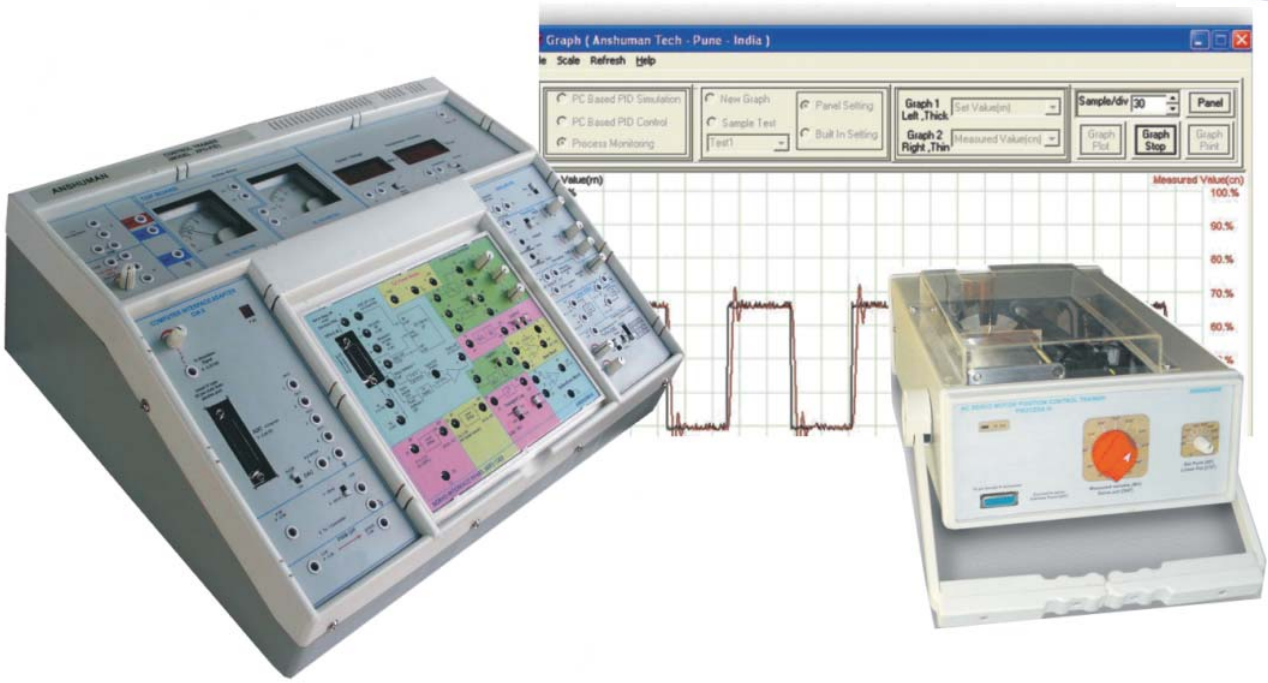
CONTROL TRAINER (Model : XPO-PID) *[a family of training systems]*



SPECIFICATION OF MASTER UNIT

Basic Resources on Top board

- **Built in power supply**

  DC supply ±12V,500mA.
  1phase sine reference for cosine firing 30Vpp max.
  17Vdc, 500mA unregulated for driving pulse X'mer
  Variable DC power supply : 7 to 14V/3A

- **Display**

  A) DPM - 2Nos.
  i) For Temp. upto 100°C & intensity in Lux (2000)
  ii) For Temp. upto 500°C
  B) Analog Meter - 2Nos.
  i) Centre zero for display of process error (±9V)
  ii) For MV/SP (0-2.5V)

- **Operating voltage**

  Switch selectable 220-240Vac, ±10%, 50Hz, 75VA

- **Mechanical Dimensions**

  Master Unit : 460mm(W), 160mm (H), 350mm(D)
  Net weight : 6.5 Kg. Gross weight : 8.5 Kg.
  b) Panel : 215mm(W), 165mm(H), 40mm(D)
  Net weight : 700gm approx.

PC (P4/XP/WIN7/FAT32) based PID controller (Optional)

- **Online monitoring / Data acquisition / PID Software :** on Installable (CD) works under XP, WIN7. PC with parallel port / USB needed.

- **Operating modes**

  a)Simulator Mode

  Tests data already stored in files (*.txt) & Drawing graph for all P,PI,PD & PID modes.

  b) Process Monitoring Mode

  Drawing graphs of analog data presented at CH 0 & CH 1 of Computer Interface. Cursors for X & Y axis for measurement & online graphs savings for reproduction

  c) PID controller Mode

  - PID controller with parameters like Integral Time Ti (0.01-64000), Sampling Time Ts (0- 99.9), (0-99.9), PID output Upper Limit Uh(0-99.9), PID output Lower Limit Ul (0-99.9).
  - Facility to set units for output viz. Percentage (%), °C, RPM, Voltage(V), mm, LPH, kg/cm², si/cm, degree.
  - Optionally experiments with advance process control scheme viz; Ratio, Cascade, feedfor ward with user selectable Aux PID, Ratio station & programmable FF transfer function calculator.

- **Computer Interface Adapter / CIA**

  - Optoisolated Adaptor to prevent damage to PC parallel port (25 pin LPT) due to wrong connections. Interfaces through 25 pin M to F cable 1mtr Length. P4/XP not in scope of supply.

  4 ADC channels : 0 to 2.5V full scale.
  1 DAC channel : O/P 2.5 V FS.
  V to I Function block : Input : 0-2.5Vdc
  O/p: 0-20 or 4-20mA,
  in 100E load Max

  - USB converter to interface 25 pin D connector on CIA panel to USB using PIC18F microcontroller 28 Pin SOIC enclosed in 25 Pin D shell using Type A to mini B cable.

Analog PID (APID) controller

with built in low freq. function generator

- **Controller selection P,PI,PD,PID with slide switch**

  Parameter settings: Integral Time Ti (0.5-25Sec)
  Derivative Time Td (0-2Sec)
  Proportional Band Pb (5-200%)
  Set point (-9V- +9V)

- **Operating modes :** Fast (X 100/10mSec) for oscilloscope, Slow (X 0.1/1Sec) for PC interface.
- 2 No. Level shifter converting process O/p (±9V) to 0-2.5V for PC interface & Actuator panel
- Test points for Process Error, Set Point (Rn), Measured Value (Cn), Controller output (Un).

Built in function generator

- O/p waveform selectable sine, triangular & square.
- O/p freq. range from 0.016Hz to 166Hz, 4 steps & fine control pot.

Modular Expt. Panels offered

(Must select atleast one of following panels to work)

1) Process Simulator Panel / CE1

(Provided with 49 banana tags.)

- Functional blocks for Lag (3No), Integrator (3No), Transport Lag (1No), Summer (2No), Gain (1No), Inverter (2No) for constructing simulated Type 0,1,2,3 & 1st,2nd,3rd Order processes to work under PID.
- Experiments with Lead / Lag / Lead - Lag compensators to control behaviour of matching processes using above function blocks.
- Open loop & close loop response of processes under different P, PI, PID - Analog or Digital controllers. Experimental varification of PID Controller settings (Pb, Ti, Td)
- Auto Tuning explained using Ziegler Nicolas I & II.
- Fast (10mS) & slow (1sec) mode selection for all processes to observe response on either CRO or PC using CIA.
- Drawing Bode plot & Nyquist plots, transfer function determination.
- Advance process control scheme viz; Ratio, Cascade, feed forward.
- Level shifters (2No) ±9V to 0-2.5V & 0-2.5V to ±9V to match voltage levels of PC (2.5V) and opamps (±9V).

2) Thyristor Actuator panel (TAP) /EMT9 (CE2)

(Provided with 13 banana tags.)

- Thyristor bridge based 0-200V/3A cosine firing circuit, I/P 0 to 2.5Vdc. Supports signal conditioning of RTD (PT100), Thermocouple K type & Photodiode to give output 0-2.5Vdc (FS).
- Facilitates closed loop control experiments based on temperature, light intensity, speed measurement using built in P/PI controller as well as external Analog / Digital PID controller.

3) Stepper Motor Demonstrator Expt. Panel (P25) / (Modified)

(Provided with 15 banana tags.)

Direction, speed, auto, manual operations of Stepper Motor, Position control by step operation, Position control by continuous operation , Angle control by step operation, Speed control by control switch, Angle control by software, Dynamic current / torque characteristics,. Closed loop experiment with servo pot for PID experiments, V to F function block.

4) Servo Interface panel (SIP) / CE3

(Provided with 36 banana tags.)

Control Interface circuit for AC & DC servo motor, signal conditioning circuit for speed sensor to O/P 0 - 2.5VDC (2500RPM) with speed direction.
Level shifter 0 - 2.5V to ± 9V (2nos).

- **Relay control characteristics** : Hystersis, Dead band & Relay control circuit (2term & 3 term), process block for 2Nos. of 1st order lag / integral + transport lag, error and gain block for process simulation. Phase plane analysis by display of X & X.

5) Potentiometric error detection cum magnetic amplifier interface panel (PMP) / CE4 ·

(Provided with 9 banana sockets.)

- Onboard Transformer - 2Nos.
  I)P: 0-230Vac S1 : 0 - 24Vac / 50mA,
  S2 : 0 - 6Vac / 500mA
  II)P: 0-230Vac S1 : 24 - 0 - 24 / 50mA
- Potentiometric error detector (Can be Supplied as standalone panel) function block containing :
  *360° servo pots / 10K - 2Nos.
  *Facility to study error under AC supply (24-0-24) as well as DC supply (+12) application.
- Diode Demodulator to convert AC error signal from process VI into DC error to control magnetic amplifier.
- 15 pin D (F) connector to interface with AC servo motor (process VI) & 9 pin D (F) connector to interface with synchro command station (Process VII).
- Variable control voltage 0 - 12VDC / 500mA for plotting Magnetic amplifier characteristics.

6) Computer Interface panel (CIP/PCT1)

- V to I function block: I/P 0 to 2.5V & O/P 0-20 or 4-20mA (100 load) switch settable.
- I to V function block : I/P 4 to 20mA & O/P 0 - 2.5V
- Opamp based relay controlled circuit with set point & feed back controlled to drive 2 synchronus motor using 2 relays manual & auto operation.

SALIENT FEATURES

- Learn how an Analog as well as Digital PID works.
- Learn how NAVY control systems work. using AC motor, synchros, magnetic amplifie
- Facility to monitor behavior of the controller output (Un) & process variable (MV) either on PC screen or on CRO. Settable time constants.
- P4/XP or latest version window based PID controller (DDC) software package with P, PI & PID control, Ratio & cascade control, three operating modes, Online graph drawing & data acquisition modes (SCADA). PC not in scope of supply
- Can learn about different processes using simulated building blocks as well as real life processes using replaceable experiment panels/processes and built in square / triangle / sin function generator as disturbance.
- Graph printing facility for laboratory journal entries.
- Aesthetically designed injection molded electronic desk (master unit) carrying useful experiment resources like Power supplies, DPMs, Computer Interface, Analog PID controller with central slot to hold various replaceable experiment panels / processes.
- Connection through sturdy 4mm Banana sockets & Patch cords.
- Students workbook & Instructor's Guide provided with each unit.

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Optional Process Setup : Select one process & Panel combo along with one master unit.

Process	I - Temp/Light	II - High Temp	III - DC Servo position control	IV- AC Servo position control	V- Stepper Motor	VI - AC Servo position control	VII - Synchro Transmitter Receiver	IX-AC Voltage Servo Stabilizer	X-Magnetic Levitation	XI - Inverted Pendulum
Table Top assembly / accessa-ries	Process box containing 3 high wattage (60W) bulbs under aluminum plate heater. Builtin fan, lamp as disturbance generator.	Electric Bunsen Burner (300W) with 50cc heating volume. (Works with DPID only as large transport lag)	PMDC Motor 12V DC, 40 Watt ND RPM 2000 RPM with gear box (Ratio 30 :1) **Loading :** Using PMDC Motor @12V/5A max. Servo Amplifer with builtin 12V/3A power supply.	AC geared (50:1) 2 phase servo motor. Main winding : 230VAC control winding : 6VAC /1A O/P shaft RPM 25 (D), ND RPM 2500 **Loading:** Using small PMDC motor @ 12V/1A max. Servo amplifier with built in 12V/ 3A Power Supply.	Stepper (3kgcm/12V) coupled to servo pot.)	• AC geared (50:1) 2 phase servo motor. Main winding : 230VAC control winding : 6VAC /1A O/P shaft RPM 25 (D), ND RPM 2500 **Loading:** Using small PMDC motor @ 12V/1A max. Servo amplifier with built in 12V/3A Power Supply.	• Operated from 230Vac ±10% 50Hz. • **Synchro transmi-tter/ Receiver pair** - Rotor 1phase 115Vac/ 120mA - Stator 3 phase 90VAC -9 pin D (M) connector (optional) to interface with PMP panel	• AC synchronous 2 Phase Motor / 240VAC 100mA, 60rpm , 2Kgcm Torque • Variac 0-270VAC/ 0.75 Amp.	• 12VDC / 3A Electromagnetic Coil to lift Iron Ball • Table Top set up using 30mm x 30mm alluminium profile	• PMDC motor 12VDC, 40 W, 4000 RPM • Table Top set up using 30mm x 30mm alluminium profile
Panel	TAP (CE2/EMT9)	TAP (CE2/EMT9)	SIP(CE3)	SIP(CE3)	P25	PMP	PMP (Optional)	CIP	SIP(CE3)	SIP(CE3)
Sensor	RTD for temp. control upto 100°C with built in CAL facility, Photodiode for light intensity control upto 2000lux.	K type stainless tube encapsulated TC for temp control upto 550°C.	• Photo reflective speed sensor with direction detect using 2 pairs of photo emitter detector giving quadrature O/p's •Servo pot as position feedback	Servo pot as position feedback.	Servo pot as position feedback.	• 1 No. of Servo pot as position feedback for PC interface. • **Synchro control transformer** to gene-rate position feed back for magnetic amplifier based Electrical control system (Naval application) • Mag. Amplifiers 2Nos table top units with bias & error winding (12V / 500 mA each) & load winding (6VAC / 500mA & Loading resistor 10 ohm / 5 W	• 1 No. servo pot (optional) for position feedback (0-2.5V) of command synchro for PC interface. • Acts as electrical command station (SP)for process VI if interfaced with PMP.	PT (270VAC primary / 12VAC 100mA Secondary) followed by Precision Rectifier output 0-2.5V DC	• Infrared Emitter Detector pair to locate position of Iron Ball in floating condition.	• Servo Pot to indicate vertical standing position feedback
Mechanical Dimension (mm) /Wt.	280(L)x115(W)x160(H) Power Coated / 2Kg.	200(L)x130(W)x270(H) /1.3 Kg.	365(L)x220(W)x95(H) /10 Kg.	365(L)x220(W)x95(H) /8 Kg.	220(L)x100(W)x92(H) Power Coated/2Kg.	365(L)x220(W)x95(H) /8 Kg.	220(L)x150(W)x95(H) 3.5 kg.	365(L)x220(W)x95(H) /8 Kg.	200(L)x200(W)x300(H)	200(L)x200(W)x300(H)
List of Expts.	• PID tunning by Ziegler - Nichols • Transfer function determination • Operation under various P/I/D options.		• PID tunning by Ziegler - Nichols Motor process parameter study, torque speed (optional) Dynamics measurements & transfer function determination.		• Study of Stepper motor behaviour under open loop / closed loop	• AC Servo Motor Position Control using Magnetic amplifier & synchro • Can draw characteristics curve, series parallel mode of connection	• Study of working principle of synchro transmitter and receiver	• Study of AC Servo stabilizer • Close loop and open loop behaviour of voltage stabilizer	• Study of Open / Close loop behaviour of magnetic levitation. • Study of inherently unstable system	• Study of Open / Close loop behaviour of inverter pendulum. • Study of inherently unstable system