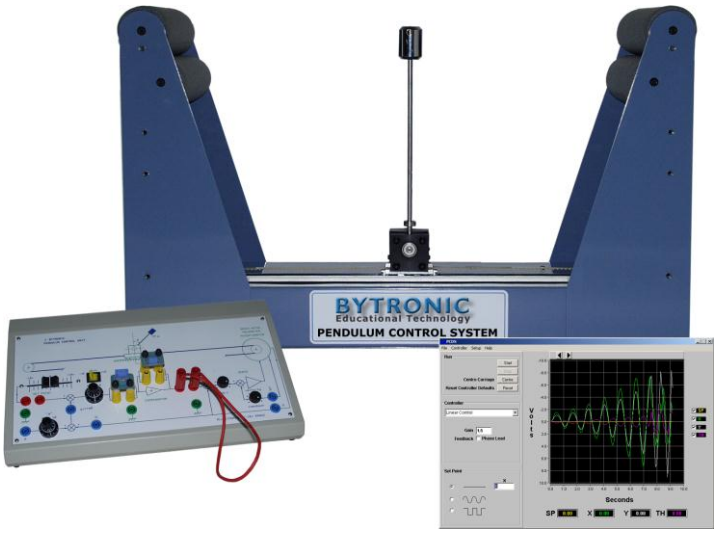
Pendulum Control System PCS2



Key Features:

- Control of inherently unstable systems and of systems with very oscillatory dynamics
- Study of control engineering theory
- Stand-alone Analogue control
- Classic control model for Analogue, Direct Digital or Fuzzy Logic control
- Two different modes, an inverted pendulum or overhead crane
- Software with attempted Linear control, attempted Harmonic control, Direct Digital control and Fuzzy Logic control

The Pendulum Control System, PCS2, is designed for the study of control engineering and theory. The PCS2 consists of a carriage module and analogue control module with a mimic of the system. It can function as a stand-alone analogue system or be interfaced to an external controller such as a PC using a suitable interface card. The PCS2 is supplied with an interface card and PCSDS software. The software includes attempted Linear control, attempted Harmonic control, and Direct Digital Control and Fuzzy Logic control. Students can compare the performance of the different controllers. Connection is through 4mm-shrouded colour coded sockets and to an interface card through the IDC connection.

The PCS2 can be used in two different modes, an inverted pendulum or an overhead crane, each mode presents a control situation that requires a separate approach and solution and an understanding of how feedback systems function. The first mode; control of an inherently unstable system, to balance the pendulum in the inverted position the pivot must be continuously moved to correct the falling pendulum. In the second mode; the carriage module is turned upside down to act as a crane, the pendulum swings into an equilibrium position with the centre of mass below the pivot, control the Linear position of the load, with very oscillatory dynamics.

Curriculum Coverage

- Getting started
- Using the PCS as an analogue control system
- Using the PCS as a digital control system
- The pendulum control problem fundamentals
- Two modes: swinging crane and inverted pendulum
- Calculation and instability of *y* for inverted pendulum
- Analogue and digital modelling
- Derivation of plant controller
- Recommended texts for block diagrams Laplace and Z transforms
- MATLAB solutions for DDC, inverted pendulum, crane

Labworks

- Static and dynamic characteristics of the pendulum control system
  - Carriage servo
  - Effect of servo gain on hysteresis
  - Transient response of the servo subsystem
  - Dynamic model of the pendulum
  - Modelling of the carriage servo
- Analogue control of an inverted pendulum
  - Measurement of the mass position
  - Software Linear control of the pendulum
  - Software Harmonic control of the pendulum
  - Transfer function for the inverted pendulum
  - Stabilisation using phase lead compensation
  - The effect of hysteresis in the servo sub-system
- Fuzzy Logic control of the inverted pendulum
  - Description of the Fuzzy Logic controller
  - Fuzzification ,rules, defuzzification
  - Use of the Fuzzy Logic controller
- Direct Digital controller design and implementation: inverted pendulum
  - Design of a DD controller using a simplified model
  - Design criteria and sample rate selection
  - Pole placement
  - Implementing the controller using the PCDS software
- Direct Digital controller design and implementation: swinging crane
  - Sample time and design objectives
  - Dead-Beat controller design using simplified plant model
  - Use of Dead-Beat controller
  - Frequency response of plant and compensator
  - Dead-Beat controller using plant model with damping
  - Ringing Pole problem
  - Correct design approach to avoid Ringing Pole problem

Specification

Mains supply	110V a.c. or 220 – 240V a.c. (switch select)
Mains fuses	2 x 5 Amp
Control unit fuses	2 x 250mA
Internal PSU	± 20V d.c. unregulated ± 15V d.c. regulated ± 10V d.c. regulated
Servomotor with integral tachometer	Normal supply voltage 24V d.c.
Maximum continuous torque	14Ncm
Maximum peal torque	36Ncm
Motor voltage constant	10.3v/1000rpm
Motor torque constant	9Ncm/A
Mechanical time constant	20ms
Rod inertia	$214gcm^2$
Tacho assembly inertia	$10.5gcm^2$
Drive belt	Kevlar braided
Angle θ measured	5K-servo potentiometer.
Position X measured	5K-multiturn potentiometer.
Control software	Multiple controllers with graphical output

Required

A suitable PC with minimum; Pentium processor, 1GB RAM, 20GB HDD, CDROM Drive, and Windows XP or above

Ordering Information

Model Number:	**PCS2**
Consists of:	1 x Pendulum cart
	1 x Analogue controller
	1 x Interface card
	1 x Weight and shaft
	1 x Star nut and metal bar
	2 x Set of compensator PCB's
	1 x Connecting cable
	2 x 4mm connecting cable
	1 x Mains lead
	1 x PCDS CD
	1 x User and courseware manual

Weights and Dimensions

Un-Packed		**Packed**	
Approximate Dimensions (mm)	685W x 220D x 425H	Approximate Dimensions (mm)	770W x 520D x 330H
Approximate Weights	12.4Kg	Approximate Weights	17.6Kg

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