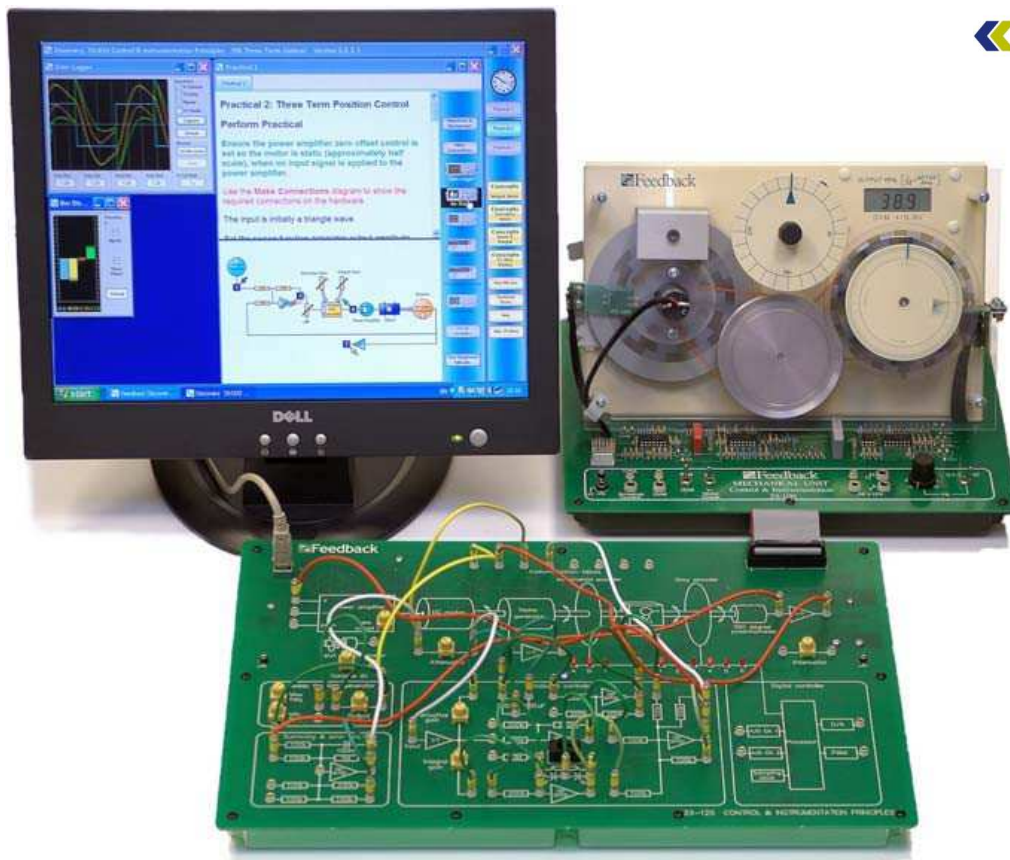


## Control & Instrumentation Principles

33-033



### Curriculum and Instrumentation

This trainer allows the investigation of control system principles by using a servo mechanism comprising a dc motor, a variety of sensors and both analogue and digital controllers. Students are also introduced to the fundamentals of transducers and signal processing.

Prior knowledge of very basic electronics is assumed as well as simple mathematics although the use of mathematics is minimised as much as practicable. The curriculum is divided into twenty four assignments ranging from basic control concepts to more advanced topics such as transfer function analysis. Selective use of the available assignments allows the trainer to be used from vocational through to higher technician and undergraduate courses.

The assignments topics include:

- Operational amplifiers
- Analogue transducers
- Motor & eddy current brake characteristics
- Positive and negative feedback
- Gain and stability
- Velocity feedback
- Following error
- System time constant
- Closed loop position and speed control
- Analogue controllers (PID)
- Feed-forward systems
- Analogue to digital conversion
- Digital speed and position measurement
- Absolute and incremental encoders
- Digital controllers
- Transfer function analysis
- Open and closed loop transfer functions

## Features

- Teaches the concepts of control, sensors and signal processing
- Real mechanical plant
- Suitable for teaching both theory and practice
- Contains both analogue and digital controllers
- Compares digital and analogue sensors
- Digital controller uses an embedded processor
- Linear and pwm motor drive
- On-board sine, square and triangle wave generator
- ESPIAL Software Package (93-420, essential, order separately)
- Open and closed loop transfer functions with Bode and Nyquist displays
- Complete workstation including power supply

## ESPIAL Software Package 93-420 (not included in 33-033)

This product includes ESPIAL Teaching Software in which each assignment comprises clear objectives, background and theory information and up to four practical exercises.

These exercises contain graphical connection diagrams for the hardware and step by step practical instructions. All required test instrumentation is provided within the software.

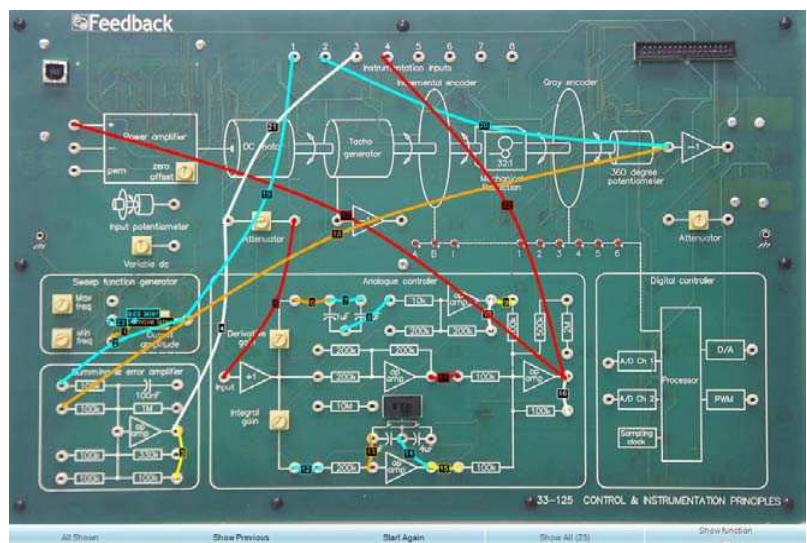
The instrumentation includes:

- Four channel real-time data logger and bar-graph display
- Voltmeter
- Frequency counter
- Transfer function analyser with Bode and Nyquist displays

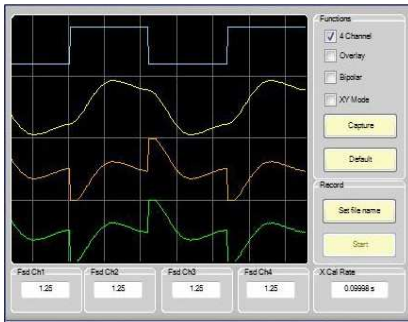
All instrumentation includes the ability to make accurate measurements using cursors as well as to print and save the displays for inclusion in student reports.

A hard copy of all the curriculum material is also provided.

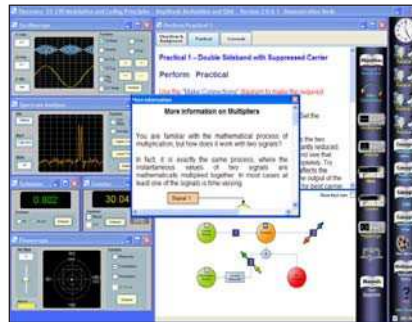
The 93-420 also includes the ESPIAL Tools software package allowing the existing teaching content to be modified as well as the creation of new material. This product is compatible with, but does not include, ESPIAL Course Manager (93-410), which comprises Course Designer and Course Presenter and allows custom courses to be developed containing assignments from any installed ESPIAL product and external resources (see separate ESPIAL datasheet for full details).



*Workboard showing easy patching sequence*



Data logger showing 4 traces



ESPIAL Software Package (93-420)



ESPIAL Course Designer (93-410)



## Mechanical Plant and Electronics

The system comprises three items.

- Mechanical plant (33-100)
- Electronic unit (33-125)
- Power supply (01-100)

The mechanical unit contains a power amplifier driving a dc motor connected to a set of transducers and an adjustable eddy current brake. The digital encoders are of open construction to allow visual inspection of their functionality. A calibrated precision input potentiometer is also available. A dual function LCD meter measures either voltages or rotation speed. Internal test signals are available to provide easy functional checks.

The electronic board contains analogue signal processing blocks, an embedded controller with USB interface, analogue to digital converters, pwm drive and the instrumentation data converters. A complete block diagram is on the front panel of the unit with access via 2 mm sockets to allow each practical to be configured rapidly and the instrumentation blocks connected. LEDs show the output signals from the digital encoders. A function generator block is provided with sine, square and triangle output signals.

The power supply provides all the voltages required for both the motor and the control system and is connected directly to the mechanical plant. A ribbon cable connects the mechanical unit to the electronic unit. A single USB cable connects the electronic unit to the PC.

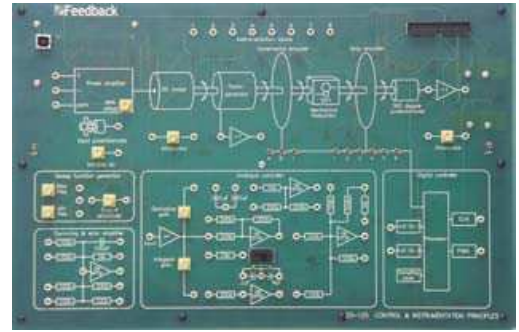
### Mechanical Plant specification (33-100)

- Open board format containing a servo mechanism and support electronics
- Permanent magnet motor with armature current signal output
- Tachogenerator 2.5 volts/1000 rpm
- Magnetic eddy current brake
- Input and output potentiometers
- Two-phase incremental shaft encoder Six bit Gray code shaft encoder Power amplifier, linear and pwm
- Switchable three figure LCD meter for speed or voltage
- Dimensions (mm) – 150 (h) x 295 (w) x 220 (d)
- Weight 2.3 kg



## Electronic Unit specification (33-125)

- Open printed circuit board with front panel mimic containing:
- Four input error amplifier
- PID analogue controller with independent gain controls
- Dual time-constant integrator
- Led display of encoder signals
- Embedded microprocessor containing multiple control algorithms
- USB2 interface
- 2 channel a/d input
- 2 channel analogue and pwm d/a output
- 4 channel a/d instrumentation interface
- Sweep function generator 0.1 Hz – 5 Hz, sine square & triangle
- 2 variable attenuators
- Variable d.c. signal



## Power Supply Specification (01-100)

$\pm 15$  volts 1.5 amps

+5 volts 0.5 amps

## Ordering Information

Control & Instrumentation Principles

33-033

ESPIAL Software Package (essential for use with 33-033, not included)

93-420

ESPIAL Course Manager (optional)

93-410



## Tender Specification

- [1] Control training equipment to introduce theory and practice of automatic control. Plant is a servomechanism.
- [2] To include a mechanical unit in open board format that carries the mechanics of the system plus support electronics. The unit to have the following features:
  - Permanent magnet motor with armature current sensing.
  - Tachogenerator.
  - Magnetic eddy current brake.
  - Input and output potentiometers.
  - Switchable three figure LCD display of speed or voltage.
  - Two-phase incremental position & speed encoder.
  - Six bit absolute encoder (Gray code).
  - Power amplifier – linear and pwm.
  - Self-test for motor drive.
- [3] To include electronic unit in open board format providing all electronic circuitry required to perform a wide range of analogue and digital control assignments from basic principles through to transfer function analysis. The unit to have the following features:
  - Front panel mimic diagram.
  - Four input error amplifier.
  - Analogue and digital controllers, both able to implement full PID with variable gains.
  - Digital controller uses embedded microprocessor with minimum sample rate of 125 Hz.
  - Interface for incremental and absolute encoders with led indicators.
  - Single amplifier configurations possible.
  - Four channel A/D data acquisition system.
  - Microprocessor has two channel A/D and one channel D/A, including pwm.
  - Variable amplitude sweep function generator with sine, square and triangle outputs.
  - USB2 interface for data acquisition and controller configuration.
- [4] To include real-time Windows-based software that provides all required real-time instrumentation and teaching assignments. Instruments to include data logger and transfer-function analyser. Complete with background and theory material together with step by step connection and practical instructions.
- [5] To include a suitable power supply
- [6] Mechanical unit dimensions to be approximately 220 mm x 295 mm



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Feedback reserves the right to change these specifications without notice