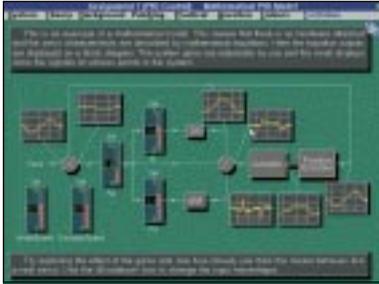


# Servo Control



A range of servo control training equipment to introduce the theory and practice of automatic control systems.

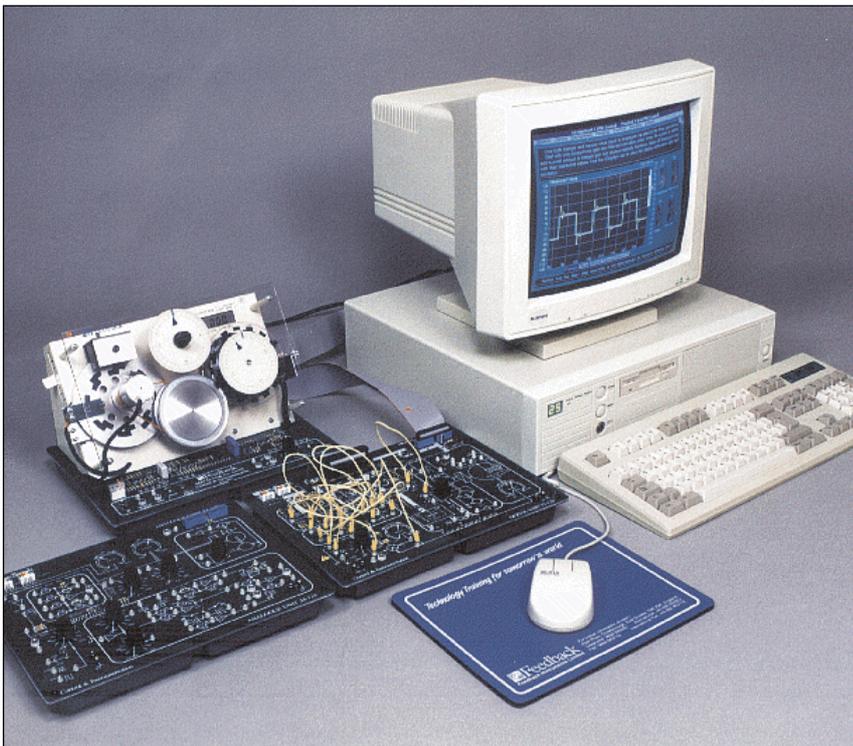
Allows investigation of open and closed loop analogue, digital, speed and position control.

Two systems are available:

- **33 Series to introduce the principles of Analogue and Digital Servo Systems.**
- **150 Series provides a more precise servo for quantitative measurements in dc, ac & Hybrid systems.**

Upgrade kits are available for both products to enable them to operate with **MATLAB** software.

## Analogue & Digital Servo Fundamentals Trainer – 33-001



System comprises:

**Mechanical Unit** with input and output potentiometers, motor, tacho-generator, absolute and incremental encoder and on-board waveform generators.

**Analogue Unit** with four input error amplifier. Optional additional time constant. Variable gain and velocity feedback. Single, two term or full PID control.

**Digital Unit** provides access to PC, has A/D & D/A converters, linear or PWM motor drive, LED display.

**Discovery** software supports the digital unit and allows assignment work to be carried out with on-screen theory, background, practicals and questions.

**Discovery** software contains PC based instrumentation, including a chart recorder. Complete with power supply.

### Curriculum Coverage

#### Analogue

- Operational amplifier characteristics
- Motor, Tachogenerator & Brake characteristics
- Simple control & speed systems
- Error channel & feedback polarity
- Influence of gain
- Velocity feedback
- System following error
- Unstable systems
- Speed control systems
- Introduction to 3-term control
- Applications of 3-term control
- Single Amplifier control circuits
- Transient velocity feedback & Derivative feedforward
- Transfer Functions & frequency response principles
- Application of frequency response methods to the system

#### Digital

- A/D and D/A conversion
- Motor control
- Potentiometer position sensors
- Digital Encoders
- Gray code encoder
- Incremental encoder
- Speed & directional encoding
- Position control using analogue sensor
- Position control using digital sensor
- Speed control using analogue sensor
- Speed control using digital sensor
- Position servo using P+D control
- Position servo using P+I control
- Position servo using PID control

**MATLAB** and their relevant toolboxes are products of The Mathworks Inc. and are not included with the systems.

# Servo Control

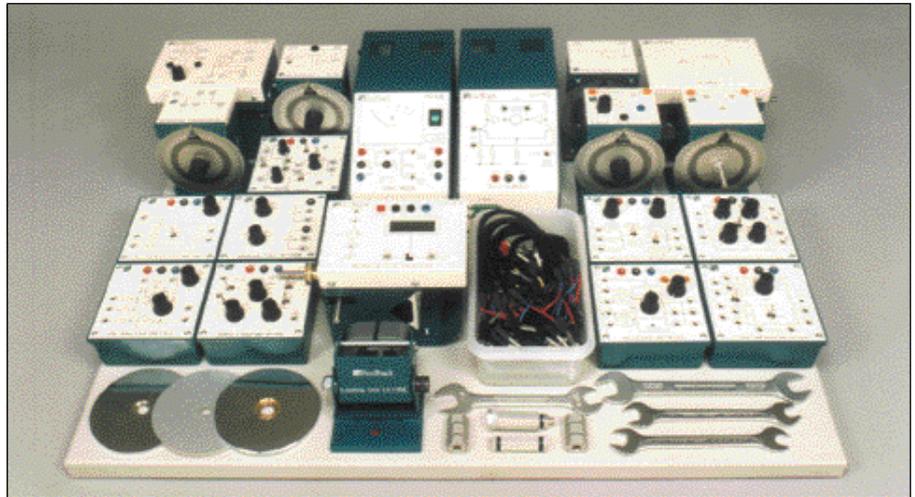
## Modular Servo System MS150

Offers a more precise servo system than the Fundamentals Trainer 33-001. It comprises individual units magnetically assembled on a baseplate.

The system is available as:

- Complete dc/ac/Hybrid system – MS150-3
- dc system – MS150
- ac system – MS150A

An add-on kit is available to convert the system to a digital servo using **MATLAB<sup>®</sup>** software. Comprehensive Assignment manuals are provided.



Speed & position control systems can be constructed. Allows investigation of how gain, damping, friction & inertia affect the system performance.

### dc Modular Servo System MS150

Is the basic set from which all other systems are derived. Comprises modules, leads, accessories, and manuals. Practical work in Book 1 is mainly qualitative and non-mathematical and covers the introduction to control systems. Further manuals introduce simple, differential equations and the operator “j”.

#### Curriculum

- Operational amplifiers
- Motor speed characteristics
- dc error channel
- Simple position control
- Closed-loop position control
- Simple speed control
- Deadband & step response
- Velocity feedback
- Analysis of simple position control with speed response
- Position response
- Closed loop frequency response
- Measurement of motor time constants
- Measurement of velocity error constant  $K_v$
- Frequency & transient response
- Measurement of following error
- Stability considerations & the use of lead, lag & combined networks
- Tacho-generator feedback and its effects on system performance including acceleration feedback
- Linearisation of systems

### ac Modular Servo System MS150A

Is available as a complete system or by adding additional modules to the dc system. The 150A is used in more specialised and advanced control applications and some detailed knowledge of ac carrier systems is required.

#### Curriculum

- Motor characteristics
- ac tacho-generator
- Motor speed control
- Characteristics of two-phase motors
- ac pre-amplifiers
- Position control systems
- Importance of phasing on torque and speed performance
- Compensation using the adjustable notch filter
- Notch filter design
- Frequency selective characteristics for the elimination of noise & harmonics
- Analysis of carrier systems
- Frequency transformation for compensator techniques
- Principles & measurement of compensation unit characteristics
- Instability
- Reduction in steady following error
- Effects of gain and damping
- Synchro link and the demodulator
- Closed loop systems

### dc/ac & Hybrid Modular Servo System MS150-3

The addition of:

- Simulated Relay unit
- PID unit
- Sample & Hold unit
- Differential Syncro unit

In addition to the subject areas covered by the 150 & 150A the full system allows the following additional topics to be studied:

#### Curriculum

- Relay characteristics & relay operated systems
- Following characteristics of relay system
- Effect of backlash on the system
- Phase-plane analysis
- PID control loop characteristics
- Speed control
- Position control
- Following error
- Waveform sampling
- Sampled data servo control
- Simulated sampled data control
- Sampled data process control systems with appendices on transfer functions or Hold Circuits and the Sampling Theorem
- Differential synchros

For further information on these and other equipment in the Feedback range please contact . . . . .

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