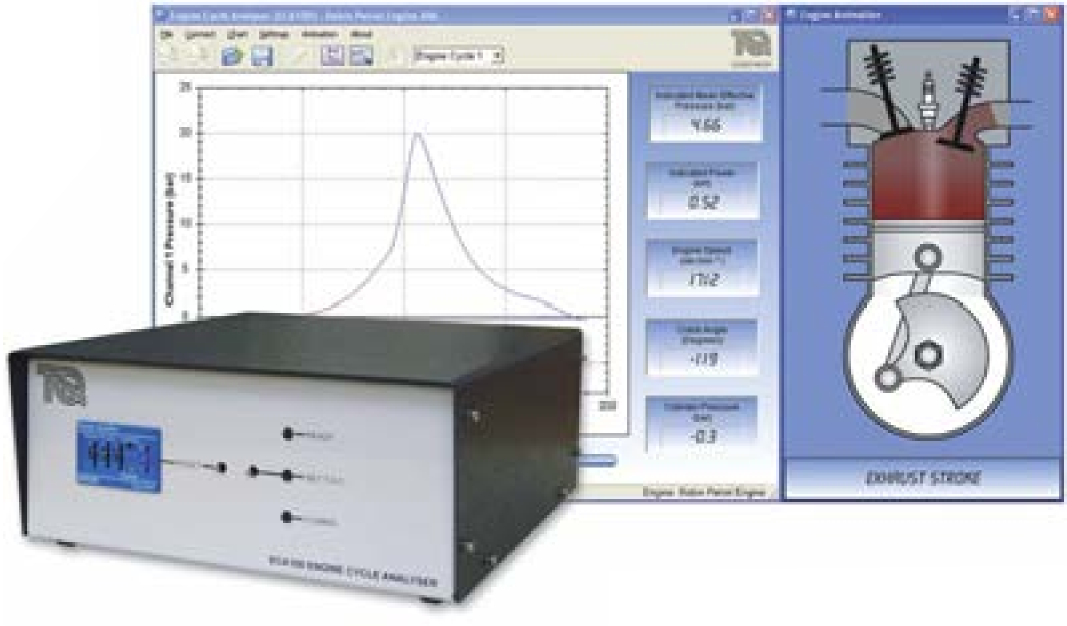
ANCILLARY FOR:

- Small Engine Test Set (TD200) 271
- Regenerative Engine Test Set (TD300) 276

ENGINE CYCLE ANALYSER

ECA100

Hardware and software to measure internal combustion engine cylinder pressure and crank angle.



- For use with TecQuipment's Small Engine Test Set (TD200) and Regenerative Engine Test Set (TD300) and engines
- Includes powerful Windows®-based software specially designed for educational use
- Automatic calculation and real-time display of p-θ and p-V plots and other important parameters
- Snap-shot, replay and animation functions
- Accurate, clear animations of crank, piston, inlet and exhaust valve positions help students visualise the engine cycle

The equipment consists of a hardware unit with connectors and leads, plus Windows®-based data acquisition and analysis software. The hardware consists of a microprocessor-based signal conditioning unit, with high-speed PC interface, housed in a rugged, protective enclosure. It accepts and conditions signals from the Cylinder Head Pressure Transducer (ECA101) and Crank Angle Encoder (ECA102), available separately. The cylinder pressure input includes a precision charge amplifier, with a digital thumb-wheel for calibration. As well as crank angle position, the signal from the Crank Angle Encoder is also used to determine engine speed.

TECQUIPMENT OFFERS A COMPLETE PACKAGE – THE ECA100S – WHICH INCLUDES THE ECA100, ONE ECA101 AND ONE ECA102

LEARNING OUTCOMES:

When used with suitable test engines, the analyser allows investigations into a variety of internal combustion engine characteristics, including:

- The thermodynamic cycle of an internal combustion engine.
- Calculation of indicated mean effective pressure and indicated power.
- Comparison of indicated mean effective pressure and brake mean effective pressure.
- Mechanical efficiency of the test engine.
- Further work using exported data such as combustion analysis.

ESSENTIAL ANCILLARIES:

- Cylinder Head Pressure Transducer (ECA101)
- Crank Angle Encoder (ECA102)
- Suitable computer

ANCILLARY FOR:

- Modified Four-Stroke Petrol Engine (TD211) 274
- Modified Four-Stroke Diesel Engine (TD212) 275
- Four-Stroke Petrol Engine (TD301) 278
- Four-Stroke Diesel Engine (TD302) 279

THERMAL POWER PLANT WITH STEAM ENGINE TRAINER

VDAS® TD1050

A laboratory-scale steam plant that demonstrates fundamental thermodynamic principles of energy conversion and mechanical power measurement.

- Introduces students to industry-standard methods of analysing steam plant performance, including Rankine cycle analysis and using the Willans line
- Uses a simple two-cylinder steam motor and an electrically heated boiler for easy understanding of the main parts of a steam plant
- Self-contained in a mobile frame that includes all instruments needed for experiments
- Allows students to copy the Marcet boiler experiment to prove the pressure-temperature relationship for saturated steam

LEARNING OUTCOMES:

- Steam plant performance, including the Rankine cycle analysis and the Willans line
- Marcet boiler experiment on saturated steam (pressure temperature relationship)

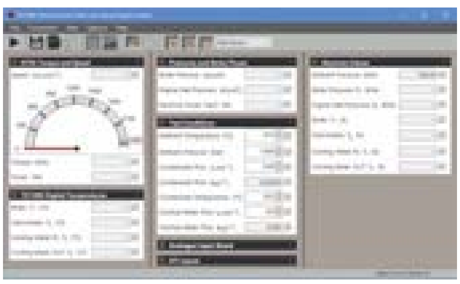
A mobile frame contains all the parts of the test set. An electric pump draws from a reservoir (included) to deliver water to an electrically-heated boiler. The boiler includes a safety valve, water level gauge and 'blow-down cock'. The boiler produces steam to turn a two-cylinder steam motor. The used steam from the motor outlet passes through a mains water-cooled condenser, then down to a waste tank or to a measuring vessel (supplied). TecQuipment supplies a stopwatch and thermometer to allow accurate measurement of the flow and temperature of the condensate (steam flow).

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Frame-mounted version (VDAS-F) 299

ALTERNATIVE PRODUCTS:

- Saturated Steam – Marcet Boiler (TD1006) 267



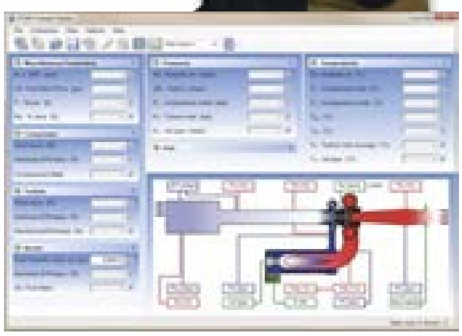
SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

TURBOJET TRAINER

ADA GT100

Allows detailed experiments that demonstrate how a single-shaft gas turbojet works, and tests its performance.

- Uses industrial parts, powered by kerosene for realistic tests and results
- Fully interlocked starting procedure and automatic shut-down
- Automatic data acquisition (ADA) included (supplied with software)
- Well-proven design – versions installed in universities, technical colleges and military training establishments in 30 countries worldwide



SCREENSHOT OF THE GT100 SOFTWARE

LEARNING OUTCOMES:

Various investigations into single-shaft turbine thrust jet performance, including:

- Effect on thrust generation by variation in rotational speed and propelling nozzle area
- Isentropic, polytropic and mechanical efficiencies of compressor, combustion chamber and turbine
- Pressure ratios of turbine, compressor and non-dimensional characteristics
- Combustion chamber pressure losses and combustion efficiencies
- Specific fuel consumption, thermal efficiency, air standard cycle, work ratio and heat balance

A steel frame that holds a gas generator, combustion chamber, oil and fuel tanks, pumps, ancillaries and guards. Air passes into an air box, into a compressor, then into the combustion chamber. A pump transfers fuel from the fuel tank to spray through a nozzle into the combustion chamber. A high-energy spark ignites the air and fuel mixture that flows to a radial flow turbine, then a variable area propelling nozzle. The exhaust gases discharge to a suitable exhaust system. A fuel flow control valve on the instrumentation and control panel regulates the speed.

ALTERNATIVE PRODUCTS:

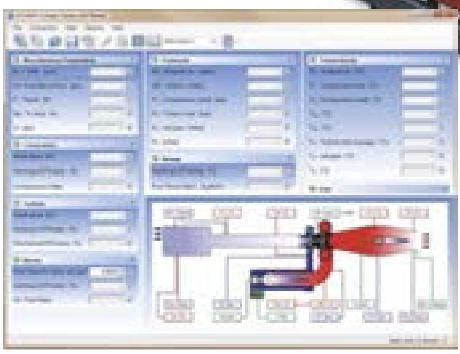
- Turbojet Trainer with Reheat (GT100RS) 285
- Two-Shaft Gas Turbine (GT185) 286

TURBOJET TRAINER WITH REHEAT

ADA GT100RS

Allows detailed experiments that demonstrate how a single-shaft gas turbojet with reheat (afterburner) works, and tests its performance.

- Uses industrial parts, powered by kerosene for realistic tests and results
- Fully interlocked starting procedure and automatic shut-down
- Automatic Data Acquisition (ADA) included (supplied with software)
- Well proven design – versions installed in universities, technical colleges and military training establishments in 30 countries worldwide



SCREENSHOT OF THE GT100RS SOFTWARE

LEARNING OUTCOMES:

Turbine, reheat and nozzle tests to find key performance information such as:

- Specific thrust and fuel consumption
- Pressure losses and ratios
- Thermal, propulsive, isentropic and mechanical efficiencies
- Work and power
- Thrust with and without reheat
- How the variable area nozzle affects thrust

Air passes into an air box, through a calibrated nozzle into a compressor, then into the combustion chamber. A pump transfers fuel from the fuel tank to spray through a special nozzle into the combustion chamber. A high-energy spark ignites the air and fuel mixture that flows to a radial flow turbine, then to the reheat section. It then passes through a variable area propelling nozzle. The exhaust gases then discharge to a suitable exhaust system. A fuel flow control valve on the instrumentation and control panel regulates the turbine speed. A second high-energy spark in the reheat section ignites the reheat fuel. This creates a secondary burn (or afterburn) using some of the remaining oxygen in the hot exhaust gases leaving the turbine.

ALTERNATIVE PRODUCTS:

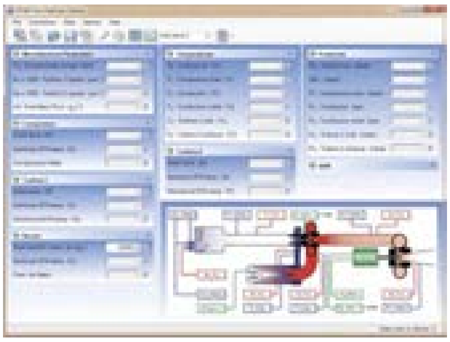
- Turbojet Trainer (GT100) 284
- Two-Shaft Gas Turbine (GT185) 286

TWO-SHAFT GAS TURBINE

ADA GT185

Allows detailed experiments that demonstrate how a two-shaft gas turbine works, and tests its performance.

- Uses industrial parts, powered by kerosene for realistic tests and results
- Fully interlocked starting procedure and automatic shut-down
- Automatic Data Acquisition (ADA) included (supplied with software)
- Direct-coupled (no belts) eddy current dynamometer for accurate loading, speed control and true shaft power measurement
- Well proven design – versions installed in universities, technical colleges and military training establishments in 30 countries worldwide



SCREENSHOT OF THE GT185 SOFTWARE

LEARNING OUTCOMES:

Turbine tests to find key performance information such as:

- Specific fuel consumption
- Pressure losses and ratios
- Thermal, isentropic and mechanical efficiencies
- Work and power

Combustion chamber:

- Pressure loss
- Combustion efficiency
- Air and fuel ratio

A steel frame holds a gas generator, power turbine, combustion chamber, oil and fuel tanks, pumps, ancillaries and guards. Air passes through a calibrated nozzle and air box, into a compressor, then into the combustion chamber. A pump transfers fuel from the fuel tank to spray through a special nozzle into the combustion chamber. A high-energy spark ignites the air and fuel mixture that flows to a gas generator turbine. A fuel flow control valve on the instrumentation and control panel regulates the turbine speed. Hot gas from the gas generator turbine passes through a short duct to the power turbine. The exhaust gases then discharge to a suitable exhaust system. The power turbine couples direct to an eddy current dynamometer. A load cell on the dynamometer measures torque and a sensor measures the dynamometer speed, to allow calculation of true shaft power.

ALTERNATIVE PRODUCTS:

- Turbojet Trainer (GT100) 284
- Turbojet Trainer with Reheat (GT100RS) 285

ENVIRONMENTAL CONTROL

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It is gratifying indeed to work with a company with exemplary customer service such as yours. Thank you on behalf of the entire Department of Civil Engineering at Oregon Tech.

PATRICK KILE
OREGON INSTITUTE OF TECHNOLOGY

ENVIRONMENTAL CONTROL

The Environmental Control range offers teaching equipment covering the fundamental theories associated with thermodynamics, fluid mechanics and heat transfer. This enables students to understand environmental control in the real industrial and consumer world. Experiments allow students to explore the workings of cooling towers, refrigeration, air-conditioning, humidity and solar energy; utilising psychrometric and p-h charts.

AUTOMATIC DATA ACQUISITION VDAS®

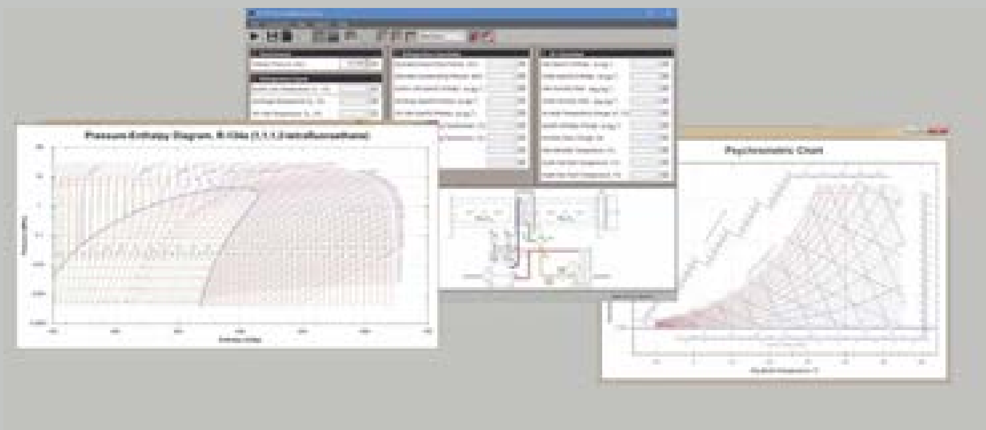
Look at the products in this range that work with TecQuipment's unique Versatile Data Acquisition System (VDAS®) – **SEE PAGE 299.**

KEY FEATURES AND BENEFITS:

FUNDAMENTALS OF HVAC: The range provides the capabilities to study the fundamental components of an HVAC course.

DATA ACQUISITION AS STANDARD: Most products in the range come with TecQuipment's Versatile Data Acquisition System, offering high specification and great value.

INDUSTRIAL AND DOMESTIC: With units covering air-conditioning and cooling towers, students can study the elements of both industrial and domestic environmental control.



COOLING TOWERS

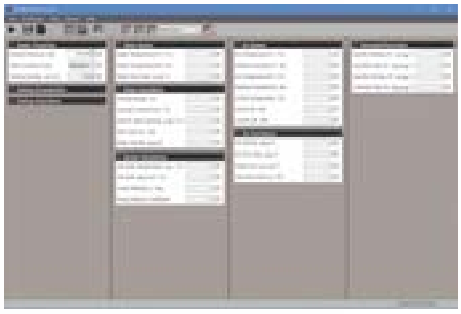
VDAS® EC1000

Bench-top unit demonstrates the operational characteristics of an evaporative cooling tower.

EC1000A

EC1000B

EC1000C



SCREENSHOT OF THE VDAS® SOFTWARE

SHOWN WITH THE PACKING CHARACTERISTICS COLUMN (EC1000D)

- The EC1000 includes one column with packing for immediate experimentation potential
- Three extra interchangeable columns, containing different packing densities and arrangements, further extend experimental capabilities
- An additional interchangeable column with no packing demonstrates free-fall cooling
- VDAS® connectivity included featuring data acquisition via USB

LEARNING OUTCOMES:

How key variables affect the performance of a cooling tower, including:

- Variation of water flow rate
- Variation of air flow rate
- Packing density and arrangement
- Variation of water temperature
- Energy and mass balance

A centrifugal pump delivers the heated water to a spray nozzle at the top of the column. The water sprays into the column, passing over 'packing' inside the column and returning to the heated water tank. The fan directs air upwards through the column in counter flow to the water, extracting the heat. Electronic sensors measure the air and water flow, humidity, pressures and temperatures at key points, shown on clear, multiline displays. This gives all measurements needed to understand the evaporative cooling tower operation. A clear tube above the heated water tank allows the user to measure the water lost to evaporation.

RECOMMENDED ANCILLARIES:

- Cooling Column Type A (EC1000a)
- Cooling Column Type B (EC1000b)
- Empty Cooling Column (EC1000c)
- Packing Characteristics Column (EC1000d)

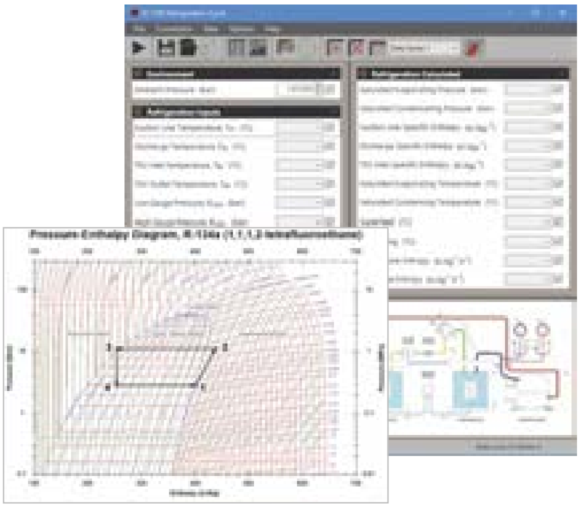
REFRIGERATION CYCLE

VDAS® EC1500

Bench-top unit that allows students to investigate the stages of refrigeration.

- Pressure and temperature measurements taken around the refrigeration circuit
- VDAS® connectivity included featuring data acquisition via USB
- VDAS® software allows students to visualise experimental parameters using pressure-enthalpy charts
- LCD display of all measured parameters (temperature and pressure)

The refrigeration circuit features high and low-pressure gauges, a pressure switch, sight glass, filter dryer and TEV valve. The circuit also includes pressure transducers that connect to the instrumentation. Four thermocouples placed around the refrigeration circuit allow the observation of temperatures; these can be used for the calculation of potential super-heating and sub-cooling. The evaporator and condenser coils are submerged in heat source and heat sink water tanks for the clear demonstration of a practical heat pump. A small pump provides circulation of the water between the heat source and sink for steady state experiments.



SCREENSHOTS OF THE VDAS® SOFTWARE
CHARTS CAN BE DOWNLOADED

LEARNING OUTCOMES:

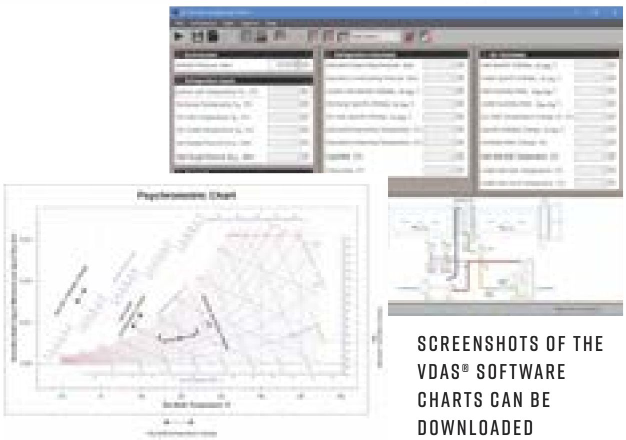
- Learn to use a p-h chart
- Determine Coefficient of Performance (CoP)
- Determine superheat and sub-cooling

AIR CONDITIONING TRAINER

VDAS® EC1501

Bench-top trainer, allows students to investigate the fundamental principles of air conditioning.

- Pressure and temperature measurements taken around the refrigeration circuit
- Relative humidity and temperature measured either side of the evaporator
- VDAS® connectivity included featuring data acquisition via USB
- Software allows students to visualise experimental parameters using psychrometric charts
- LCD display of all measured parameters (relative humidity, temperature and pressure)



SCREENSHOTS OF THE VDAS® SOFTWARE CHARTS CAN BE DOWNLOADED

LEARNING OUTCOMES:

- Learn to use p-h charts
- Learn to use psychrometric charts
- Determine Coefficient of Performance (CoP)
- Determine superheat and sub-cooling
- Determine enthalpy change in the air flow

The unit features an air-cooled condenser unit connected to an evaporator located in an air duct. The air duct contains relative humidity and temperature sensors on both sides. A small fan provides air flow down the duct; air flow rate can be manually adjusted. The refrigeration circuit features high and low-pressure gauges, a pressure switch, sight glass, filter dryer and TEV valve. The circuit also includes pressure transducers that connect to the instrumentation. Four thermocouples placed around the refrigeration circuit allow observation of temperatures; these can be used for the calculation of potential super-heating and sub-cooling.

HUMIDITY MEASUREMENT

TE6

Illustrates the principles of humidity measurement and compares various methods of measurement.

- Allows students to compare different humidity measuring instruments
- Includes air filter to help prevent dust and other impurities from entering instruments
- Includes mechanical and electronic instruments to measure temperature and humidity
- Variable flow-rate fan to demonstrate the effect of air flow on humidity measurement

FULL SPECIFICATION DATASHEETS

Datasheets contain full specifications such as size, weight, noise output, fluid capacity, voltage requirements etc. Download from each individual product webpage.

TECQUIPMENT.COM (search product)

LEARNING OUTCOMES:

- Measurement of air flow rate in a duct
- Measurement of relative humidity using different types of instrumentation
- Comparison of measurement methods for accuracy and ease of use

A square cross-section duct supports a blower unit. The duct contains a selection of instruments to measure humidity and temperature. A fan in the blower unit above the duct supplies a flow of air and a hand-operated valve varies the air flow rate. This allows students to study the effect of air flow on the instruments. An orifice plate and manometer measure the flow rate. An air filter in the air flow path stops dirt or other particles affecting the instruments. The instruments include a whirling hygrometer that students use near the outlet of the duct, providing an extra method of measuring temperature and humidity. The back of the duct includes an extra port. It allows students to introduce low-pressure steam into the duct.

SOLAR ENERGY

> The TecQuipment teaching solutions and scalable teaching equipment has allowed the Thermal Engineering and Energy Department to provide training up to Masters degree level with continuous and undeniable quality.
>
> **PROFESSOR JEAN-NOËL BLANCHARD**
> IUT ORLEANS, FRANCE

SOLAR ENERGY

The Solar Energy range offers teaching equipment for the core principles of solar energy, including photovoltaic cells, flat plate solar thermal energy collectors and focusing solar energy collectors. Students can learn about the efficiencies and limitations of each method of harnessing and converting solar energy for use in the real world.

VERSATILE DATA ACQUISITION SYSTEM VDAS®

The Solar Energy products work with TecQuipment's unique Versatile Data Acquisition System (VDAS®) – **SEE PAGE 299.**

KEY FEATURES AND BENEFITS:

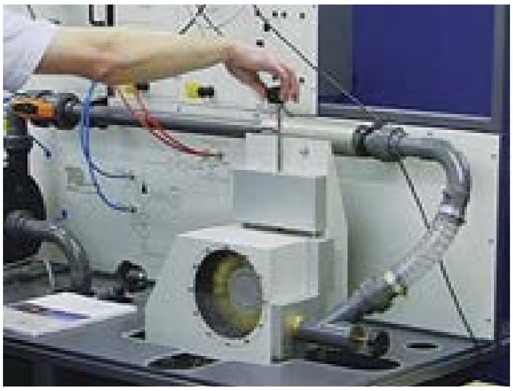
PHOTOVOLTAIC, FOCUSING AND FLAT PLATE ENERGY COLLECTION: Demonstrates three key methods used in harnessing solar energy.

AUTOMATIC DATA ACQUISITION: VDAS® is particularly useful when monitoring longer duration experiments.

SAFE AND EASY SET UP: Low temperatures, safe connections and simple, hand-operated controls allow the set up an experiment safely and quickly.

LOOK AT OUR OTHER RELEVANT RANGES

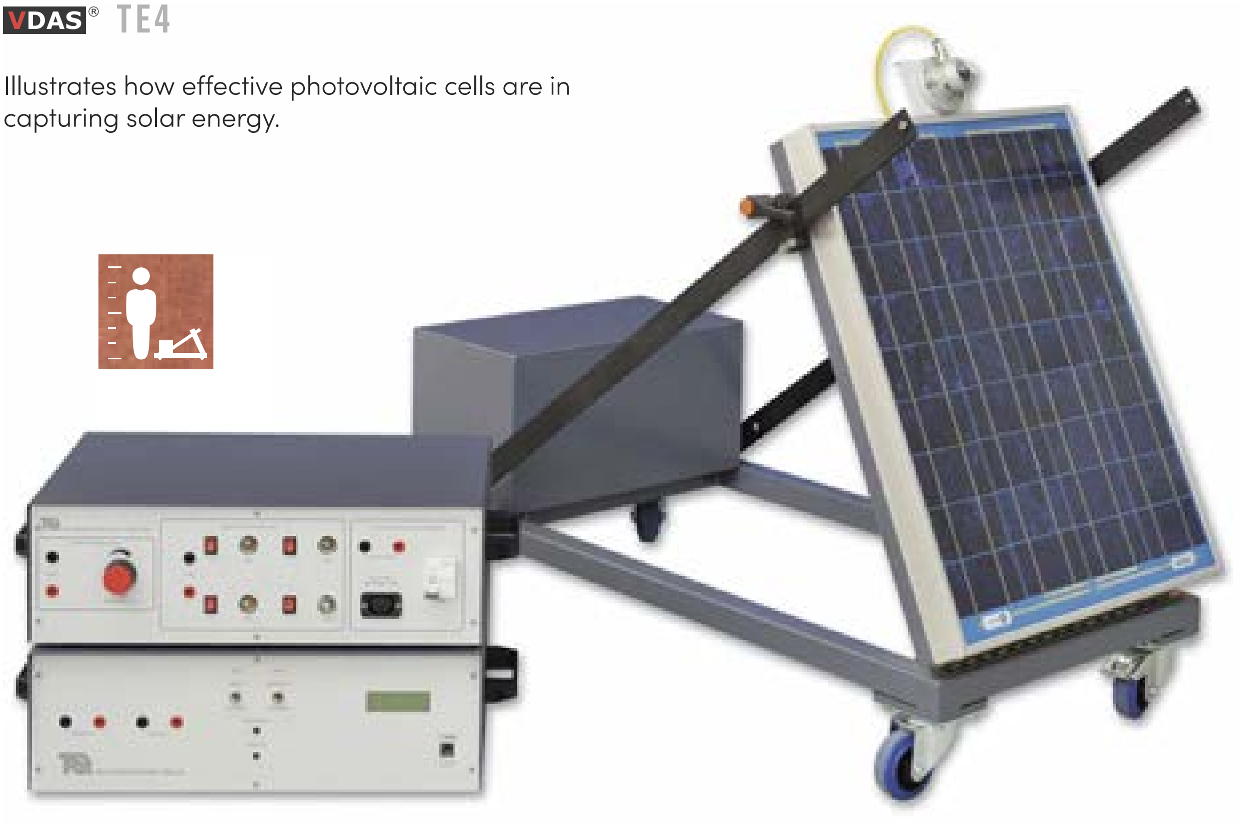
Other TecQuipment products link directly to renewable energy. For example, our **MODULAR FLUID POWER** products (pages 134–148) include turbines to harness the energy in water. The **AERODYNAMICS** and **FLUID MECHANICS** ranges include experiments to demonstrate how shapes affect air and water flow. These are essential tools for engineers when designing wind or water energy systems.



PHOTOVOLTAIC CELLS

VDAS® TE4

Illustrates how effective photovoltaic cells are in capturing solar energy.



- Demonstrates the performance of a high-efficiency photovoltaic cell array and battery storage system
- Includes solarimeter, charge controller and control module with digital displays and DC outputs
- Supplied with both high and low-rated batteries to allow students to investigate charge and discharge cycle of the system in a typical laboratory session as well as longer cycles
- Includes three different types of electrical load

SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

The TE4 uses a commercially available solar panel made from high efficiency cells. The solar panel is on a wheeled, lightweight frame that allows adjustment of the panel angle, relative to the sun. A solarimeter on the frame measures incident radiation. The panel recharges a choice of two batteries through a charge controller. The charge controller recharges the battery at the correct rate of charge without damage to the battery. The frame holds a high-performance, deep-cycling battery in a storage box. The equipment also includes a second lower-rated battery. This allows students to examine the charge and discharge cycle of the system in a typical laboratory session.

LEARNING OUTCOMES:

- Performance of the solar panel
- Demonstration of float mode
- Demonstration of load cut

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ALTERNATIVE PRODUCTS:

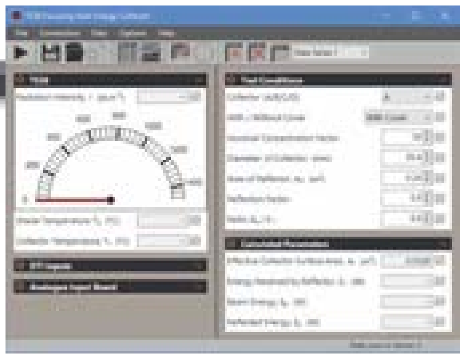
- Focusing Solar Energy Collector (TE38) 296
- Flat Plate Solar Thermal Energy Collector (TE39) 297

FOCUSING SOLAR ENERGY COLLECTOR

VDAS® TE38

Illustrates the workings of a focusing solar energy collector and allows students to study its performance.

- Mobile, self-contained focusing solar energy collector specially designed for educational use
- Demonstrates principles, advantages and limitations of focusing solar energy collectors
- Includes four different sizes of collector for studies of different energy concentration ratios
- Removable transparent cover allows students to compare properties of shielded and unshielded collectors



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

LEARNING OUTCOMES:

- Demonstrations of the performance, advantages and limitations of a focusing solar energy collector
- Understanding the effective use of the direct component of solar radiation
- Measurement of the efficiency of the collector with and without a transparent cover
- Measurement of the maximum possible energy collector temperature

A highly-polished stainless steel parabolic reflector, supported on trunnion bearings on a turntable. By adjusting the horizontal and vertical position of the reflector, students focus solar energy onto an energy collector. The energy collector is a brass cylinder with an embedded thermocouple that measures the cylinder temperature. To enable students to compare different concentration ratios, TecQuipment supplies four different sizes of energy collector. Also supplied is a removable transparent cover for the collector, so students can study the properties of shielded and unshielded collectors. Attached to the reflector carrier is a solarimeter (pyranometer) that measures the incident solar radiation.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299
- Stopwatch (SW1) 28

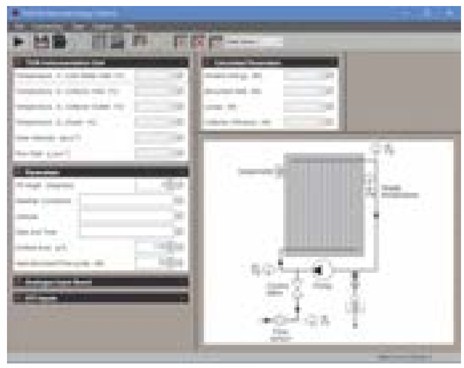
ALTERNATIVE PRODUCTS:

- Photovoltaic Cells (TE4) 295
- Flat Plate Solar Thermal Energy Collector (TE39) 297

FLAT PLATE SOLAR THERMAL ENERGY COLLECTOR

VDAS® TE39

Illustrates the workings of a flat plate solar energy collector and allows students to study its performance.



SCREENSHOT OF THE OPTIONAL VDAS® SOFTWARE

- Educational flat plate solar energy collector with full instrumentation
- Allows students to investigate the effective use of a renewable, environmentally friendly energy source
- Purpose designed and built solar panel for high quality
- Includes digital display of flow, radiation intensity and temperatures at different points throughout the apparatus

LEARNING OUTCOMES:

- Efficiency of the collector
- Efficiency and heat losses
- Effect of collector angle

The panel has a thin sheet metal absorber, backed by riser tubes and insulating material, to reduce heat loss to the rear. A box with a clear cover encloses the panel, forming the collector. To allow users to adjust its angle, the frame has a hinge. Cold mains water enters the collector. Sunlight energy heats the water in the collector. The heated water returns to a pump that mixes it with the incoming cold water. A pressure-sensitive valve allows the heated water to leave the equipment at the same rate as cold water enters it. A flow transducer measures the water flow rate and a solarimeter (or pyranometer) measures incident radiation. Thermocouples measure the water temperature at all the important points, and the shade temperature.

RECOMMENDED ANCILLARIES:

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 299

ALTERNATIVE PRODUCTS:

- Photovoltaic Cells (TE4) 295
- Focusing Solar Energy Collector (TE38) 296

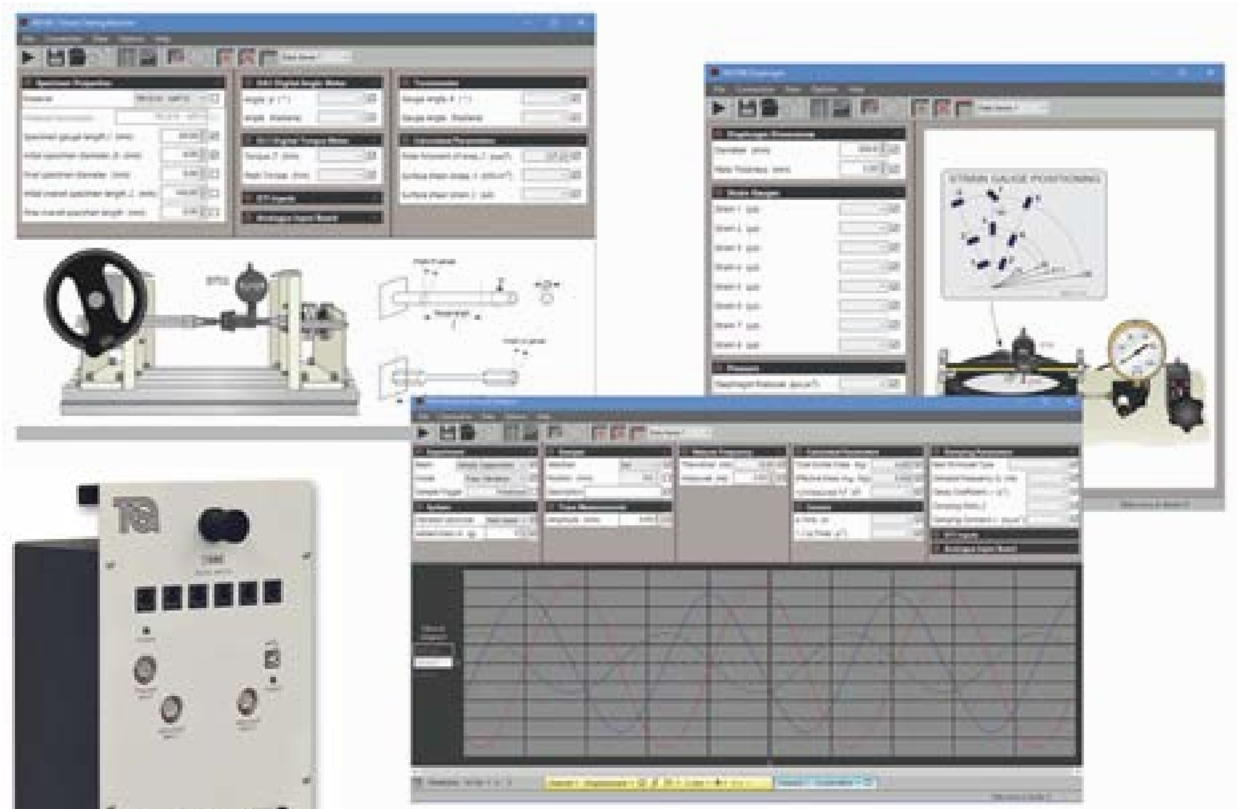
BRAZING THE PIPEWORK OF THE EC1500

VERSATILE DATA ACQUISITION SYSTEM

> “
>
> Every time we look at the quality of the materials you have used to build these apparatuses, and the user-friendliness of your software, we thank you and wished other companies can learn from you.
>
> **PROFESSOR M. KHOSROWJERDI**
> WESTERN NEW ENGLAND UNIVERSITY, SPRINGFIELD, MASSACHUSETTS USA

VERSATILE DATA ACQUISITION SYSTEM VDAS®

High-capacity, accurate, efficient and user-friendly automatic data acquisition for over 60 TecQuipment products.



SAMPLE SCREENSHOTS OF THE VDAS® SOFTWARE

FRAME-MOUNTING VERSATILE DATA ACQUISITION SYSTEM (VDAS-F) INTERFACE UNIT

LATEST VDAS® SOFTWARE AVAILABLE ONLINE

DOWNLOAD VERSION 3.0 FOR IMPROVED USABILITY

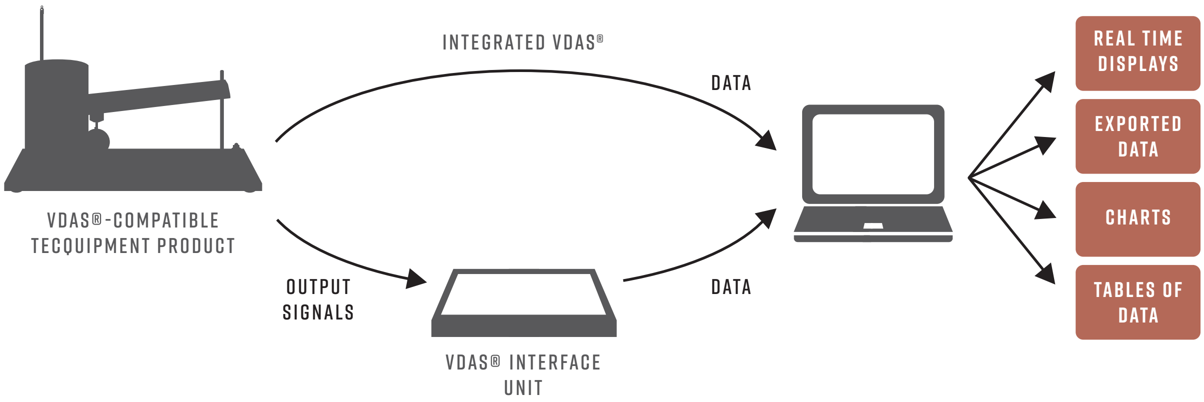
TECQUIPMENT.COM/DOWNLOADS

- Cost-effective digital automatic data acquisition hardware, software and accessories to enhance teaching and laboratory sessions
- Real-time traces, data capture, monitoring and display of experiment readings on a computer
- Available in frame-mounting, bench-top and integrated (selected products only) for convenience
- Selected TecQuipment products are available with integrated VDAS® which connect directly to a PC
- Similar software layout for all VDAS®-compatible products – no need to learn new software when changing experiments

BENCH-TOP VERSATILE DATA ACQUISITION SYSTEM (VDAS-B) INTERFACE UNIT

TecQuipment's Versatile Data Acquisition System (VDAS®) works with a growing list of over 60 TecQuipment products, enabling real-time display and capture of experiment data.

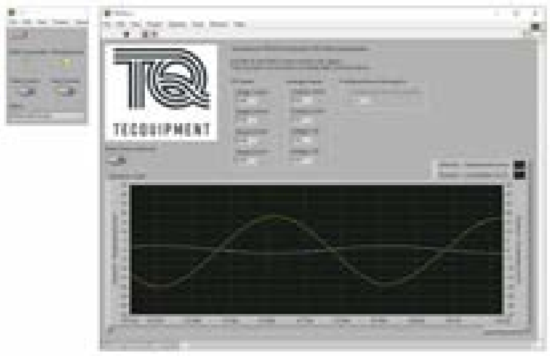
VDAS IS A REGISTERED TRADEMARK OF TECQUIPMENT LTD



WHY CHOOSE VDAS®?

LABVIEW DATA ACQUISITION

Experimental data from TecQuipment products can be acquired in real-time within National Instrument's LabVIEW software environment. All TecQuipment VDAS®-compatible products are supported by the VDAS®-LabVIEW software package which is freely available from the TecQuipment website. LabVIEW users have the flexibility to extend TecQuipment's software to perform novel data processing, presentation and analysis.



VDAS® SHOWN WORKING WITH THE FREE VIBRATIONS OF A CANTILEVER (TM166) EQUIPMENT

VDAS® ENABLED PRODUCTS

AERODYNAMICS

FLUID MECHANICS

MATERIALS TESTING AND PROPERTIES

THEORY OF MACHINES

THERMODYNAMICS

ENGINES

ENVIRONMENTAL CONTROL

SOLAR ENERGY

Search for VDAS® on our website for the latest list of VDAS®-compatible products.

TECQUIPMENT.COM

* Is supplied with VDAS-F, VDAS-FC or VDAS-B as standard

** Is supplied with Integrated VDAS® as standard

GENERAL-PURPOSE ANCILLARIES AND INSTRUMENTS

THE FOLLOWING ITEMS ARE ANCILLARIES TO SOME OF THE OTHER PRODUCTS AND PRODUCT RANGES IN THIS CATALOGUE. SOME WILL ONLY WORK WITH TECQUIPMENT PRODUCTS, AND SOME WILL ALSO WORK AS GENERAL-PURPOSE LABORATORY EQUIPMENT.

PLEASE NOTE:

The specifications of these ancillary products are correct at the time of printing.

They are designed or chosen to work with the correct TecQuipment products or product ranges. If it is intended that these ancillaries are to be used as general-purpose laboratory equipment , please check its datasheet or ask our experts at TecQuipment **BEFORE ORDERING**.

📄 This symbol means that we keep an up-to-date datasheet on our website (www.tecquipment.com).

☎ This symbol means that Tecquipment or the local distributor must be contacted for the latest specification.

OSCILLOSCOPES

DUAL BEAM STORAGE OSCILLOSCOPE

☎ H405A

A two-channel 50 MHz digital storage oscilloscope .

Works with several TecQuipment products and is good for general-purpose use.

OSCILLOSCOPE

☎ OS1

A dual channel 50 MHz digital oscilloscope.

Works with several TecQuipment products and is good for general-purpose use.

PRESSURE INSTRUMENTS AND EQUIPMENT

COMPRESSOR

☎ CE1B

A laboratory-scale compressor providing ten litres a minute flow at a pressure of 3 bar (45 PSIG).

Works with several TecQuipment products and is good for general-purpose use.

CONSUMABLES PACK

CK1

A selection of jubilee clips, connectors, glass manifolds, caps, valves, tubes, weights, hangers and other consumables; all commonly used on TecQuipment products.

STROBOSCOPES AND TACHOMETERS

STROBOSCOPE

📄 ST1

A portable, mains-powered stroboscope that gives 60 to 7,500 flashes a minute in one continuous range. Includes a display of flash speed and works with an internal or external trigger.

Works with several TecQuipment products and is good for general-purpose use.

OPTICAL TACHOMETER

☎ OT1

A hand-held, battery-powered optical tachometer with a digital display and a speed range of 3 to 99999 rev.min^{-1} (rpm). It works with reflective surfaces or stick-on reflective tape.

Works with several TecQuipment products and is good for general-purpose use.

KEYWORD INDEX

PLEASE NOTE: For ease of use we have only shown the main TecQuipment products relating to the keywords in this index. However, there may be other similar products that are also suitable for your needs. These are listed as alternative products in the main pages of this guide.

D

E

F

G

H

CONTACTING TECQUIPMENT

PURCHASE ENQUIRIES

For all purchase enquiries please contact the local agent or: **SALES@TECQUIPMENT.COM**

Purchase enquiries can be:

- Requests for data sheets, catalogues and further information
- Technical advice for product selection prior to purchase
- Prices and quotations

AFTERSALES

There is a dedicated team of people at TecQuipment that are committed to providing a high level of aftersales care and support to all our customers, past and present.

No matter how old the equipment is, we continue to provide support.

L-R: ANDREW RATCLIFFE - TECNICAL SUPPORT MANAGER, DAVE GIDDINGS - ICT MANAGER, MATTHEW FELLOWS - APPLICATIONS ENGINEER

For all aftersales queries please contact:
CUSTOMER.CARE@TECQUIPMENT.COM
or use the form on our website at:
TECQUIPMENT.COM

Aftersales queries can be:

- Requests for manuals and user guides
- Quotations for spares and consumables
- Post-sales technical advice and support

SALES AND MARKETING TEAM

PRODUCT LIST

This is a list of our main line items so some ancillary products may not appear. Please refer to the main line item to find any ancillaries (for example, to find AF80a look at AF80). Alternatively, check our website at **TECQUIPMENT.COM** or contact our expert Sales team.

FLUID MECHANICS LABORATORY AT THE UNIVERSITY OF NOTTINGHAM

UNIVERSITY OF NORTHWESTERN ST PAUL BUILDS NEW ENGINEERING PROGRAMME WITH HELP FROM TECQUIPMENT

When the University of Northwestern St Paul, located in Minnesota in the USA, set out to build new laboratories while meeting USA degree accreditation requirements, they scoured the educational teaching equipment market for a supplier that could deliver:

- High quality products and customer service
- Competitive prices
- Purpose-built equipment with teaching flexibility in mind
- A single supplier source for the majority of the practical teaching needs

"We chose TecQuipment because they ticked all the boxes and some more. They were great to work with from start to finish, from initial discussions at ASEE 2016 in New Orleans, through to the more recent installation, training and commissioning in August 2018. Even when we encountered problems, the Lab Midwest team and TecQuipment dealt with the situation with smiles and joyfulness," explained Rachel Friesen, Laboratory Technician at the University of Northwestern.

DEGREE ACCREDITATION

The legacy of teaching engineering at the University of Northwestern goes back to the debut of pre-engineering in 1983–1984 and then to the establishment of the engineering dual degree programme in conjunction with the University of Minnesota in 2000. Students in the dual degree programme would typically enrol in mathematics, science, and engineering courses at the University of Northwestern for three years and then transfer to the University of Minnesota for the final two years of the curriculum. The decision to offer a complete bachelor's degree programme in engineering at Northwestern, beginning in 2016, was made, with accreditation as a high priority. They already had a strong teaching team with lots of experience, but another requirement for accreditation was the addition of modern and practical teaching equipment to prepare students for the industry workforce.

FLEXIBLE TEACHING REQUIREMENTS AND SPACE LIMITATIONS

"Our current laboratory space was renovated from art studios and kitchens, which means space is a high concern," explained Friesen. "This was another reason why we opted for TecQuipment products that are compact, while still being big enough for groups of students to work on them together."

In addition to this, they were looking for equipment that would run pre-set experiments, as well as offer flexibility for the teaching team to design their own laboratory experiments.

COST SAVINGS

The University of Northwestern looked at four main suppliers of equipment, comparing the product specifications, cost and comprehensive equipment provision.

"TecQuipment was both cost effective as well as able to provide the majority of the equipment that we needed to teach both our thermal-fluids and materials laboratories," commented Friesen.

THE LABORATORY SET-UP

At the University of Northwestern, theory and laboratory courses do not relate one-to-one. For example, the materials laboratory consists of mainly destructive testing equipment that explores concepts from both the material science and mechanics of materials courses.

"Our favourite piece of equipment has been the Universal Testing Machine. Despite also having a higher capacity piece of equipment in the laboratory, we like this one because it is an easy-to-manipulate, hands-on machine," explained Friesen. The compact size means that the instructors have the freedom to move it around and can allow students to operate it. Plus, if it should break, they felt confident about the repair process. Friesen explained further: "It is so very fun to watch the students pumping the hydraulic arm and then see them edge further and further away as they anticipate the break in material. It has also given the engineering department an opportunity to educate the rest of the university and local community about what we do. We've had groups from our alumni community, human resources and the local community come along to the department, get hands-on and break something with this piece of equipment. It allows us to show them that engineering is not all equations and work on computers."

Other equipment for exploring materials included the purchase of the Torsion Testing Machine and Creep Testing Machine.

DEDICATED THERMO-FLUIDS LABORATORY

For the thermo-fluids laboratory, they purchased a Digital Hydraulic Bench and experiments to mount on it, including the Flow Measurement Methods apparatus and Flow Calibration apparatus. They also purchased freestanding apparatuses including the Piping Networks apparatus and Two-Stage (Series and Parallel) Pumps. For learning about heat transfer and thermodynamics, they opted for the Heat Transfer experiment base unit with a range of experiments, Heat Exchanger Service Module base unit and experiments, a Free and Forced Convection experiment, a Radiation experiment and, lastly, a Refrigeration Cycle experiment.

A SEAMLESS EXPERIENCE

"Throughout the process of purchase we have had excellent service from the TecQuipment team and local agent, Lab Midwest. It extended from the initial quote, where it was clear to see what was and what wasn't included, through to the set up and installation - which was incredible. Paul Holslin from Lab Midwest worked with me for a week in 90-degree heat unpacking crates. Then, TecQuipment specialist Matthew Fellows did a wonderful job of walking us through all the products, answering questions and resolving the small transit damage issues," summarised Friesen.

Rachel Friesen went on to emphasise the people element. "Another thing I really appreciate about working with TecQuipment is that you are working with people, not just with nameless assistance at a generic email address. It's that personal care and attention that has never left me feeling that I'm waiting unnecessarily."

TecQuipment Ltd, Bonsall Street, Long Eaton, Nottingham NG10 2AN, UK