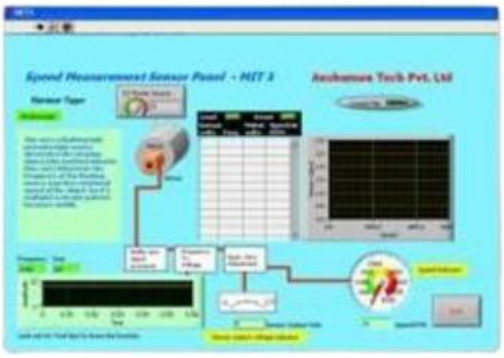
Transducers and Instrumentation Trainer (Model: TMS-MIT)



Consisting of:

a) **SENSOR TRAINER KIT MODEL - TMS - MIT Master Unit with** Computer Interface (PC is not in scope of supply, however PC/XP/Window7/8/10 with USB port from lab is needed)
b) Strain gauge Transducers (MIT1)
c) Piezo resistive transducer for pressure measurement (0-20PSI) with mounted pressure sensor (0-30PSI) with hand pump & bourdon pressure gage model mit-1ai
d) Force/Weight measurement using piezo transducer-0 - 20kg. Uses weighing scale sensor of range 40kg.model mit-1c
e) Displacement Sensing Transducers full specification covering LVDT, inductive, capacitive, resistive (MIT 2)
f) Humidity measurement demonstrator using polymer hybrid sensor. model MIT2e
g) Speed Sensing Transducers with all six sensors (MIT 3)
h) Sound sensing transducers (MIT 4) Distance measurement using ultra sound sensor
i) Light Sensing Transducers using all sensors (MIT 5)
j) Temperature Sensing Transducers with PT100, thermocouple J&K, thermister, Bimetallic relay, IC sensor (MIT 6)
k) Vibration sensor and airflow sensor experiment panel (MIT-7)
l) Operational amplifiers Circuit Experiment Panel (P-16)
m) Advance operational amplifiers Experiment Panel(P-17)
n) Passive/Active/M Derived Filter Panel (P-32)
o) **CONTROL TRAINER (Model-TMS-PID) Master Unit** containing Analog PID as well as PC based PID with computer interface adaptor & self extracting PID S/W on CD with USB Adaptor (PC is not in scope of supply, however PC/XP/Window7/8/10 with USB port from lab is needed)
p) Thyristor actuator panel -CE2 with real life process setup for temperature & light (Process I) Note:-Must need TMS-PID Master Unit as Quoted above to work with
q) Servo interface Panel (SIP/CE3) with DC Servo Position Control Set up (Process III) Note:-Must need TMS-PID Master Unit as Quoted above to work with

Transducers and Instrumentation Trainer

Trinity

Features of the Trainer:

a. It should introduce students to input sensors, output actuators, signal conditioning circuits, and display devices through various hands-on practical activities.
b. It should be a self-contained, compact trainer system with all the necessary power supplies, light sources, and compressed air supplies to carry out the range of hands-on experimental work.
It should be possible to build and test complete systems for rotary speed and position, making the trainer ideal for use in closed-loop engineering teaching.
d. The trainer should have a detailed curriculum manual that provides background theory, practical activities, and student assessment questions.
e. It should allow students to create a personalized record of their work and record practical results as they work through the curriculum materials.

Topics to be Covered:

- Positional Resistance Transducers
- Wheatstone Bridge Measurements
- Temperature Sensors
- Light Measurement
- Linear Position or Force
- Capacitive Sensors
- Inductive Sensors
- Optical Sensors
- Electronic switch
- Basic Closed-loop Systems Equipment and Terms Used

Applications

- Sensors, Transducers and Actuators
- Environmental Measurement
- Rotational Speed or Position Measurement
- Sound Measurements and Output
- Linear or Rotational Motion
- Display Devices
- Basic Signal Conditioning Amplifiers
- Signal Conversions
- Comparators, Oscillators and Filters
- Mathematical Operations
- Closed-loop systems Characteristics
- Practical closed-loop systems

Input Transducers:

- Carbon track with at least 100 ka
- Wire wound 10 k.C2 with 270-degree rotation & precision rotary potentiometers 201d-2 with maximum permissible wiper 10 mA current.
- Slide potentiometers 10 kn with over 50 mm travel or better.
- NTC thermistors between 4.2k to 5.1 k.C2 at room temperature or so.
- Type thermocouples with LM335 IC integrated.
- IC temperature sensor with a linear output of 10mV/°C or better.
- Photoconductive cell made from cadmium sulfide doped with silver typically giving 1000 lux 130 a

- Photovoltaic cell with an active area of 5mm*13mm producing 300 mV to 500 mV at sunlight or so.
- Phototransistor: either photo darlington transistor or silicon NPN transistor.
- PIN diode.
- Linear variable differential transformer with an inductance of 68 uH per coil & minimum mechanical travel of over 10mm.
- Linear variable capacitor with range between 25 pF to 50 pF or so.
- Strain gauge with an output voltage of at least 2 to 3 V at no load.
- Air-flow sensor with heater power of 1W.
- Air pressure sensor with an output impedance of 1.6 kQ.
- Slotted opto-sensor with output voltage 4.9V or so when beam admitted.
- Reflective opto-sensor with output voltage 3V to 4 V — under reflected beam.
- Inductive Proximity Sensor range from 0.9mH to 1.1 mH or so.
- Hall Effect sensor.
- Precision servo-potentiometer.
- Tacho-generator.
- Humidity sensor with an output voltage change of 20mV or better.
- Dynamic microphone with an output impedance of 400 to 600 a
- Ultrasonic receiver with output amplitude of 5 mV to 60 mV or better.

Output Devices:

- Heater with a Resistance range between 45 - 49 0; Power output around 2.7-3.3 W; Temperature rise above ambient 38-42 Deg. C.
- Filament lamp with a rated voltage 12V and rated power approx. 1W; Resistance open-circuit 16-18 K2; Resistance @12V applied 155-165 a.
- DC motor with a resistance 6-6.5 f); No Load current@12V around to be 115-125mA; Shaft speed@l2V, no load 2300-2500 rpm.
- Ultrasonic transmitter driven by approx. 40 kHz. Oscillator and Input impedance 450-550 O.
- Loud speaker with impedance 7.5-8.50 and Power rating 90-200 mW.
- Buzzer with supply voltage 8V-16V and Supply current 10mA - 18mA.
- Solenoid with Coil resistance 45-55 CZ and Coil power@12V around 2.5- 3.5
- Relay with a Coil voltage 8.4-14.4V and Coil resistance 310-330 S2; Operate voltage 7-8.5 V; Release voltage 1.6-2 V.
- Solenoid valve with a Coil voltage 10.8- 13.2 and coil resistance 135-145 52
- Counter/Timer with seven segment LED displays and count rate 0-550Hz
- LED Bar graph display with input voltage range between -35V to 35V. 1. Analog 1 0V center-zero meter with applied voltage between -15V to +15 V;
- DC resistance 18-21k0; Full scale current range between -500pA to 500pA.

Signal Conditioning Circuits:

- Buffers
- Inverters
- Comparator with switchable hysteresis
- Amplifiers with gain and offset control
- Current amplifier
- Summing amplifier
- Differential amplifier
- Instrumentation amplifiers

- AC amplifier
- Oscillator 40kHz
- Filter 40kHz
- Low-pass filter with switchable time constant
- Precision full-wave rectifier
- Sample and hold circuit
- Integrator with switchable time-constant
- Differentiator with switchable time constant
- V/F and F/V converters
- V/I and I/V converters
- Alarm oscillator with switchable latching
- Power amplifier
- Electronic switch

Internal Power Supplies:

- -5V, +5V IA precision supply
- -12V, +12V 1A regulated supply

Pneumatic Supply:

- Internal Pneumatic Pump

50MHz 2 Channel Digital Storage Oscilloscope
(Make : Keysight , Model No.: EDUX1052A)

- 200kpts memory, 1GSa/s Sample Rate,
- digital voltmeter, 5-digit frequency counter,
- 7” color display, 100,000 wfrm/s update rate,
- USB Interface and LAN interface.
- Warranty 3year

3 ½ Digit Digital Multimeter with Large Display
(Make : TRINITY, Model No. TDM-3020)

- With Large Display
- DC Voltage: 200Mv/2V/20V/200V/1000V:±(0.5%+3)
- AC Voltage: 2V/20V/200V/750V : ±(0.8%+5)
- DC Current: 20Ma/200Ma/20A : ±(0.8%+4)
- AC Current: 20Ma/200Ma/20A : ±(1.0%+5)
- Resistance:200ı/2Kı/20Kı/200Kı/2Mı/200 Mı:±(0.8%+3)
- Capacitance: 20Nf/2Uf/200Uf : ±(2.5%+20)
- Frequency : 2kHz/200kHz : ±(3.0%+15)
- Celsius : (- 40 ~ 1000) ºC : ±(1.0%+3
- Frequency, Temperature Measurement, With Large Display

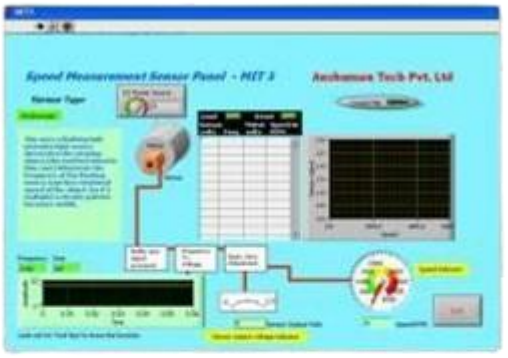
Controller Consisting of :
(Make : HP/DEL)

- 12th Generation Intel® Core™ i5 processor
- Intel® Core™ i5-12400 (up to 4.4 GHz with Intel® Turbo Boost Technology, 18 MB L3 cache, 6 cores, 12 threads)
- Windows 11Home Single English Language,
- 16GB, 1x8GB,DDR4, 2666 MHz
- 512 GB SSD Solid State Drive, Intel® UHD Graphics 730
- 24 in TFT Display, Optical Mouse - Black
- 125 USB Black Wired Keyboard, 1 VGA; 1 HDMI-out 1.4b
- 260w PSU Broze/EPA chassis (MINI Model)
- 1500VA UPS

313, 3rd floor, E-10-12, Triveni Complex, Jawahar Park, Vikas Marg, Laxmi Nagar,
NEW DELHI- 110092, (INDIA), Ph: 011-22016186, 22541518, Mob: +91-9810190925,
Email: info@trinitymicrosystem.com / sales@trinitymicrosystem.com, Website: www.trinitymicrosystem.com

Transducers and Instrumentation Trainer

(Model : TMS-MIT)



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- Instrumentation amplifiers
- AC amplifier
- Oscillator 40kHz
- Filter 40kHz

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- Low-pass filter with switchable time constant
- Precision full-wave rectifier
- Sample and hold circuit
- Integrator with switchable time-constant
- Differentiator with switchable time constant
- V/F and F/V converters
- V/I and I/V converters
- Alarm oscillator with switchable latching
- Power amplifier
- Electronic switch

Internal Power Supplies:

- -5V, +5V IA precision supply
- -12V, +12V 1A regulated supply

Pneumatic Supply:

- Internal Pneumatic Pump

SALIENT FEATURES

- Aesthetically designed injection moulded electronic desk. Master unit carrying useful experiment resources like Power supplies, DPMs, Computer Interface, Bar graph LED indicator Function Generator etc. while the central slot will carry replaceable exper iment panel secured in an ABS molded plastic sturdy enclosure. Order MUs x 7 Nos. + 7 panels + addons as required.
- Has colorful screw less overlay showing schematic & its connection tag numbers for easy connectivity. Transparent acrylic overlays will be offered optionally for sensors in MIT-2, 3, 6 panels only.
- Hands on learning by plotting sensor characteristics. Panel 1 to 6 are basic sensors, Panel 7 onwards are applied sensor pane ls. Set of Users Guide provided with each Unit
- Data aquistion control trainer (Lab view [optional] based EXE program using MIT3/MIT6 instrumentation for other panels) Labview not in scope of supply. Labview is trademark of NI.

Master Unit

- **Built in power supply :**

  DC supply +/- 12V,500mA, Variable 7V to 14V @ 3Amp.

- **Built in function generator**

  O/P waveform- sine, triangular & square, TTL O/P freq. 1Hz to 200KHz in ranges with amplitude & freq. control pots, o/p voltage 10Vpp.

- **On board measurement**

  DC voltmeter 2V/20V (1 No) & LED BAR graph with 10 LED indicator to display 0-2.5V or 0-4V input.

- **Computer interface** (Optional)

  Interfaces through 25 pin parallel port [LPT port] optoisolated adaptor to prevent damage to PC parallel port (25 pin LPT) due to wrong connections. Interfaces through 25 pin M to F cable 1 mtr Length. P4/XP/WIN7/8/10 not in scope of supply. Lab View based (optionally) executable to support virtual instrumentation with drivers supplied.

  4 ADC channels : 0 to 2.5V full scale

  1 DAC channel : o/p 2.5 V/12 V switch selectable full scale

  V to I Function block: Input : 0-2.5Vdc, Output : 0-20 or 4-20mA, upto max. 2Vdc GND compliance

- V to PWM function block : I/P -0-2.5V, O/P-1KHz PWM O/P +9V.
- USB IO module (HID class) to interface 25 pin D connector on CIA panel to USB PC port enclosed in 25 pin D shell using Type Ato mini B cable.

- **Mechanical Dimensions**:
  a) **Master Unit** : 460mm(W), 160mm (H), 350mm(D)
     Net weight : 6Kg, **Gross weight :** 8Kg.
  b) **Panel :** 215mm(W), 165mm(H), 40mm(D),
     Net weight : 700 gm approx.

- **Operating voltage :** 220V / 230V ±10%, 50Hz, 75VA

Modular experiment panels

- Optionally can be ordered as standalone panels (except MIT 10 panel) with built in power supply.
- Not all subassemblies under particular class of sensor can be assembled together on one panel. These are normally sold as separate units.

313, 3rd floor, E-10-12, Triveni Complex, Jawahar Park, Vikas Marg, Laxmi Nagar,
NEW DELHI- 110092, (INDIA), **Ph:** 011-22016186, 22541518, **Mob:** +91-9810190925,
Email: info@trinitymicrosystem.com / sales@trinitymicrosystem.com, **Website:** www.trinitymicrosystem.com

1) Strain Gauge Transducers (MIT1)

- Piezo resistive transducer for strain measurement.
- Micrometer 0-20mm (Accuracy 0.01mm) for strain generation.
- Strain gauges mounted on cantilever in half & full

Wheatstone bridge and **instrumentation amplifier** with Zero & span adjustment for calibration.

- Experiments on Gauge factor determination, Strain indicator, Displacement measurement using Strain gauges.

MIT1a : Piezo resistive transducer for pressure measurement (0-15psi)
Note : (cannot share with Level setup) Pressure sensor 0-15 psi (20 psi max.), gage type, Pressure generating handpump connected using T connector to the sensor and Bourden pressure gauge for measurement & calibration. Cannot share MIT-1 with any other option addon. Optionally Mclloyd pressure measurement **P to I experiment** *(Model : MIT1aii)*: Can be performed using MIT Master Unit (V to I FB)

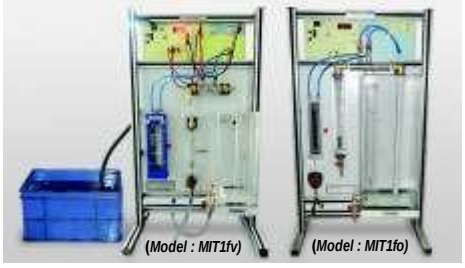
MIT1b : Piezo electric transducer for impact meas urement with atten uat or & peak detector.

MIT1c : Force / Weight measurement using piezo transducer (0- 20 kg weighing scale sensor).

MIT1d: Level measurement by measuring water column height using pressure sensor by Air bubbler method in 500mm calibrated acrylic water tank, water pump, vibratory air pressure pump, manual bypass valve mounted on a compact (530 x 910mm) table top panel. Can not share MIT1 with a, f options simultaneously.

MIT1fv : Flow measurement using Venturi

MIT1fo : Flow measurement using Orifice



Compact, lightweight setup of size (190X700) consisting of venturi OR orifice plate sensor (200LPH), ball valve to isolate, uses DPT sensor mounted in MIT1, water pump, rotameter (1000 LPH for Venturi and 200 LPH for Orifice), U tube mercury manometer (70-0-70 mm of hg), 6 QRC's to measure differential pressure, flow measurement tank (5 litre), submercible water pump, Sump water tank (15 litre). [Cannot share MIT1 with option a,d simultaneously. Order venturi or Orifice separately]. cc, cv and cd determination for orifice & venturi.

MIT1 g : Static Torque Measure-ment Setup (530 x 910 mm) : using 30 x 30 aluminum profile with Fulcrum long arm end of 300 mm (optionally 1000mm) mounted on bearing to carry weight pan to suspend 100 gms x 10 nos. while short arm is held by full bridge strain gauge sensor to display toque in kg (meter)

MIT1h : Flapper Nozzle mechanism demonstrator: Consists of :

- Micrometer 0-20mm (accuracy 0.01mm) provided to displace flapper.
- Nozzle (3.5mm Ø) mounted at right angle to flapper on MIT1 panel.
- Back pressure is displayed on Bourdon pressure gauge (0-15psi) & also applied to Piezo resistive pressure sensor (15 psi) with Signal conditioning circuit to convert pressure into voltage (0-2.5V) & V to I function block (0-20mA or 4-20mA output) on Master unit (MU) .
- Needs compressed air supply through external AFR (set to 1 bar). Compressor is not in Scope of Supply (Optional).

2) Displacement Sensing Transducers (MIT2)

- **Micrometer** 0-20mm (Accuracy 0.01mm)
- **Precision phase sensitive rectifier**
- Measurement frequency of 1KHz sine
- Signal conditioning circuit with zero and span adjustment for calibration of variac sensor output voltage 0-2.5V or suitable for DPM.
- **Zero & span adjustment for calibration of following transducers**

i) Resistive linear transducer : 0 -20mm
ii) Capacitive linear transducer : 0 -20mm
iii) Capacitive angular transducer : 0 - 90 degree
iv) Inductive linear transducer : 0 -20mm
v) LVDT transducer : 0 -20mm or (-10to+10mm)

Optional ADDONS

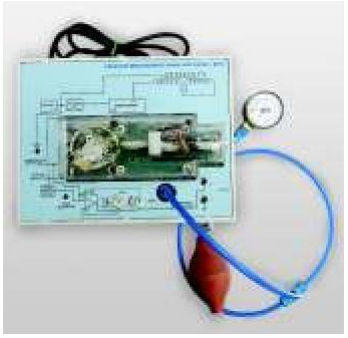
MIT2a : Level measurement by **capacitance** transducer using 500 mm calibrated acrylic water tank, water pump, manual flow valve mounted on compact light weight (530 x 910 mm) table top panel.

MIT2b : Level measurement by float type : Rotary pot transducer using 500 mm calibrated acrylic water tank, water pump, manual flow valve mounted on compact light weight (530 x 910 mm) panel. Set up may be shared with (a)

MIT2c : Level measurement by torque tube method using displaser with rotary pot wheel & float transducer using 500 mm calibrated acrylic water tank, water pump, manual flow valve mounted on compact light weight (530 x 910 mm)

MIT2d : Angular measurement using rotary pot 0-180° Span.

MIT2e : Humidity measurement demonstrator using polymer hybrid sensor or using either capacitive or resistive type sensor.



MIT2f : Pressure measurement using LVDT :

- Bourden pressure gauge (0-15psi) mechanism coupled to LVDT sensor (0-20mm).
- Pressure measurement up to 0-15psi.
- Pressure generating hand pump connected using T connector to the sensor gauge and another bourden pressure gauge for measurement & calibration.

3) Speed Sensing Transducers (MIT3)

- **12V DC motor** with speed varying from 0-4000rpm & rotating slotted wheel having 8 slots
- Individual signal conditioning circuit with **programmable threshold comparator.**
- **F to V Converter with span & zero amplifier**
- **6 Nos. of Speed transducers & their experiments:**
  1) Magnetic pickup,
  2) Photo reflective,
  3) Photo interruptive
  4) Inductive pickup with
  5) Stroboscope envelop detector.
  6) Hall sensor.

Optional ADDON

MIT3a : Flow measurement : Compact, lightweight set up of size (190mm x 700mm) with small water pump, **Vane type** flow sensor (200 LPH) & rotameter (200 LPH), 6 litres plastic water tank. (Size : 130 x 130 x 375mm)

4) Sound Sensing Transducers (MIT4)

- 40KHz gated oscillator to generate **Ultrasonic** sound waves.
- Sound Sensors :

i) Ultrasonic **Distance** Measurement.

ii) Level measurement using ultrasonic sensor (optional)

iii) Speed measurement using doppler effect (optional)

a) DC motor speed measurement using ultrasonic sensor

b) Fan speed measurement using ultrasonic sensor

c) Doppler amplitude measurement using MIT7 vibration setup

5) Light Sensing Transducers (MIT5)

Incandescent lamp with variable intensity

- **5 Nos. of Light sensors & their experiments:**

1) Photo diode with **I to V converter**
2) Photo transistor with **I to V converter**
3) Photo resistor/LDR with R to V converter using constant current source.
4) Photovoltaic cell / Solar cell
5) Opto coupler, Laser diode, Infrared LED, Red LED

Optional ADDON

a) **Elementary Fiber Optics :** ***(Model : MIT5a)*** 3 nos of transmitter diodes (RED (660nm) / BLUE / IR (950nm), 1 no detector (photo transistor), 1m PMMA Cable, I/Ps - TTL & AC Coupled (0-4V), O/P's- AC, DC Coupled & TTL O/P,

Experiments performed : Setting up ANALOG LINK (10KHz BW)(Study DC Characteristics & frequency response of different transmitter diodes), Setting up **digital link** (50KHz BW) (observe effect of varying square wave frequency on receiver output). Needs external FG.

b) **Optical filters** ***(Model : MIT5b)*** for Red, Green, Blue & Yellow colour to determine sensitivity transducers for colors. (optional)

6) Temperature Sensing Transducers (MIT6)

- **Instrumentation Amplifier** to amplify thermocouple signals
- Built in heat bar / mini oven driven by **Power Amplifier** of sufficient wattage
- Temp. selection upto 95 degree C in 5 ranges with ON / OFF closed loop control.

Temp. sensors: i) Thermocouple J with room temp. calibration pot. ii) Thermocouple K with room temp. calibration pot. iii) Thermister (100K), iv) PT100, v) IC sensor (AD 590)

vi) Bimetallic switch

7) Vibration sensor and Air flow sensor experiment Panel - MIT7

Vibration (accelerometer) sensor

i) Operation Range : Audio frequency (2KHz - 3.5KHz),

ii) Power amplifier : 1W capacity as a vibration generator,

iii) Piezo electric sensor

iv) Determination of acceleration (accelerometer), velocity, displacement components.

Air flow sensor (Hot wire Anemometer) :

i) Preheated thermister = 100 ohm, ii) DC fan (12V, 1 ½") to generate variable airflow in a mini wind tunnel with manual outlet control, iii)Bridge amplifier to O/P 0 = 2V at various temperatures (Fan speed).

8) Electrical Parameters Measurement Sensor Panel: (MIT8)

Panel Facilitates measurements of AC voltage, current (peak, average, RMS), power-S (apparent), P (active), Q (reactive), cos (PF 0.5 lag to 0.5 lead), CT (5/1 Amp) as a current transducer and PT (230V/ 12V) as a voltage transducer mounted on the panel itself.

Loading Setup provided with 100 W lamp bulb **(Process I modified)**, multi tap Reactive (inductor, capacitor) load, 4 relays to automate PC based measurement. PC interface supported by master unit (Optional).

9) Encoder (Absolute /Incremental) Experiments Panel (MIT9)

Panel consists of 4 bit up/down counter with parallel loading to latch absolute encoder O/P (4 bit), comparator to stop turn table at set position, incremental encoder circuit with direction detect and incremental position clock. Position displayed on 5 Leds to indicate direction and position of turn table (1 of 16).

Encoder Set up : RTU base unit with turn table motor as prime mover with 5 track pattern stuck from below photo reflective emitter detector LED (5 pairs) signal conditioning PCB mounted from below & 9 pin D connector cable attached to MIT9 panel. Optionally working of Pyroelectric Infrared sensor (PIR sensor).

10) Temperature sensor calibration panel (MIT10)

Compact light weight setup (***Model: MIT10a)*** (size: 190X700) consisting of process vessel (SS 304) with 750W heater, Bourdon Type Thermometer, provision to mount either one RTD/NTC (thermistor) & one K type TC or 2 TCs (standard & under calibration), EMT9 panel acts as heater controller consisting of signal conditioning circuit for RTD or NTC & TC. Acrylic Water Tank with Submersible Pump & Fish Tank compressor for cooling purpose.

• Optionally PC interface & control using CIP panel.***Model: MIT10b)***

11) Dead Weight Pressure gauge & calibration Tester (MIT11)

Bourdon pressure Gauge : Dial =4", Range=10kg/cm2 QRC External calibration port, **Weights :** 5 kg, 2 kg, 1kg **Rack Size** : 4 x 3

12) Hall Sensor based AC/DC Current Measurement Expt. Panel (MIT12)

It needs current injector panel EMT23C & EMT39B for AC/DC current & DC voltage measurement, mounted in Alu. profile rack.

AC/DC current hall sensor (x2nos.): Closed Loop current measurement using Hall sensor IC (max. I/P upto 20A, 50/60Hz), Isolation = 2.1KV, Proportional O/P = 0 - 2.5V, 1 CH Optional. DC Voltage transducer (x2 nos): Using high speed opto coupler IC (max. up to 600Vdc), isolation = 2 KV, 1 CH Optional.

Function Blocks Used : Precision rectifier (x 2 nos) with gain = 5, LPF (x2nos) with gain = 2, Span Zero Circuit to interface with ADC(0-2.5Vdc) for both current and voltage, only 1 functional block each supplied, 2nd optional, zero current detector.

13) Smoke Detector Panel (FAT1)

- Photoelectric smoke sensor
- Operating voltage – 12VDC
- Standby current – 20uA
- Alarm current –35mA@12VDC
- Alarm output – Remote LED
- Temperature range – 0% ~ 95%RH

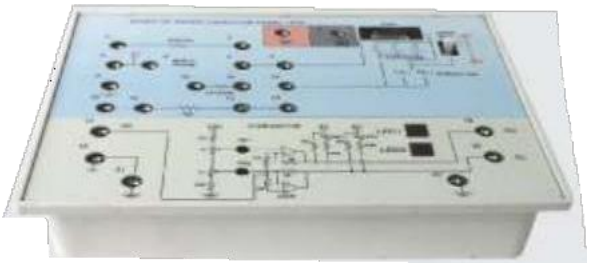
14) Thermoelectric effect measurement panel (MIT15)

- Panel consists of thermoelectric modules- 2 nos. Size- 40X40mm, Operating voltage- ±12V, Wattage- 40W), foil type (35X30mm) PT100 sensor- 2 nos., loading/heating resistor (5Ω/50W), heat sink & cooling fan (12V) are mounted in the aluminium tray. Needs variable 0-12V to drive Peltier module.
- Forced air cooling to maintain heat sink at room temperature

1) **Peltier effect :** Study of Peltier effect (heater/cooler) using thermoelectric module (Range- 200 to 75 degree C).
2) **Seebeck effect** : Study of Seebeck effect (electric voltage generator) using thermoelectric module (Range- 0 to 600mV).

15) I to P and P to I converter Trainerl (MIT16)

- Compact light weight setup consisting of EMT8, EMT9 and CIP panels in the top row.
- ±12V/500mA power supply, DPM display on EMT8.
- Industry standard I to P converter module with input 4-20mA, output 3-15psi & input air supply through AFR mounted on composite pvc board below (set to 1 bar).
- 3 numbers of bourdon pressure gauges of 0-2 bar with 2"dial (1no.), 0-15psi with 4" dial (2nos.).
- Piezo resistive pressure sensor 0-1bar mounted in CIP panel with signal condition circuit on EMT9 panel to convert pressure 0-15 psi into voltage 0-2.5V & V to I function block (0-20mAor 4-20mAoutput)on CIP panel.
- SS tubing ¼' with 2 numbers of ball valves.
- Needs external compressed air supply (4-7 bars).



16) Study of super capacitor panel (P41)

(Provided with 22 banana Sockets)

Panel consists of 5 numbers of one Faraday (1F/5V) super capacitors and there exists provision to group them as 3F and 5F by using DPDT switch, provided with charging/ discharging resistors and leakage current measurement sensor, Comparator function block to measure charge and discharge time on DSO, onboard regulated supply to prevent damage to super capacitor due to over voltage. Need +12Vdc external power supply.

Experiment performed : 1) Experiment to determine charging and discharging time of super capacitor. 2) Experiment to determine leakage current of super capacitor.

313, 3rd floor, E-10-12, Triveni Complex, Jawahar Park, Vikas Marg, Laxmi Nagar,
NEW DELHI- 110092, (INDIA), **Ph:** 011-22016186, 22541518, **Mob:** +91-9810190925,
Email: info@trinitymicrosystem.com / sales@trinitymicrosystem.com, **Website:** www.trinitymicrosystem.com

ELECTRICAL AND ELECTRONIC SYSTEM TRAINER

(Model : TMS-CT)

Optional : Bread Board Panel

Optional : Bread Board Panel :

Bread board panel with 1280 tie points and 400 distribution points, totalling to 1680 points along with 4mm banana sockets for tapping from the trainer +5V, +12V, GND for the circuits to be assembled on bread board using single stand (#22/24)wire.

SPECIFICATIONS OF MASTER UNIT

- **Built in Power Supply**
  DC Supply : 5V / 1A. & ± 12V, 1A. 0 to 15V DC (Variable), 100 mA **(Isolated)**, 0 to 30V DC (Variable), 100 mA **(Isolated)**, **High Volt** DC 15V to 110V, 100mA
  AC Supply : 12-0-12V AC,150 mA. Short circuit Protected.

- **Built in Function Generator**
  O/p Waveform : Sine, Triangle & TTL O/Ps
  Output Frequency : 1 Hz to 1MHz in 6 ranges, with amplitude & frequency control pots. O/P Voltage 20Vp-p max. (Sin/TRG)
  Modulation I/P : AM : - I/P voltage ± 5V (100% modulation) O/P - For 0V (min), + 5V (max.) - 5V (Phase reversal of O/P) FM : I/P voltage ± 400mV (± 50% modulation)

- Clock Generator : 10 MHz TTL clock.
- Data Switches (10 No.) & bi-colour LED status indicators 10X2 Nos, for High/Low indication.
- Pulser switches (2 Nos.) with four debounced outputs - 2No.
- BNC to 2 channel banana adapter - 2No.
- Logic probe to detect High/Low level pulses upto 1MHz, with bi-colour LEDs to indicate status.
- 2 / 4 digit 7 segment display with BCD to 7 segment decoder.
- Onboard DPMs provided with mode/range selection. (8 combinations)
  (A) DC volt : 2V/200V - 1No.
  (B) DC current : 2mA/200mA - 1No.
  (C) DC Volts/Current : 20V/200mA - 1No.
- Onboard moving iron meters provided for
  (A) AC Current : 1 AMP - 1No.
  (B) AC Voltage : 15V - 1No.
- Onboard speaker : 8 Ohms, 0.5 Watt (1No.)
- Onboard POTS : 1K - 1No.
  1M - 1No.
- **Mechanical Dimensions**
  (A) 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 : 700 gm approx.
- **Operating Voltage:** 220/240Vac switch settable ±10%, 50Hz/60VA.

SALIENT FEATURES

- Aesthetically designed injection molded electronic desk (Master unit) carrying useful experiment resources Variable Power supplies / Status / Pulsar / Function Generator, DPMs etc. while the central slot will carry replaceable experiment panel secured in an ABS molded plastic sturdy enclosure, and has colorful screw less overlay showing circuit & its connection tag numbers for easy connectivity.
- Connection through Sturdy 4mm Banana Sockets & Patch Cords.
- Hands on learning by constructing circuits using optionally power bread board panel or using Discrete component panel or using Linear IC Trainer panel.
- Set of Users Guide provided with each Unit.
- Order 10 Master units & multiples of 10 or more panels set.

MODULAR EXPERIMENT PANELS : Following experiment panels normally work in conjunction with CT Master Unit. However they can be ordered as stand alone units with built in power supply.

Discrete Component Panel [DCP] :

Panel with following discrete components : 7 Resistors, 5 diodes, 1 LDR, 1 Zener, 3 NPN transistors, 1 PNP transistors,1 UJT, 4 Capacitors, 1 HV Capacitors, 2 SCR, 2 FET & MOSFET, 1 12V RELAY, 3 Inductors,1 Linear pot, 1 Triac, 1 Audio transformer, 1 PUT, 1 HW Resistor, 1 DIAC, 92 Banana sockets for patch cording to construct various circuits.

Liner IC Trainer Panel (LIT) :

IC Used : LM339, TL084, 741, 555, Sockets : 142, Discrete component used : Resistors. -15 Nos, Capacitors -15 Nos., Transistors - 2 Nos, Diode - 4 Nos Zener Diode - 1 No., Regulators- 3 Nos. Pot- 1, Experiment >40.

Magnetism, Electromagnetism and Transformer Experiment Panel (P1)

[Provided with 37 banana tags.]

Faraday's law of magnetic induction, Left-hand rule for north pole of coils / conductors & Corkscrew rule for flux around current carrying conductor. Fleming's left-hand rule (motor law -force on a current carrying conductor in a magnetic field), Lenz's Law.

Transformer: BH curve, calculation of total Iron core loss (Hyst & Eddy loss) using CRO, DC-AC resistance, transformation ratio, loading of transformer, Auto transformer, self & mutual inductance calculations.

DC, AC & Wave Shaping Circuit Experiment Panel (P2)

[Provided with 81 banana tags]

DC : Resistance, current and voltage measurements, Loading of Potentiometer, Ohm's law, Power DC circuits, Series, parallel and mixed circuits, Kirchoff's law, Superposition theorem, Thevenin's & Norton's theorems, Reciprocity, Compensation, Tellegen, Millman theorems & Maximum Power transfer theorem, Voltage distribution of capacitors in series & parallel, total capacitance of capacitors in series and parallel, charging and discharging of capacitor through resistance & time constant, Wheatstone's Bridge, 2 Port Network Y, Z,h, ABCD Parameters & Star Delta Network, T & Pi attenuators.

AC : AC Voltage & Current Measurements - R-L series, R-C series, R-L-C series circuit (Series Resonance). R - L parallel, R-C parallel, R-L-C parallel(Parallel Resonance), Active, Reactive power & power factor(Vector Diagram), average & RMS Value measurement.

Wave Shaping: Differentiator, Integrator, Clipping, Clamping, Passive filters LC / RC, LPF/ HPF

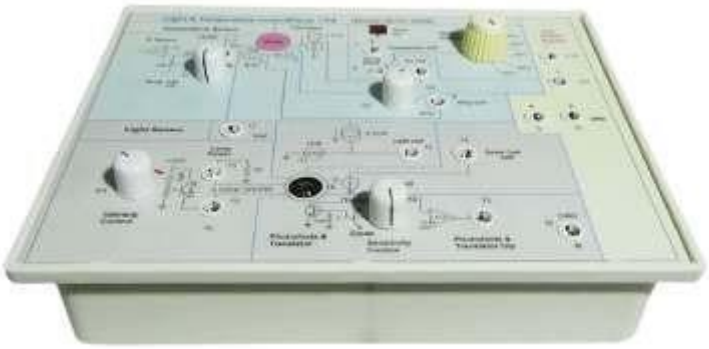
LABWISE EXPERIMENT PANEL SELECTION CHART	
Electricity & Networks (3)	P1, P2, P38
Discrete Electronics (12)	P3, P4, P5, P6, P7, P8, P9, P10, P11, P31, P35, DCP
Digital Electronics(10)	DIT I, DIT II, P12, P13, P14, P15,P26, P28, P33, P34
Opamps / Linear Electronics(9)	LIT, P16, P17, P18, P26, P32, P33, P35, P39
Power Electronics(8)	P20, P21, P22, P25, P29, P30, P36, P37
Communication Electronics(5)	P18, P19, P23, P27, P32
Measurement(3)	P24, P38, P40, P41

Semi conductor & Power Semi conductor Device Characteristics Experiment Panel (P3)

[Provided with 41 banana tags]

Characteristics of following devices : Silicon diode, Semiconductor Testing using Multimeter, Germanium diode, zener diode, LED, diac, bipolar transistor (NPN, PNP), Field Effect Transistor (FET), MOSFET, IGBT, UJT, Silicon Controlled Rectifier (SCR), Triac, Optocoupler, Thermistor, V-I Character istics on CRO of SCR, Triac, Transistor as a Switch & MOSFET as a Switch. Optionally Band gap energy calculations.

Note: Needs Isolated (2 nos.), high voltage (100V) power supplies & 8 combinations of meters.



Sensors & Transducers Experiment Panel (P4)

[Provided with 17 banana tags]

Temperature Sensors: AD 590 (IC Sensor), RTD (PT100), Thermistor, (NTC).

Light Sensor: Photo Transistor & Photo Diode,LDR, Photovoltaic Cell.

Rectifier, Filter, Zener Regulator Experiment Panel (P5)

[Provided with 67 banana tags]

Transformer & its study (Transformer DC/AC resistance, Transformation Ratio, Electromagnetic Induction, Loading of Transformer), Half wave rectifier, Full wave rectifier, Bridge rectifier, Filter, Voltage multiplier, Zener shunt regulator

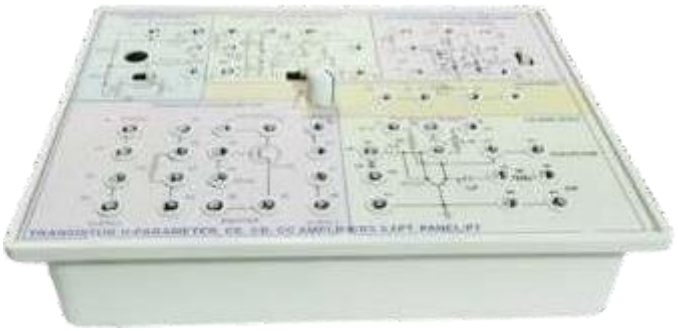
TCT MCT + CT PNP/NPN

Transistor (Devices) Curve Tracer / Multi curve tracer (8 digital channel) for study of Electronics.

Voltage Regulator Experiment Panel (P6)

[Provided with 40 banana tags]

Zener regulator with current boost transistor, Transistorised series regulator, IC voltage(variable) regulator using IC 723 (Positive/negative voltage regulator), IC current regulator using IC LM317.



Transistor h-parameters & CB / CC / CE amplifiers experiment panel (P7)

[Provided with 53 banana tags]

Thermal stability (Transistor bias stability), Determination of h-parameters, Calculating I/P, O/P impedances, 3dB bandwidth, of transistor amplifiers CB, CC, CE, Cascode, effect on I/P impedance by bootstrapping & transistor switch.

Transistor Amplifier Experiment Panel (P8)

[Provided with 48 banana tags]

Calculating efficiency & 3dB bandwidth of amplifiers Differential amplifier, 2 stage R-C coupled amplifier, Transformer coupled amplifier, common source FET amplifier, common drain FET amplifier (source follower) Push pull amplifier, Complementary symmetry amplifier, Class-D or switching amplifier.

Oscillator & Multivibrator Experiment Panel (P11)

[Provided with 25 banana tags]

Hartley oscillator, Colpitts oscillator, Crystal oscillator, Clapp oscillator, Blocking oscillator, Astable multivibrator, Monostable multivibrator, Bistable multivibrator, Twin T Oscillator, RF tuned oscillator, Miller ramp generator.

Transistor Signal & Feedback Amplifiers Experiment panel (P9)

[Provided with 40 banana tags]

Calculating efficiency & 3dB bandwidth of amplifiers Class A, B, AB, C, D. Calculating I/P, O/P, impedances & 3dB bandwidth of current. voltage shunt feedback, current voltage series feedback.

Digital Logic Gates Experiment Panel (P12)

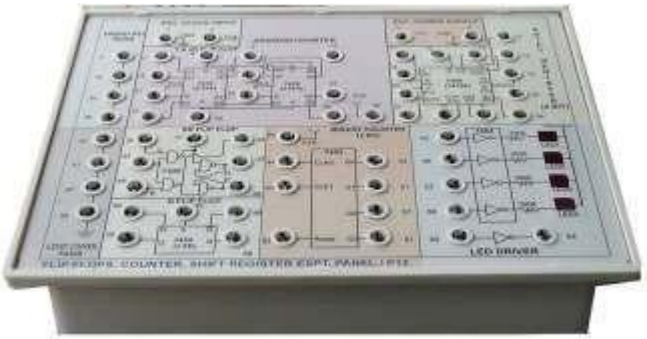
[Provided with 28 banana tags]

AND, OR using Diode Logic, Inverter using transistor logic, NAND, NOR, EX-OR, EX-NOR, Demorgan's theorems, Input / Output characteristics, propogation delay.

Transistor / Diode Applications Experiment Panel (P10)

[Provided with 61 banana tags]

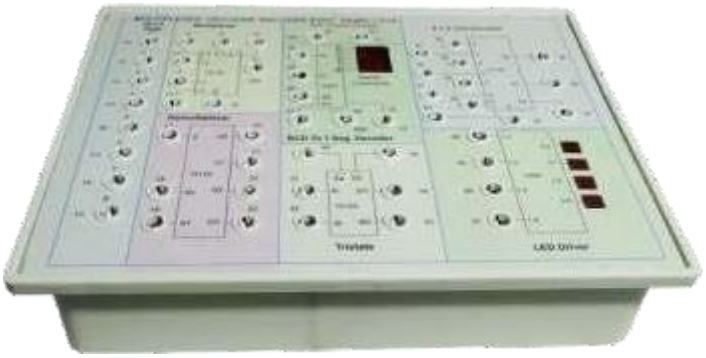
Components suitably arranged so that following 30 projects can be constructed: Electronic storage tank, One way street, “Invisible power” Radio, Transistor, Electronic trigger, Transistor and amplification, Sunrise-Sunset light, Slow -motion Sunrise-Sunset light, Secret code key, Highs & lows of oscillations, Beacon light, Music from a pencil, Leaky facet, Bee, Electronic canary, Burglar alarm, Touching light, Rain detector, Radio station, Wireless rain detector, Metal detector, Blowing 'ON' a candle, Blinker, Two transistor oscillator, Timer, Memory, AND, OR, NAND, NOR gate.



Flip Flop, Counters & Shift Register Experiment panel (P13)

[Provided with 64 banana tags]

R-S Flip-flop, 'D' flip-flop, 'T' flip-flop, 'J-K' flip-flop, Master- slave J-K flip-flop, Binary Counter, Rotary feed back application of counter, Decade counter, Shift registers: Shift left/Right/Ring counter, Parallel mode, Twisted ring counter, Johnson Counter.



Multiplexer, Decoder & Encoder Experiment panel (P14)

[Provided with 51 banana tags]

Multiplexer, Decoder / Demultiplexer, BCD to seven segment decoder driver, Tristate logic, Encoder.

Half/Full Adder, Subtractor, ALU Experiment panel (P15)

[Provided with 56 banana tags]

Half adder, Half subtractor, Full adder, Full subtractor, ALU, Applications of ALU: Mathematical-addition, subtraction; Logical-AND, OR, EX-OR, NOT etc; Code conversion- binary to gray, gray to binary,BCD to Excess-3, Excess-3 to BCD, 9's compliment,10's compliment, Substitution of CAM for timing control.

Operational Amplifier Circuit Experiment panel (P16)

[Provided with 68 banana tags]

Inverting amplifier, Non-inverting amplifier, Summing amplifier, Difference amplifier, Integrater circuit, Differentiator circuit, Precision rectifier: Half wave & full -wave, Voltage to current converter, Current to voltage converter, op-amp parameter (For detail expt. use P39) characteristics, Instrumentation amplifier, Schmitt trigger, Comparator, Sign Changer, Offset Null, Peak detector, Clipping circuit, Clamping circuits (DC restorer), Waveform Generator, Window comparator, Dead band zone circuit etc.

Standalone Panel P16

Advance Operational Amplifier Experiment Panel (P17)

[Provided with 56 banana tags]

Lowpass filter, High pass filter, Bandpass filter, Band stop (Notch) filter, Wien Bridge oscillator, Phase Shift oscillator, Sample & hold circuit, Log amplifier, Antilog amplifier, Voltage to frequency converter, Frequency to voltage converter, Root extractor.

Timer (555) & Frequency (565) application Experiment Panel (P18)

[Provided with 54 banana tags]

Using 555: Timer (1 shot/Monostable), Free running (Astable), Bistable. Applications of 555: PAM, PWM, PPM, Buzzer, Saw tooth generation, long duration timer, tachometer, missing pulse detector. Using PLL (IC565), VCO, Phase detector, Determination of Lock freq., Capture freq., & freq. Multiplier / Synthesizer, FM demodulation (Using PLL).

Technical Specifications of Standalone Power Supply

Sr. No.	Power Supplies	Current Rating	Common	Connection
1.	±12V fixed	500mA	GND	No separate sockets, but internally connected
2.	±5V fixed	300mA (shared with +12V	GND	No separate sockets, but internally connected
3.	0-12V variable	100mA	Isolated COM1	Pot knob & 2 sockets on the front plate
4.	0-12V variable	100mA	Isolated COM2	Pot knob & 2 sockets on the front plate
5.	15-100V variable	120mA	GND but common with +5V (only for P3)	Pot knob on front plate & 2 sockets on the hind plate

AM / FM Transistor Radio Kit (P19) [No. of Test points = 17]

Functional study of RF amplifier, Mixer, Local oscillator, If amplifier, Detector & Audio amplifier for both AM & FM radios. Supplied either fully assembled or optionally CKD form. Operates from 9V built in battery. Wall transformer optional (12V).

Mechanical Dimensions : W= 370mm, H=172mm, D=67mm

Power Semiconductor Application Expt. Panel (P20)

[Provided with 29 banana tags]

Triac lamp dimmer,AC fan regulator, SCR/DIAC operated light sensitive switch using LDR, SCR/DIAC operated temperature sensitive switch using thermistor, UJT relaxation oscillator, Half and full wave (Phase shift controlled) rectifier using SCR, Timer using SCR & UJT.

DC-DC, DC-AC Experiment panel (P21)

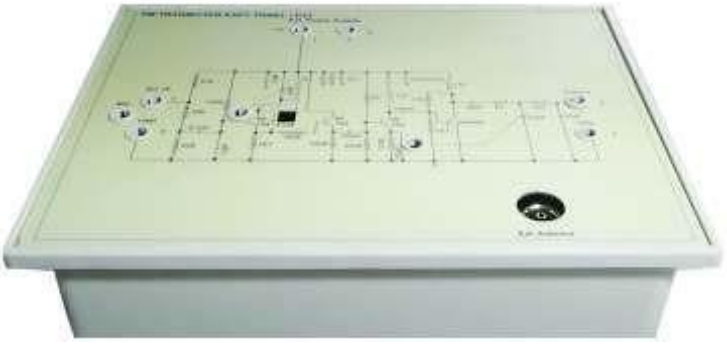
[Provided with 14 banana tags]

DC to AC, AC to DC, DC to DC Voltage converter circuit. DC to AC Circuit (Converts 5VDC I/P to 12-0-12VAC O/P) AC to DC circuit (Converts 12-0-12VAC I/P to±12VDC O/P) DC TO DC by combining two above circuits to get (5VDC Input to ±12VDC O/P)

Power Semiconductor Application Expt. Panel II (P22)

[Provided with 17 banana tags & 11 TPs]

SCR phase shift controlled converter using IC555 through opto isolator (Potentiometric), Triac AC power control using IC 555 (Potentiometric) (optoisolated), SCR AC power control using UJT/PUT (Potentiometric) Triac AC power control using UJT/PUT (Potentiometric), SCR/Triac temperature control using thermister, SCR/Triac intensity control using LDR, Opto isolated DC switch & Photo relay & thermal relay (street light control). power control using UJT/PUT (Potentiometric) Triac AC power control using UJT/PUT (Potentiometric), SCR/Triac temperature control using thermister, SCR/Triac intensity control using LDR, Opto isolated DC switch & Photo relay & thermal relay (street light control).



FM Transmitter Experiment Panel (P23)

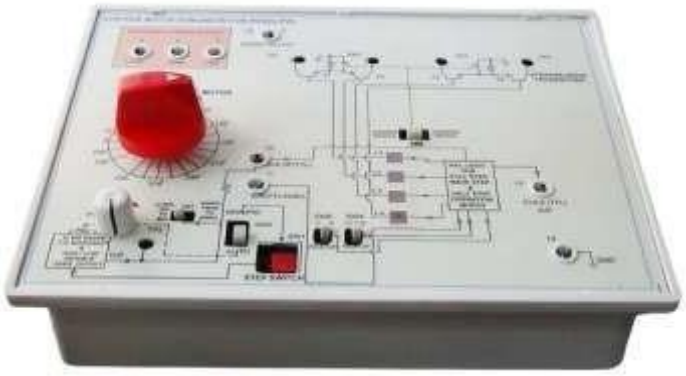
[Provided with 10 banana tags]

Single band frequency range : 88 to 108 MHz Power O/P : 100 mW.

DC/AC Bridge circuits Expt. Panel (P24)

[Provided with 52 banana tags]

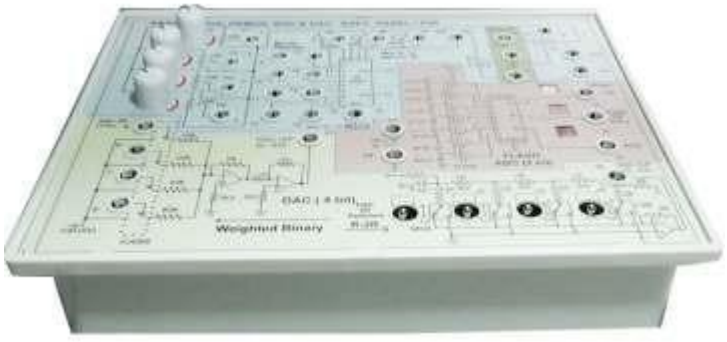
Wheatstone's Bridge, Kelvin's Bridge, Maxwell's Bridge, Hay's Bridge, Desauty's Bridge, Owen's Bridge, Anderson's Bridge, Shearing Bridge, Wien bridge. Provided with 2 capacitor decades (100pF to 100uF), 1 resistor decade(10E to 10MΩ), 1tapped wire wound 10 taps (0.01Ω) 10K 10T pot, 100Ω pot, fixed resistors of 10 & 4.7Ω , Earphone & its socket.



Stepper Motor Demonstrator Expt. Panel (P25)

[Provided with 15 banana tags]

Control of direction, Step rate, Auto / Manual operation of stepper either built in 7.5^0 step or optionally external 3 kg-cm motor (1.8^0) in half / full / wave stepping modes / current chopper mode.



Analog Multiplexer / Demultiplexer & ADC, DAC Expt. Panel (P26)

[Provided with 40 banana tags]

8 Channel Analog Multiplexer, 1 of 8 Analog Demultiplexer, Flash A to D Converter (3 bit), D to A Converter (4 bit) : weight ed binary and R- 2R.

Audio System expt. Panel (P27)

[Provided with18 banana tags]

Study of mic characteristic and Polar plot (Optional PC interface graph plotting s/w), 5-band graphic equalizer, Active cross over network, Study of HPF/BPF/LPF, 3W L/S amplifier with ext. L/S box.

Study of Logic Gates & Applications Expt. Panel (P28)

[Provided with 58 banana tags]

Logic Gates, & input output characteristics Boolean Algebra Theorems, Demorgan's Theorems, Logical equations, Digital code lock, R-S flip-flop using NOR gates, Multivibrators - Astable, Monostable & Bistable multivibrator etc.,4 bit synchronous counter, Synchronous non binary counter/Decade counter /MOD 10 counter etc.

Switch Mode Power Supply Experiment Panel (P29)

[Provided with 11 banana tags]

SMPS (TV), To study Crow bar protection circuit

3 Ph. Sequence Indicator & Study Experiment Panel (P30)

[Provided with 7 banana tags]

Study 3 phase 440V Electric utility supply -Determination of over voltage, under voltage, single phasing and reverse phasing / Displays OV,UV,SP,RP on digital display, Motor protection relay for temperature & over current protection, 9V Battery / +12V supply operated.

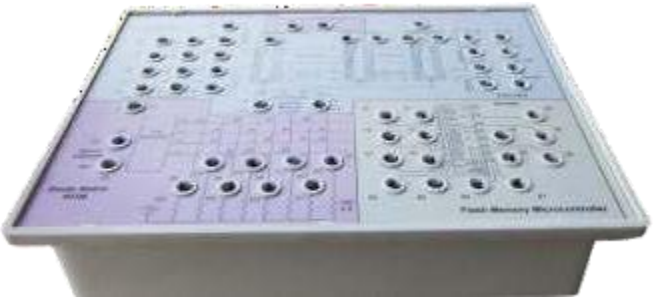
JFET, MOSFET & IGBT Expt. Panel (P31)

[Provided with 49 banana tags]

MOSFET : Drain characteristics of MOSFET, MOSFET Amplifier, MOSFET Switch, current mirror using MOSFET.

JFET : Characteristics of JFET, JFET amplifier, JFET crystal oscillator, Phase shift osc. Using FET, Phase splitter using FET, FETAnalog switch, current mirror using MOSFET.

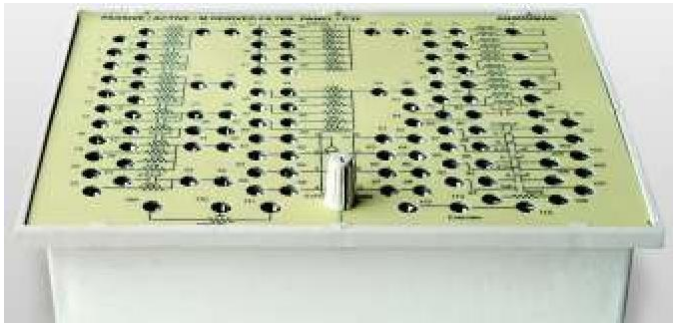
IGBT : Characteristics of IGBT, IGBT as switch.



Memory Experiment Panel (P34)

[Provided with 55 banana tags]

Constructing ROM with Diode Matrix (4x8 bits), RAM with D flip flop, EEPROM (28C64) - 8K x 8, EPROM (2764) 8K x 8, RAM (6264) 8K x 8. Flash memory microcontroller.



Passive / Active / M Derived Filter Panel (P32)

[Provided with 114 banana tags]

Passive (RC) filters- Low pass , High pass, Notch filter,

Active filters- Low pass, High pass, Unity gain phase shifting, Butterworth, Bessel, Chebyshev filter

LC (M derived / constant K type filters)- T type high pass Active filters, High pass M derived, Band stop, Band pass, M derived Band pass, Constant K type pass band, Band Elimination, Composite Low/High pass filter can construct above filters & plot their characteristics.

Oscillator & Amplifier Experiment Panel (P35)

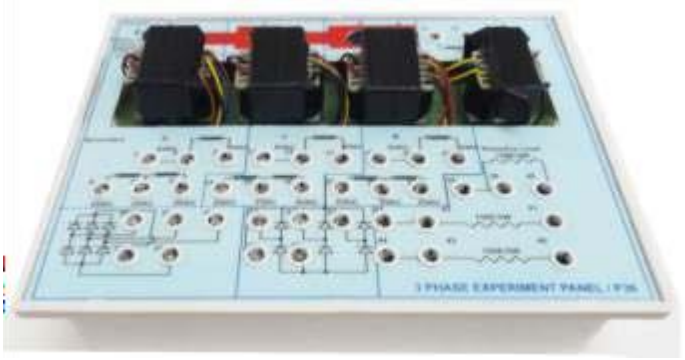
[Provided with 19 banana tags]

Blocking Oscillator Circuit, Schmitt Trigger / Oscillator, OTL Amplifier, OCL Amplifier, 0.5W/8 ohm Loud speaker with Audio amplifier, Mic with preamplifier, Electronic Birdcall circuit, transistorized wien bridge oscillator & phase shift oscillator. 8 bit fault switches to simulate various commonly occurring faults.

ADC & DAC Circuits Experiment Panel (P33)

[Provided with 30 banana tags]

8 bit ADC, 0-5V I/P:- Dual slope ADC, Tracking ADC, SAR ADC, RAMP ADC, Bipolar ADC using level translator, Delta Sigma ADC , 8 bit DAC:- O/P Range 0-5V & +/-5V.



3 Phase Laws Experiment Panel (P36)

[Provided with 40 banana tags]

Star, Delta relationship between V.I. Use of Low voltage isolated secondaries to prevent shocks, various rectifier circuits. Need 3 phase 4 wire supply.

Advance DC to DC Converter Panel (P37)

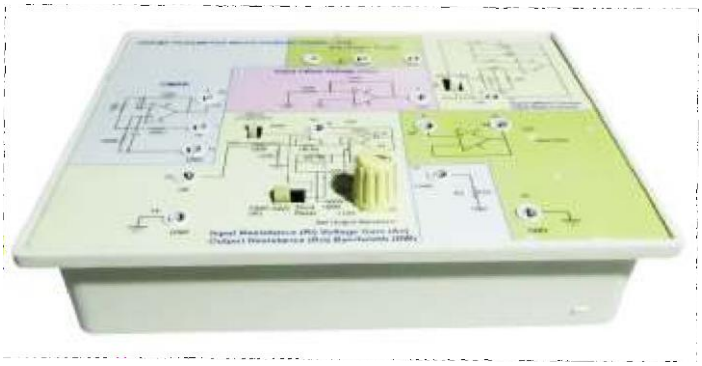
[Provided with 63 banana tags]

Open loop & Closed loop scheme for Step Up (Boost), Step Down (Buck), Polarity Inverter (Buckboost), Forward, Fly back, Push Pull, Negative Voltage Converter, Cascaded Negative Voltage Converter, Cuk Converter, Various SMPS topologies.

AVO Meter, Lamp, Relays, Cells Expt. Panel (P38)

[Provided with 45 banana tags]

1.5 x 4 No. cells for series parallel expts., moving coil meter (100 uA) to construct voltmeter, ammeter AC / DC and ohmmeter, bulbs in series parallel, Relay characteristics, staircase lamp logic, Static & Dynamic characteristics.



OP-AMP Parameter Measurement Panel (P39)

[Provided with 15 banana tags]

Experimental measurement of 9 parameters 1) Opamp input resistance 2) Output resistance 3) Open loop voltage gain 4) Bandwidth 5) Offset voltage 6) CMRR 7) Input offset current 8) Input bias current 9) Slew rate

Note : Except probably CMRR & bandwidth most of these parameters can not be measured with accuracy on standard OPAMP circuit panel (P16 etc.), you need dedicated circuits.

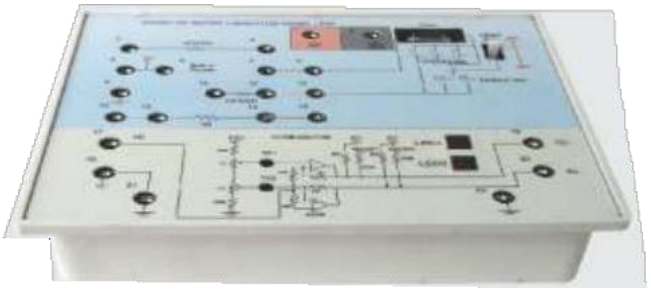
Cable Fault Locator Experiment Panel (P40)

[Provided with 49 banana tags & 8 BNC Sockets]

Panel consists of 7 step capacitor bank (100PF-100µF), wire wound pot - 25Ω & 100Ω, 10KΩ (10 turns) pot, BNC connectors (8 nos), RG58 cables 25m x 3nos. & 1.5m x 3nos.

Function blocks - AC to DC convertor for null detector, Sine generator (1KHz, 5Vp-p), Variable power supply (1.2 to **7**Vdc settable)**,**TDR , Needs +/-12Vdc external power supply.

Experiments covered: 1) Murray loop for ground fault and short circuit fault. 2) Varley loop for ground fault and short circuit fault. 3) Fisher loop for ground fault. 4) Open circuit fault by capacitance measurement. 5) To identify & localise cable fault by using TDR.(Time Domain Reflectometry)



Study of super capacitor panel (P41)

[Provided with 22 banana Sockets]

Panel consists of 5 numbers of one Faraday (1F/5V) super capacitors, can group them as 3F and 5F using DPDT switch, provided with charging/ discharging resistors & leak-age current sensor

Function blocks Measure charge and dis-charge time on DSO, onbard regulated supply to prevent over voltage to super capacitor. Needs +12VDC external power supply.

Experiments covered: 1) Measure charging and discharging time 2) Measure leakage current.

Crompton Potentiometer Calibration Panel (P42)

[Provided with 18 banana tags]

Panel consists of 20 step resistive bank (10Ex20), 25E wire wound pot, Fix resistor (10K), Variable current source (0-110mA) x 2 nos., Needs 2 external power supplies (12Vx 2nos), DMM or Galvanometer

Meters under test : Voltmeter (DMM), Ammeter (DMM)

Experiments covered: : 1] Calibration of voltmeter using Crompton potentiometer 2] Calibration of ammeter using Crompton potentiometer 3] Measure low resistance by Crompton potentiometer.

CONTROL TRAINER (Model : TMS - PID)

SALIENT FEATURES

- Learn how an Analog as well as Digital PID works.
- 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.
- Useful for Post Graduate projects and research purpose.
- Optionally SDK for Matlab & Labview provided.

Specification of Master Unit (MU)

Basic Resources on Top board

- **Built in power supply**

  DC supply ±12V,500mA.

  1phase sine reference for cosine firing 30Vpp max.

  17Vdc, 500mAunregulated 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 speed 2000 rpm & voltage upto 20V.

  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 (WIN7/8/10) based PID controller (Optional)

- **Online monitoring / Data acquisition / PID Software :** on Installable (CD) works under XP, WIN7/8/10 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 & CH1 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 (0.1- 99.9), Derivative Time Td (0.1-99.9), Proportional Band Pb(1-999), Derivative Gain Kd(1-999), Set Value Rn (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/cm^2, µsi/cm, degree.
  - Supports experiments with advance process control scheme viz; Ratio, Cascade, feed forward with user selectable Aux PID, Ratio station & programmable FF transfer function calculator, selective and split control strategies, Multi DPM Screen.

- **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. PC/WINXP/7/8/10 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 IO module to interface 25 pin D connector on CIA panel to USB PC port enclosed in 25 Pin D shell using Type A to mini B cable.

- V to PWM function block : I/P -0-2.5V, O/P-1KHz PWM O/P ±9V.

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.
- Variable amplitude control 0 to +9V.

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 (3 No.), Integrator (3 No.), Transport Lag (1 No.), Summer (2 No.), Gain (1 No.), Inverter (2 No.) 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 dot.

5) Computer Interface panel / CIP

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

Process -I Temperature/Light

Optional Process Setup :

Process I	Temp/Light
Table Top assembly / accessaries	Process box containing 3 high wattage (60W) bulbs under aluminum plate as heater. Built in fan, lamp as disturbance generator.
Panel	TAP (CE2/EMT9)
Sensor	RTD for temp. control upto 100°C with built in CAL facility, Photodiode for light intensity control upto 2000lux.
Mechanical Dimension	280(L)x115(W)x160(H) Powder Coated Weight : 2Kg.

List of Experiments:

- PID tunning by Ziegler - Nichols
- Transfer function determination
- Operation under various P/I/D options.
- Open loop response to step input (transfer function determination)
- Close loop control with Analog PID
- Close loop control with Digital PID
- Close loop control with built in Proportional controller / lag compensator (PI controller)
  PID control with PWM O/P

Process -II High Temperature

Process II	High Temp.
Table Top assembly / accessaries	Electric Bunsen Burner (300W) with 50cc heating volume. (Works with DPID only as large transport lag)
Panel	TAP (CE2/EMT9)
Sensor	K type stainless tube encapsulated TC for temp control upto 550°C
Mech. Dimension / Wt.	200(L)x130(W)x270(H) Powder Coated Weight: 2Kg.

List of Experiments

- PID tunning by Ziegler - Nichols
- Transfer function determination
- Operation under various P/I/D options.
- Open loop response to step I/P transfer function determination)
- Close loop control with Digital PID
- Close loop control with set point change
- Close loop control with process disturbance

Process III : DC Servo Position Control

Process III	DC Servo Position Control
Table Top assembly / accessaries	• 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 built in 12V/3A power supply.
Panel	SIP (CE3)
Sensor	• Photo reflective speed sensor with direction detect using 2 pairs of photo emitter detector giving Quadrature o/p's • Servo pot as position feedback
Mechanical Dimension /Wt.	365(L)X220(W)X95(H)mm / 10Kg

List of Experiments

- PID tunning by Ziegler Nichols Motor Process parameter study torque speed (optional) Dynamics measurements & transfer function determination.
- Close loop position control using 2/3 step controller.
- Close loop using 2/3 step controller with simulated processes.
- Open loop speed control of DC servo motor process III.
- Speed/Velocity control of DC motor
- Close loop control with analog pid
- Close loop control with digital PID
- Position control of DC motor
- Cascade control of speed & position feedback

Process IV : AC Servo Position Control

Process IV	AC Servo Position Control
Table Top assembly /accessories	• 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.
Panel	SIP (CE3)
Sensor	Servo pot as position feedback
Mechanical Dimension / Wt.	365(L)X220(W)X95(H) mm / 8 kg.

List of Experiments

- PID tunning by Ziegler Nichols Motor Process parameter study torque speed (optional) Dynamics measurements & transfer function determination.
- Close loop position control using 2/3 step controller.
- Close loop using 2/3 step controller with simulated processes.
- Working with real life process IV. (AC servo motor position control)
- Position control of AC motor
- Open loop Response and determination transfer function.
- Torque-Speed Characteristics Of AC Servo Motor Close loop control of AC SERVO Motor (optional)
- Set Point Position Control of AC Motor

Process V : Stepper Motor

Process V	Stepper Motor
Table Top assembly / accessaries	Stepper (3kgcm/12V) Coupled to servo pot.
Panel	P25
Sensor feedback	Servo pot as position
Mech. Dimension (mm) /Wt.	220(L) x 100(W) x 92(H) Powder Coated / 2Kg.

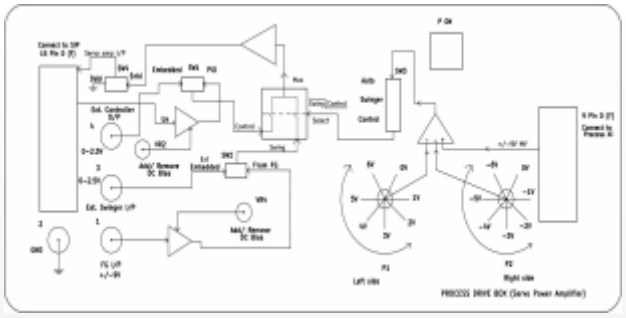
List of Experiments

1) Study of Stepper motor behaviour underopen loop / closed loop
2) Open loop stepper control under Manual/Auto modes
3) Closed loop stepper motor control using PID Controller

Process IX : AC Voltage Servo Stabilizer

Process IX	AC Voltage Servo Stabilizer
Table Top / 240VAC 100mA assembly/ accessaries	• AC synchronous 2 Phase Motor 60 rpm, 2 kgcm Torque. • Variac 0-270VAC/0.75Amp.
Panel	CIP
Sensor	PT (270 VAC Prim. /12 VAC 100mA Sec.) followed by Precision Rectifier O/P 0-2.5V DC
Mechanical Dimension/Wt.	365(L) X 220 (W) X 95 (H) mm/ 8 kg.
List of expt.	• Study of AC Servo stabilizer • Working with real life process IX (Servo Voltage Stabilizer) • Close loop and open loop behaviour of voltage stabilizer

Process XI : Inverted Pendulum



Process XI	Inverted Pendulum
Process XI setup	Table top assembly containing DC Servo motor 24VDC/1.3A, 1600 RPM, 12N/cm, 20W, mounted on alluminium profile (30 x 30) table with 10K servo pot as F/B, 300mm long pendulum with 18 dia MS sphere, round track PCB slip rings with 3 graphite brushes.
Process Drive Box	Containing servo amplifier with built in power supply 12V/3A. **Front Operator Panel :** Consisting of 15 pin D (F) connector to interface to SIP & 9 pin D(F) to connect to process XI, 4mm BS5 socket to apply swinger FG I/P from TMS-PID (MU), 3 position switch to select Auto/control/swinger mode, 2 pot knobs to set angular range for control. Optionally can interface with embedded controller using to 2 AOs (3.3V compatible), 1 AI for MV on SIP (3.3V compatible) for students project
Panel	SIP(LEJ) located in TMS-PID MU
Feedback Sensor	10K heavy duty Servo pot to indicate vertical standing position, O/P (+9-0- 9V)
Mech. Dimension/Wt.	Table : 200(L) x 200(W) x 350(H) (mm), Wt. of setup = 5Kg Drive Box: 365(L) x 220(W) x 95(H)mm Wt. : 8 kg

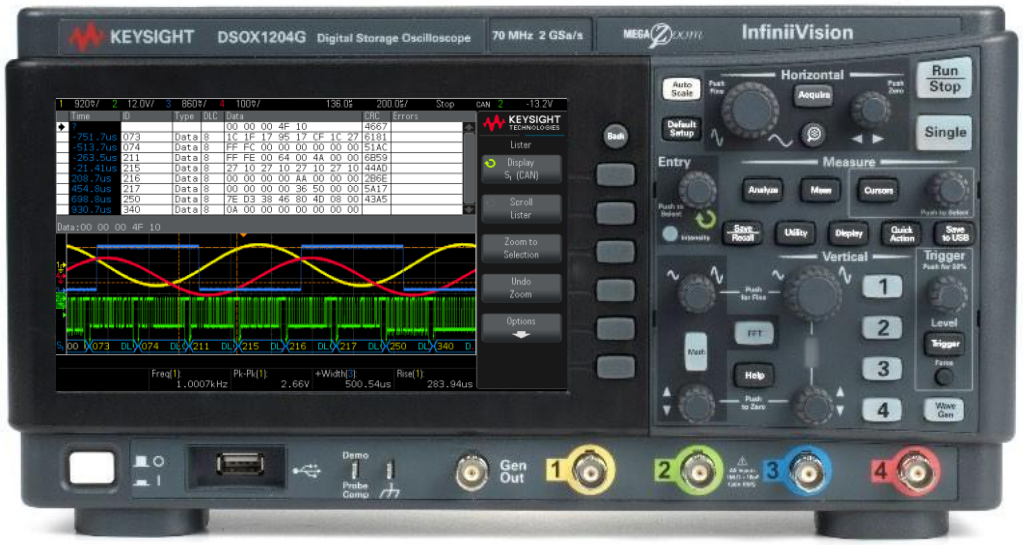
List of Experiments :

- Close loop upright position control of rotary inverted pendulum using 2/3 terms relay controller. Here PID software is used in process monitoring mode to plot
- Close loop upright position control of rotary inverted pendulum using Digital PID controller. Here PID software acts as controller as well as graph plotting device
- Close loop upright position control of rotary inverted pendulum using Op-amp based proportional controller (gain of 100 hence can be termed as ON/OFF too). Here Virtual workbench / PID software is used for plotting graph.
- Close loop upright position control of rotary inverted pendulum using Op-amp based controller & 2/3 term relay control.

DATA SHEET

InfiniiVision 1000 X-Series Oscilloscopes

2-channel and 4-channnel models with 50 MHz to 200 MHz bandwidth



KEYSIGHT TECHNOLOGIES

Leading Technology in a Value-Priced Oscilloscope (DSOX models)

Keysight's InfiniiVision 1000 X-Series oscilloscopes are engineered to give you quality, industry-proven technology at unbelievably low prices. Now it's easy to get professional measurements and accessible expertise at your fingertips. Don't settle for less – and test to impress.

- 70 to 200 MHz bandwidth (DSOX models)
- Frequency response analysis (Bode gain & phase plots), included in models with WaveGen
- See more signal detail with 200,000 waveforms/sec update rate
- Have confidence in your measurements with Keysight-custom technology that leverages more than 60 years of oscilloscope expertise
- Test quickly and easily with a simple, intuitive user-interface and built-in help and training signals
- Get professional-level functionality with industry-leading software analysis including standard serial bus analysis for the most popular serial bus standards, and 6-in-1 instrument integration

	DSOX1202A 2 channels	DSOX1202G 2 channels with function generator	DSOX1204A 4 channels	DSOX1204G 4 channels with function generator
Bandwidth	70 MHz (base bandwidth) 100 MHz (D1202BW1A) 200 MHz (D1202BW2A)		70 MHz (base bandwidth) 100 MHz (D1200BW1A) 200 MHz (D1200BW2A)	
Analog channels	2		4	
External trigger	Front panel input (Displayable as a 3rd digital channel)		Back panel input (not displayed)	
Sample rate per channel (max)	2 GSa/s (one- or two-channel operation) 1 GSa/s (if external trigger view is turned on)		2 GSa/s (one- or half-channel[1] operation) 1 GSa/s (three- or four-channel operation)	
Memory depth per channel (max)	2 M points (one- or two-channel operation) 1 M points (if external trigger view is turned on)		2 M points (one- or half-channel[1] operation) 1 M points (three- or four-channel operation)	
WaveGen	Not available	20-MHz function generator	Not available	20-MHz function generator
Bode plot	Not available	Standard	Not available	Standard
Waveform update rate	200,000 waveforms per second			
Serial protocol analysis	Standard : I²C, SPI, UART/RS-232, CAN, LIN			
Segmented memory	Standard			
Mask/limit testing	Standard			
Built-in training signals	Standard			
Integrated digital voltmeter	Standard			
Frequency counter	Standard			
Waveform math	Add, subtract, multiply, divide, FFT (magnitude and phase), low pass filter			
Automatic measurements	14 amplitude, 14 timing, and 4 pulse count measurements			
Display	7-inch TFT LCD WVGA			
Connectivity	USB 2.0 (host and device), LAN			

1. Half-channel operation on a 4-channel model refers to two-channel operation when using channel-1 or channel-2 AND channel-3 or channel-4. Example: If viewing just channel-1 and channel-3, maximum sample rate is 2 GSa/s and maximum memory is 2 M points. But if viewing channel-1 and channel-2, maximum sample rate is 1 GSa/s and maximum memory is 1 M points.

Leading Technology in a Value-Priced Oscilloscope (EDUX models)

EDUX1052A and EDUX1052G

Provide a quality education for students and prepare them for industry with professional level instruments. The 1000 X-Series leverages the same technology as our higher-end oscilloscopes, allowing students to learn on the same hardware and software being used in leading R&D labs. Don't settle for less – set your students up for success.

- Built-in training signals that enable students to quickly learn to capture and analyze signals.
- The educator's resource kit includes dynamic teaching labs; a comprehensive lab guide; a tutorial written specifically for undergraduate students; and an oscilloscope fundamentals PowerPoint slide set for professors and lab assistants.
- IoT systems design applied courseware. The 1000 X-Series oscilloscope can be used with the U3800A Internet of Things(IoT) Systems Design Applied Courseware.
- Bode plots are fundamental concepts. The 1000 X-Series' frequency response analyzer capability is the perfect tool to help students understand the gain and phase performance of passive RLC circuits or active op-amps (available in "G" model only).
- Optional DSOXBODE Bode plot training kit available. See page 8 for additional details.
- BenchVue Software with the BV0004B BenchVue Oscilloscope app (standard) lets you control and visualize the 1000X-Series and multiple measurements simultaneously.

	EDUX1052A 2 channels	EDUX1052G 2 channels with function generator
Bandwidth	50 MHz	
Analog channels	2 + 1 (ext. trigger viewable as digital channel)	
External trigger (or 3rd digital channel)	1	
Maximum sample rate	1 GSa/s (all channels)	
Maximum memory depth	200,000 points (all channels)	
Waveform update rate	100,000 waveforms per second	
WaveGen	Not available	20-MHz function generator
Bode plot	Not available	Standard
Serial protocol analysis	Standard: I²C, UART/RS-232	
Integrated digital voltmeter	Standard	
Frequency counter	Standard	
Built-in training signals	Standard	
Waveform math	Add, subtract, multiply, divide, FFT (magnitude and phase), low pass filter	
Automatic measurements	14 amplitude, 14 timing, and 4 pulse count measurements	
Display	7-inch TFT LCD WVGA	
Connectivity	USB 2.0 (host and device), LAN	