CONTROL ENGINEERING

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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

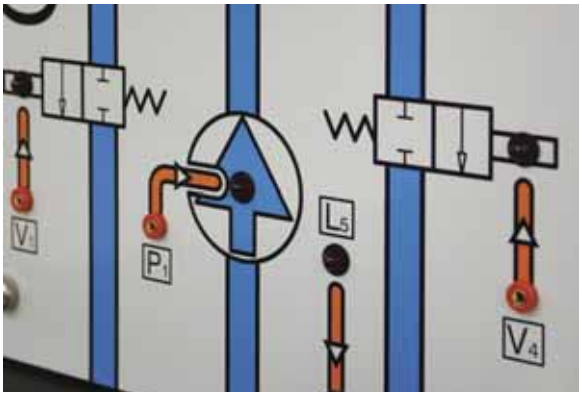
CONTROL ENGINEERING

DETAILED EXPERIMENTATION

Each unit in the Control Engineering range focuses on a specific principle. This gives students the opportunity to develop a deep understanding of each concept, naturally progressing from introductory to advanced experimentation.

EASE OF USE

The majority of the apparatus in the Control range can be connected to TecQuipment's dedicated Controllers (CE120 and CE122). The units have clear diagrams, highlighting each of the PID elements, for simple analogue or digital execution of the experiments.

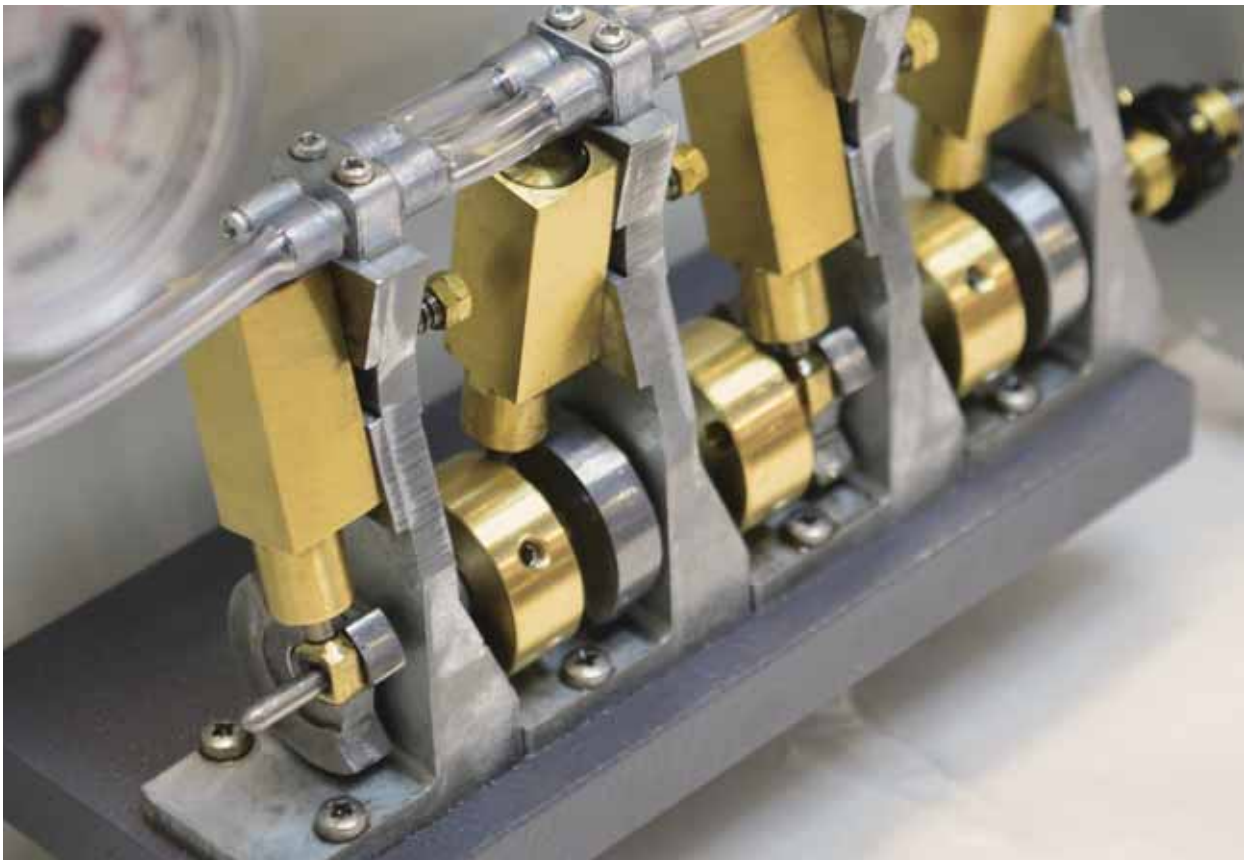


KEY FEATURES AND BENEFITS:

- **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.

POWERFUL SOFTWARE

All our Control Engineering products work with software. Most of the academic products work with TecQuipment's own CE2000 control software.

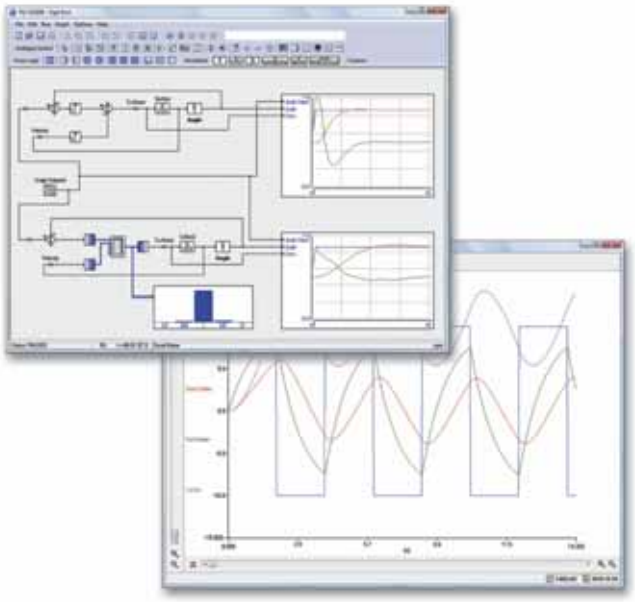


CE2000

CONTROL SOFTWARE

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



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.

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)

CE120
CONTROLLER

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.

MODULAR SYSTEM

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:

ANCILLARY FOR:

CE122

DIGITAL INTERFACE

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

MODULAR SYSTEM

ESSENTIAL BASE UNIT (CE122)

EXPERIMENT MODULES
(CE103, CE105-CE110)

FEATURES:		BENEFITS:
Connects between a computer and selected Control 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.

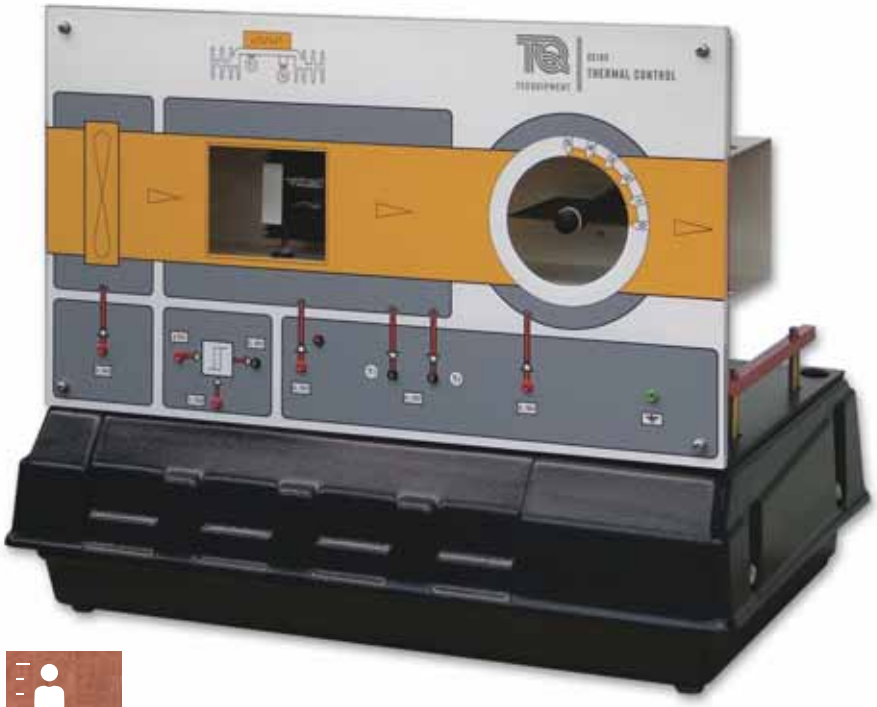
AVAILABLE EXPERIMENT MODULES:

CE103

THERMAL CONTROL PROCESS APPARATUS

A compact, self-contained, bench-mounted temperature control apparatus 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 Thermal Control Process Apparatus mimics a common industrial process, including an air-conditioning plant, where a combination of adjustments can control temperature.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 64
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 65

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 63) 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

CE105/CE105MV

COUPLED TANKS APPARATUS

A self-contained, bench-mounted apparatus designed to allow students at all academic levels to investigate basic and advanced principles of open and closed-loop control of flowrate and liquid level in single and dual tank 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

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

The Coupled Tanks Apparatus investigates basic and advanced control engineering principles. This includes the study of static and dynamic systems. It is also an ideal system to use with other control strategies such as fuzzy logic.

The CE105 shows fluid transport and liquid level control problems in process control.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 64
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 65

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 63) 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

CE106

BALL AND BEAM APPARATUS

A compact, self-contained, bench-mounted apparatus designed to allow students at all academic levels to investigate basic and advanced principles of control, including control of 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 Ball and Beam Apparatus demonstrates the control problems of unstable systems, for example a rocket or missile during launch, which needs active control to prevent the missile going unstable and toppling over.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 64
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 65

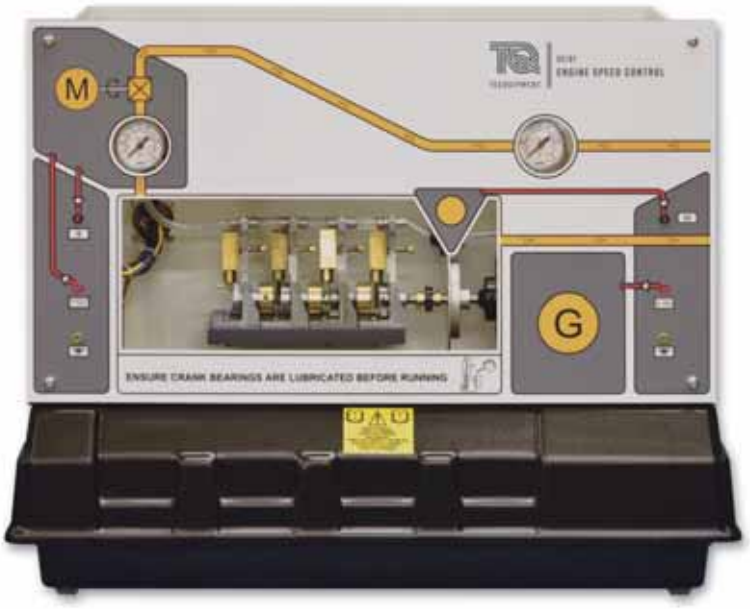
Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 63) with editable, pre-made control experiments for use with the CE106.

CE107

ENGINE SPEED CONTROL APPARATUS

A compact, self-contained, bench-mounted apparatus designed to allow students at all academic levels to investigate basic and advanced principles of control, including control of 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

The CE107 Engine Speed Control Apparatus demonstrates the problems of regulating the speed of rotating machines, especially problems with non-linear control systems.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 64
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 65

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 63) with editable, pre-made control experiments for use with the CE107.

ESSENTIAL ANCILLARIES:

- Compressor (CE1B) 297

RECOMMENDED ANCILLARIES:

- Optical Tachometer (OT1) 297
- Stroboscope (ST1) 297

TECQUIPMENT CONTINUES TO INVEST HEAVILY IN OUR IN-HOUSE MANUFACTURING FACILITIES

CE108

COUPLED DRIVES APPARATUS

A 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 CE108 Coupled Drives apparatus demonstrates the problems of controlling speed and tension in coupled drives. Many applications use coupled drives, for example: magnetic tape drives, textile machines and paper mills.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 64
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 65

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 63) with editable, pre-made control experiments for use with the CE108.

RECOMMENDED ANCILLARIES:

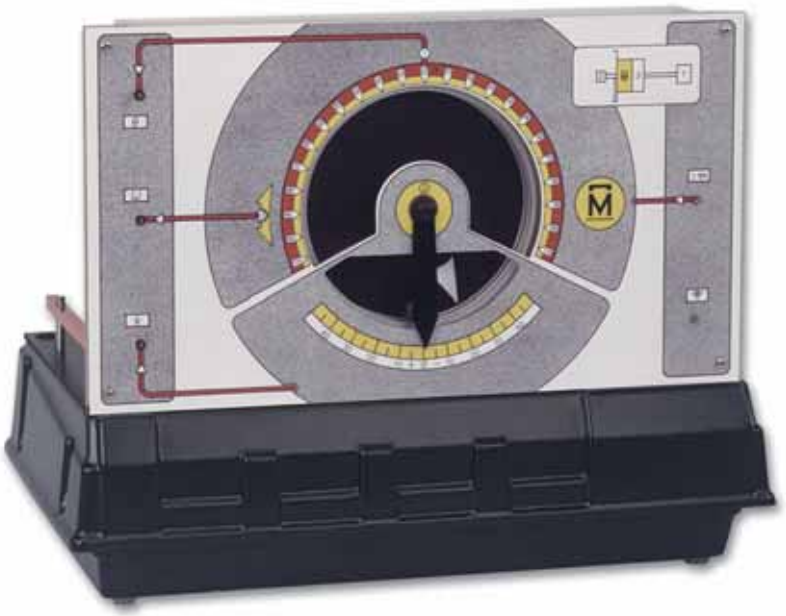
- Optical Tachometer (OT1) 297

CE109

BALL AND HOOP APPARATUS

A compact self-contained bench-mounted apparatus designed to allow students at all academic levels to investigate basic and advanced principles of control, including systems that are naturally oscillatory.

- 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 CE109 Ball and Hoop Apparatus demonstrates the use of electromechanical servo systems for position and velocity control. It also works as a model to show liquid slop problems, for example: aircraft missile fuel storage, fuel tankers and industrial pumping systems.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 64
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 65

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 63) with editable, pre-made control experiments for use with the CE109.

RECOMMENDED ANCILLARIES:

- Optical Tachometer (OT1) 297
- Oscilloscope (OS1) 297

CE110

SERVO TRAINER

A compact, self-contained, bench-mounted DC servo apparatus designed to allow students at all academic levels to investigate basic and advanced principles of control. In particular, the CE110 deals with control issues relating to position and speed control in servo systems.

- 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 Servo Trainer demonstrates DC servo position and speed control systems using typical industrial techniques. It has a DC servomotor, a DC generator and a flywheel mounted on a common shaft.

ESSENTIAL BASE UNIT:

- Controller (CE120) – A controller with analogue and digital controls and instruments **OR** 64
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) 65

Both the CE120 and the CE122 include TecQuipment's CE2000 Control Software (see page 63) with editable, pre-made control experiments for use with the CE110.

AERODYNAMICS LABORATORY AT THE EAST AFRICAN SCHOOL OF AVIATION

TecQuipment continues to have a strong and solid working relationship supporting The East African School of Aviation (EASA) in Nairobi Kenya, bringing aviation theory to life with aerodynamics laboratory equipment.

EASA is an international aviation centre. It provides training programmes to people across Africa that meet the needs of the global aviation industry. As a centre of excellence, they demand the latest technology for illustrating the principles of aerodynamics.

Being leaders in the field of aerodynamic training technology and with evidence of high quality and excellent customer service, TecQuipment was chosen to help kit-out their training facilities.

Following a visit to the TecQuipment headquarters and factory in the UK, the Head of Training, Mak'omondi Lucas Owino, commented:

> "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."

SUBSONIC WIND TUNNEL NEWLY INSTALLED AT EASA, NAIROBI

DELIVERING HIGH QUALITY PRODUCTS WITH EXCELLENT CUSTOMER SUPPORT

Specialist members of the customer service team regularly travel to site to install TecQuipment's laboratory equipment. In this instance, Installation, Commission and Training Manager Dave Giddings flew to Nairobi to ensure that everything was up and running as quickly as possible.

DAVE GIDDINGS WITH STAFF FROM EASA AT TECQUIPMENT'S HEADQUARTERS IN NOTTINGHAM

THE EASA AERODYNAMICS LABORATORY

The centrepieces of the EASA lab are a subsonic wind tunnel and a flight demonstration wind tunnel. To complement this, they also purchased two modular air flow benches.

SUBSONIC WIND TUNNEL 300 MM (AF1300) AND ANCILLARIES

A compact, practical open-circuit suction wind tunnel for studying aerodynamics. Plus ancillaries including the Three Component Balance, Smoke Generator, Multi-tube Manometer and a range of aerofoil, drag, boundary layer low and high wing models.

FLIGHT DEMONSTRATION WIND TUNNEL (AF41) AND DATA ACQUISITION MODULE

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

MODULAR AIR FLOW BENCH (AF10) AND MULTI-TUBE MANOMETER

A fully mobile bench to provide basic airflow facilities to enable a wide range of practical airflow investigations. Suitable for demonstration, laboratory and project work at a basic level.

EASA'S AERODYNAMICS LABORATORY

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

A NEW PIECE OF EQUIPMENT

Here's a picture taken by the Universiti Teknologi Malaysia (UTM) of their latest TecQuipment install and training session.

Thanks to Jonathan Bonkoske from Texas State Technical College for their photo of their install of TecQuipment's Power Systems training equipment last week #tstcproud #technicallybetter

STUDENTS WORKING IN THE LAB

Students from the University of Louisville @UofL USA learning about flow measurement using their latest lab equipment from TecQuipment.

Salem Sayed Hegazy, Senior Lab Specialist at United Arab Emirates University demonstrates a Two-stage parallel pump experiment (H83) using VDAS® data acquisition software, recently supplied by TecQuipment #UAEUNEWS