Government of Maharashtra

Directorate of Vocational Education and Training

Craftsman Training Scheme

SPECIFICATION FOR ELECTRICAL - ELECTRONICS TRAINER

Version 4, 2024

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An integrated workbench consisting of instrument panel and working table should suitable for students to learn and perform various experiments of electronics and electrical related subjects. Instruments should internally electrically connected and should be fitted in the panel such that only front panel and necessary interfaces are easily accessible to use. Structure of workbench should be made up of 1.5 mm thick CRC powder coated pipes with top made up of good quality 19 mm thick plywood and covered with 1.8 mm off white colour mica. The bench working area should be covered by 2 mm thick antistatic mat which help students to controls static discharge as static cause interference or damage to students, equipment and circuitry. There should be demonstration / training at consignee end on how to use Workbench and utilization of this bench for various applications.

1.3 Structure and design of Workbench should follow the below specifications:

- 1.3.1 The basic structure should be made of 38 X 38 X 1.5 mm CRC powder coated pipes for sturdiness.
- 1.3.2 The overall dimensions of Workbench should be not less than Width = 1200 mm; Depth = 750 mm; Height = 1150 mm
- 1.3.3 MS drawers 03 numbers:
  Width = 275 mm; Depth = 375 mm; Height = 100 mm and Thickness = 1.2mm with handle and separate lock on each drawer should be provided
- 1.3.4 For the panel section, raised back height of 1200mm from floor with matching height support from the side at a depth 500mm for instrument housing with a MS Panel strip below it for housing Electrical Sockets and Switches for external use.
- 1.3.5 Two Pole MCB (32A - Havells / Siemens) to be provided for safety of Workbench
- 1.3.6 There should be provision to mount main / mother training and development platform on front panel along with the instruments for easy performing the experiments which should provide visibility for the students working in a group.
- 1.3.7 Workbench should work on Mains Supply - 240 V AC, 50 Hz

1.4 Technical specifications of instruments and facility to be installed on the Workbench should be as under:

1.4.1 70 MHz Four Channel Digital Storage Oscilloscope
1.4.2 10 MHz Function Generator with Counter (DDS Technology)
1.4.3 Dual DC Programmable Power Supply, 2 X 30 V, 2 A
1.4.4 Temperature controlled Soldering and De soldering station with soldering iron and de soldering gun
1.4.5 Multimeter cum LCR Meter
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1.4.7 Induction Coil
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1.4.9 Various Meter assembly - Analog voltmeter, ammeter, wattmeter, multifunction meter, energy meter, power factory meter, frequency meter and flux meter
1.4.10 A set of training platform with experimental boards to cover experiments mentioned

1.5 50 MHz Digital Storage Oscilloscope:
50 MHz, 4 analog Channel Digital Storage Oscilloscope should have 1 GSa / s sampling and minimum 12 Mpts Memory Depth, Vertical range 1 mV / div -10V / div, Horizontal range 5ns / div to 50 s / div, PC interface USB Host and Device, LAN, Aux Output (Trig Output / passfail), it should also have automatic measurements and Frequency counter, advance and multi triggering like edge, slope, pulse, video, pattern facilities, 7 inches WVGA TFT Display.

1.6 10 MHz Function Generator with Frequency Counter (DDS Technology):
Direct Digital Synthesis based waveform generation technique, 3.5 Inch TFT True Color LCD, 10 MHz Sine, 4 MHz Square and 350 Khz Pulse, Ramp, Triangle and Arbitrary waveforms 5 MHz, Noise, and DC waveforms, More than 25 Arbitrary waveforms, 10 Bits, 100 MSa/s, 4 K points arbitrary waves, AM, FM and FSK modulation types, Sweep and Burst / ASK operation, 10 mVpp to 20 Vpp amplitude range, graphical interface for user to create and generate custom waveforms, display of many parameters on same screen, time mark generation, 50 MHz External Frequency Counter, serial interface.

1.7 30 V - 2 A Dual output DC Programmable Power Supply:
Dual DC 0-30 V, 0-2 A Power Supply with color LCD for Voltage and Current, Step increment for Voltage - Keypad, Cursor and Encoder for setting, Constant Voltage and Constant Current Source, Resolution Voltage 100 mV, Current 10 mA, Load and Line Regulation with standard parameter, indication of Over load, over voltage, over current and short circuit by beeper, Front panel control through state of art technology using microcontroller.

1.8 Soldering / De soldering Station:
60 W Microcontroller based Temperature Controlled Soldering and De soldering Station with Set / Read of temperature with separate display for soldering and disordering, Menu keys to set temperature, Digital calibration to avoid analog components tolerances, Burn proof silicon cable with thermal resistance up to 600° C, Blower with 12V DC SMD Iron, de soldering pump diaphragm type, Input voltage for soldering and de soldering 170 to 270 V, temperature range for soldering 180 to 270°C and for de soldering 180° to 480°C. SMD Iron to solder and de solder SMD components.

1.9 Digital Multimeter cum LCR Meter:

Large 1999 Counts LCD Display 3 ½ Digital Multimeter with LCR Tests AC / DC Voltage and Current, Resistance, auto ranging Frequency and Capacitance, Transistor (hFE) Check, duty cycle, Diode and Continuity measurement Data Hold and Display Back Light Safety DC voltage range 200 mV to 1000 V, DC current Range 20 mA to 10 A, AC Voltage 200 mV to 750 V, AC Current 20 mA to 10 A, Resistance 200 Ohm to 2000 M Ohm, Frequency 2 KHz - 15 MHz, Capacitance 2 nF to 200 microF, Inductance 2 mH to 20 H, Diode Test 1.0 mA ± 0.6 mA 3 Vmax, Duty Cycle Range 10% to 90%

1.10 1KVA Single Phase Transformer

- 1.10.1 Rating: 1KVA
- 1.10.2 Primary Voltage: 0-125V, 0-125V
- 1.10.3 Secondary Voltage: 0-125V, 0-125V with multi taping arrangement
- 1.10.4 Flexibility to configure step-up, step-down and Isolation Transformer.
- 1.10.5 Load Test and correspondingly determine the Efficiency and Voltage Regulation in a Single Phase Transformer
- 1.10.6 Study of Transformer
  - 1.10.6.1 Study of Transformation Ratio in a Single Phase Transformer
  - 1.10.6.2 Study of Polarity Test in a Single Phase Transformer
  - 1.10.6.3 Study of Open Circuit Test in a Single Phase Transformer
  - 1.10.6.4 Study of Short Circuit Test in a Single Phase Transformer

1.11 Inductor Coil:

3 Nos to Study Power Factor through inductive coil 0.8 mH, 500 mA, Input 240 v AC

1.12 Dimmer stat and Rheostat:

Single phase close type 10 A Dimmer stat with output range is 0-270 V AC and operating range is 240 V AC**,** Sliding type 220 Ohm, 2.8 A Rheostat with insulated wire copper carbon brush sliding contacts

1.13 Various Meter Assembly:

- 1.13.1 Digital Panel Meter:
  - 1.13.1.1 Should be Microcontroller based, reliable and accurate designed with 3.5 Digit Seven Segment Display in following ranges:
  - 1.13.1.2 AC Voltmeter - Voltage (02 Nos): 0 - 500V
  - 1.13.1.3 DC Voltmeter - Voltage (02 Nos): 0 - 300V
  - 1.13.1.4 AC Ammeter - Current (02 Nos): 0 - 10A
  - 1.13.1.5 DC Ammeter - Current (02 Nos): 0 - 10A

1.14 Analog Meters (1 each):

Analog voltmeter DC (0-10 V), (0-1 V) and Analog Ammeter (0 -1 A), (0-500 mA)

1.15 Single Phase Wattmeter:

Microcontroller based Accurate and Reliable design, 4 - Digit Seven Segment Display Input voltage 0-250 V AC, Input Current: 0 - 5A AC, Watt : 10-1500 W

1.16 Single Phase Multifunction Meter:

Single phase multifunction meter to measure seven different parameters like Voltage: 10 - 240 Vrms, Current: 0.2 - 5 Arms, Active Power: 10-1200 Watt, Apparent Power: 10-1200 VA, Reactive Power: 10-1200 VAR, Frequency 45-55 Hz, Power Factor 0.50L - 0.50C with display on seven segment.

1.17 Digital Energy Meter:

Microcontroller based Accurate and Reliable design, CT is used as current transducer for better accuracy, 4-Digit High brightness Seven Segment Display.

1.18 Power Factor Meter:

Microcontroller based Accurate and Reliable design, 4-Digit High brightness Seven Segment Display, Frequency Accuracy 45 - 55 Hz.

1.19 Frequency Meter:

Accurate and reliable direct reading design, 4 Digit High brightness seven segment display, directly reads mains line frequency between 45 to 55 Hz

1.20 Flux Meter:
Type: Digital 4 digit seven segment display; range: 0.1 to 10 Kilo Gauss; sensor probe with a protective cover; Mains operated.

1.21 A set of training platform with experiment boards to cover experiments mentioned:
The training platform should have functional blocks indicated on mimic, on board DC and AC power supplies, Function Generator 1Hz to 100KHz in 06 decades Sine / Square/ Triangle waveforms and variable amplitude upto 5V, on board 16 bit data switches and 16 bit LED display, on board Speaker, and Potentiometers, BCD to Seven segment display and pulsar switch (push to on). The training platform must have on board 2 channel of voltage measurement v1, v2 (0-15v), 2 channel of current measurement I1, I2 (0-100 ma), both channel reading must be display on 16X2 LCD.
All experiment boards / modules and should have internally mounted active and passive components, test points, facility to measure signal and waveform at various stages in the circuit, block diagram of the circuit should be printed on mimic, should have an option to work with build in or external power supplies given with other instruments and with main training platform / workbench. The main training platform should have minimum size of 300mm X250mm and the experiment modules / boards should have minimum size of 125mm X 170mm.The complete solutions should comprise with following experimental boards:

1.21.1 Verification of Kirchhoff's Current Law and Voltage Law
1.21.2 Study of V-I characteristics of Silicon Diode, Zener Diode, Light Emitting Diode (LED)
1.21.3 CB, CE, CC configuration of PNP / NPN Transistor and to evaluate Input resistance, Output resistance and Current gain
1.21.4 Study the characteristics of MOSFET, JFET, UJT, DIAC, TRIAC, SCR, IGBT, PUT
1.21.5 SCR triggering circuits, triggering techniques of SCR, Triggering of SCR using UJT, using IC 555 and using IC 74121, application of SCR as a lamp flasher, SCR Alarm Circuit
1.21.6 Study of Half-Wave Rectifier, Full-wave Center-tapped Rectifier, Full-wave Bridge Rectifier
1.21.7 Study of Zener Diode as a Voltage Regulator, with line and load regulation, Transistor Series Voltage Regulator, Transistor Shunt Voltage Regulator,
1.21.8 Study of Clipper (Positive / Negative, Series / Shunt) and Clamper Circuits
1.21.9 Study of design and functioning of Hartley Oscillator, Colpitt Oscillator, Wein Bridge Oscillator, Voltage Controlled Oscillator, Phase shift Oscillator
1.21.10 To study the IC 555 as a MoNostable (One-Shot) Multivibrator, Astable (Free-Running) Multivibrator, Bistable Multivibrator
1.21.11 Study of Series and Parallel R-L-C Resonance
1.21.12 Study of single stage and multi stage RC-Coupled amplifier
1.21.13 Study of Logic gates AND, OR, NOT, NAND, NOR, XOR, XNOR and to verify its truth table
1.21.14 Design of Logic gates using Universal gates NAND / NOR.
1.21.15 Methods of generating EX - OR function, Application of Ex-OR gate; Parity Generator
1.21.16 To verify De-Morgan’s theorem
1.21.17 Study of Binary Half Adder, Full Adder, Half Subtractor
1.21.18 Study of S-R Flip-Flop, J-K Flip-Flop, D Flip-Flop, T Flip-Flop and to verify its Transition table
1.21.19 Study of 4-to-1 Line Multiplexer and 1-to-4 Line De-Multiplexer

1.22 Standard Accessories:

1.22.1 Operating manual of complete workbench installed in PC

1.22.2 4 no. 1 X 10 Switchable probe 50 MHz (with 10X), USB to Host cable, power cord

1.22.3 BNC to BNC cable 01 no, BNC to test probe 01 No, DMM cord one set, 2mm to 2mm patch cords 10 Nos, connecting patch cords, antistatic mat, soldering / de soldering stand, wrist band, power cord.

1.23 Space Requirement for Installation:

1.23.1 Overall Length: 1200 mm

1.23.2 Overall Width: 750 mm

1.23.3 Overall Height: 1150 mm

1.23.4 Net Weight: 200 Kg (Approx.)

1.24 Electric Supply Specification: 240V AC 50 HZ

2 Electronics Work Bench

2.1 Basic Indicative Diagram

2.2 Basic Item Specification:
An integrated workbench consisting of instrument panel and working table should suitable for students to learn and perform various experiments of electronics and electrical related subjects. Instruments should internally electrically connected and should be fitted in the panel such that only front panel and necessary interfaces are easily accessible to use. Structure of workbench should be made up of 1.5 mm thick CRC powder coated pipes with top made up of good quality 19 mm thick plywood and covered with 1.8 mm off white colour mica. The bench working area should be covered by 2 mm thick antistatic mat which help students to controls static discharge as static cause interference or damage to students, equipment and circuitry. There should be demonstration / training at consignee end on how to use Workbench and utilization of this bench for various applications.

2.3 Structure and design of Workbench should follow the below specifications:

- 2.3.1 The basic structure should be made of 38 X 38 X 1.5 mm CRC powder coated pipes for sturdiness.
- 2.3.2 The overall dimensions of Workbench should be not less than Width = 1200 mm; Depth = 750 mm; Height = 1150 mm
- 2.3.3 MS drawers 03 numbers:
  Width = 275 mm; Depth = 375 mm; Height = 100 mm and Thickness = 1.2mm with handle and separate lock on each drawer should be provided
- 2.3.4 For the panel section, raised back height of 1200 mm from floor with matching height support from the side at a depth 500 mm for instrument housing with a MS Panel strip below it for housing Electrical Sockets and Switches for external use.
- 2.3.5 Two Pole MCB (32A - Havells / Siemens) to be provided for safety of Workbench
- 2.3.6 Display of computer should be fitted in front panel for easy viewing and separate tray to keep keyboard and mouse.
- 2.3.7 Workbench should work on Mains Supply - 240 V AC, 50 Hz

2.4 Technical specifications of instruments and facility to be installed on the Workbench should be as under:

- 2.4.1 50 MHz Four Channel Digital Storage Oscilloscope

2.4.2 10 MHz Function Generator with Counter (DDS Technology)
2.4.3 Dual DC Programmable Power Supply, 2X30 V, 2 A
2.4.4 Multimeter cum LCR Meter
2.4.5 Temperature controlled Soldering and De Soldering station with soldering iron and de soldering gun
2.4.6 Dimmerstat and Rheostat
2.4.7 A set of training platform with experimental boards on Analog, Digital and Power Electronics
2.4.8 Analog Voltmeter and Ammeter
2.4.9 Single unit PC loaded with Electronic circuit design and simulation software.

2.5 50 MHz Digital Storage Oscilloscope:
50 MHz 4 analog Channel Digital Storage Oscilloscope should have 1GSa / s sampling and minimum 12 Mpts Memory Depth, Vertical range 1 mV / div -10 V / div, Horizontal range 5ns / div to 50 s / div, PC interface USB Host and Device, LAN, Aux Output (Trig Output / passfail), it should also have automatic measurements and Frequency counter, advance and multi triggering like edge, slope, pulse, video, pattern facilities, 7 Inches WVGA TFT Display.

2.6 10 MHz Function Generator with Frequency Counter (DDS Technology):
Direct Digital Synthesis based waveform generation technique, 3.5 Inch TFT True Color LCD, 10 MHz Sine, 4 MHz Square and 350 Khz Pulse, Ramp, Triangle and Arbitrary waveforms 5 MHz, Noise, and DC waveforms, More than 25 Arbitrary waveforms, 10bits, 100MSa/s, 4K points arbitrary waves, AM, FM and FSK modulation types, Sweep and Burst / ASK operation, 10mVpp to 20Vpp amplitude range.

2.7 30V - 2A Dual output DC Programmable Power Supply:
Dual DC 0-30 V, 0-2A Power Supply with color LCD for Voltage and Current, Step increment for Voltage - Keypad, Cursor and Encoder for setting, Constant Voltage and Constant Current Source, Resolution Voltage 100 mV, Current 10mA, Load and Line Regulation with standard parameter, indication of Over load, over voltage, over current and short circuit by beeper, Front panel control through state of art technology using microcontroller.

2.8 Digital Multimeter cum LCR Meter:
Large 1999 Counts LCD Display 3 ½ Digital Multimeter with LCR Tests AC / DC Voltage and Current, Resistance, auto ranging Frequency and Capacitance, Transistor (hFE) Check, Duty Cycle, Diode and Continuity measurement Data Hold and Display Back Light Safety DC Voltage Range 200 mV to 1000 V, DC Current Range 20 mA to 10 A, AC Voltage 200 mV to 750 V, AC current 20 mA to 10 A, Resistance 200 ohm to 2000 M ohm, Frequency 2KHz -15MHz, Capacitance 2nF to 200 microF, Inductance 2mH to 20H, Diode Test 1.0mA +_ 0.6 mA 3 Vmax, Duty Cycle Range 10% to 90%

2.9 Soldering / De soldering Station:
60W Microcontroller based Temperature Controlled Soldering and De soldering Station with Set / Read of temperature with separate display for soldering and disordering, Menu keys to set temperature, Digital calibration to avoid analog components tolerances, Burn proof silicon cable with thermal resistance up to 600°C, Blower with 12V DC SMD Iron, de soldering pump diaphragm type, Input voltage for soldering and de soldering 170 to 270 V, temperature range for soldering 180° to 270°C and for de soldering 180° to 480°C. SMD Iron to solder and de solder SMD components.

2.10 Dimmerstat and Rheostat:
Single phase close type 5A Dimmerstat with output range is 0-270 V AC and operating range is 240V AC.

Sliding type 300 Ohm, 0.8 A Rheostat with insulated wire copper carbon brush sliding contacts. Sliding type 220 Ohm, 2.8 A Rheostat with insulated wire copper carbon brush sliding contacts. Sliding type 110 Ohm, 5A Rheostat with insulated wire copper carbon brush sliding contacts

2.11 A set of training platform with experiment boards on Analog, Digital and Power Electronics:

The training platform should have functional blocks indicated on mimic, on board DC and AC Power Supplies, Function Generator 1 Hz to 100KHz in 06 Decades Sine / Square / Triangle Waveforms and Variable Amplitude upto 5V, on board 16 Bit Data switches and 16 Bit LED display, on board Speaker, and Potentiometers, BCD to Seven segment display and pulsar switch (push to on). The training platform must have on board 2 channel of voltage measurement V1, V2 (0-15 V), 2 channel of current measurement I1, I2 (0-100 ma), both channel reading must be display on 16X2 LCD.

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2.11.6 Study of Half-wave Rectifier, Full-wave Center-tapped Rectifier, Full-wave Bridge Rectifier with Capacitor filter.

2.11.7 Study of Zener Diode as a Voltage Regulator with line and load regulation, Transistor Series Voltage Regulator, Transistor Shunt Voltage Regulator, 78xx, 79xx and Using IC 723 Regulator

2.11.8 Study of Clipper (Positive / Negative, Series / Shunt) and Clamper Circuits

2.11.9 Study of Active Low Pass Filter, High pass filter, Band Pass filter, Band Reject filter and to evaluate, Pass band gain and plot frequency response

2.11.10 Study of design and functioning of Hartley Oscillator, Colpitt Oscillator, Wein Bridge Oscillator, Voltage Controlled Oscillator, Phase shift Oscillator

2.11.11 To study the IC 555 as a Monostable (One-Shot) Multivibrator, Astable (Free-Running) Multivibrator, Bistable Multivibrator

2.11.12 Study of Series and Parallel R-L-C Resonance

2.11.13 Study of single stage and multi stage RC-Coupled amplifier, Darlington pair RC-Coupled Amplifier, Class B Amplifier, Transformer Coupled Amplifier,

2.11.14 Study of Operational Amplifier as Inverting Amplifier, Non - inverting Amplifier, Buffer, Comparator, Zero crossing detector, Schmitt Trigger, Adder, Subtractor, Square Wave Generator, Differentiator, Integrator, Logarithmic Amplifier, Voltage Controlled Current Source, Current Controlled Voltage Source, V to I and I to V converter

2.11.15 Study of Logic gates AND, OR, NOT, NAND, NOR, XOR, XNOR and to verify its truth table

2.11.16 Design of Logic gates using Universal gates NAND / NOR.
2.11.17 Methods of generating EX - OR function, Application of Ex-OR gate; Parity Generator
2.11.18 Binary to Gray, Gray to Binary conversion, and BCD to Excess-3
2.11.19 To verify De-Morgan's theorem
2.11.20 Study of Binary Half Adder, Full Adder, Half Subtractor
2.11.21 Study of S-R Flip-Flop, J-K Flip-Flop, D Flip-Flop, T Flip-Flop and to verify its Transition table
2.11.22 Study of 4-to-1 Line Multiplexer and 1-to-4 Line De-Multiplexer
2.11.23 Study of 4-bit synchronous binary up Counter, 4-bit asynchronous binary up/ down Counter and a modulo-N programable Counter (IC 74LS190)
2.11.24 Study of shift registers (SISO, SIPO, PISO, PIPO)
2.11.25 BCD to 7 segment Decoder Using IC 74LS47
2.11.26 Study of different Optical Transducers, Photoconductive Cell, Photovoltaic Cell, Phototransistor, PIN Photodiode its signal conditioning circuitry and transducer controlled switching

2.12 Analog meters (1 each):
Analog voltmeter DC (0-10 V), (0-1V) and Analog Ammeter (0 -1 A), (0-500 mA)

2.13 Single unit PC loaded with Electronic circuit simulation software:
2.13.1 The All-in-One PC should come with following configuration and loaded with single user licensed Content and programs: 24" Full HD with Intel Core i3, 4GB DDR, 1TB 7200RPM hard disk, wired keyboard and mouse, 720P HD camera, 1DVDRW, with Windows10 single user License Copy.
2.13.2 Electronic circuit simulation software with 1 user license:
2.13.2.1 Circuit Design and Simulation Software with PCB Design with Gerber and G Code Generation
2.13.2.2 3D View of PCB
2.13.2.3 Breadboard View
2.13.2.4 Fault Creation and Simulation
2.13.2.5 Program to understand design, analysis, simulation and PCB layout of analog, digital, MCU and mixed electronic circuits.
2.13.2.6 It should have library consisting of sufficient types of components, measuring instruments and virtual instruments. Analyze SMPS, RF, Communication, power electronics and optoelectronic circuits.
2.13.2.7 3D view of selected components on the schematic diagram with run time simulation, visualization of PCB design with enclosures in 3D.
2.13.2.8 The software should support the symbolic analysis.

2.14 Standard Accessories:
2.14.1 Operating manual of complete workbench installed in PC
2.14.2 4 No. 1 X 10 Switchable probe 50MHz (with 10X), USB to Host cable, power cord
2.14.3 BNC to BNC cable 01 No., BNC to test probe 01 No., DMM cord one set, 2mm to 2mm patch cords 10 Nos., connecting patch cords, antistatic mat, soldering/ de soldering stand, wrist band, power cord.

2.15 Space Requirement for Installation:
2.15.1 Overall Length: 1200 mm
2.15.2 Overall Width: 750 mm
2.15.3 Overall Height: 1150 mm
2.15.4 Net Weight: 200 Kg (Approx.)

2.16 Electric Supply Specification: 240V AC 50 HZ

3 Pneumatic and Hydraulic Actuators

3.1 Basic Indicative Diagram

3.2 Hydraulic Actuators

3.2.1 Floor standing powder coated MS Structure with castor wheels with locking system, on which cylinder, power pack and piping are mounted. Seamless piping should be used to make a circuit such that Double Acting Cylinder operation can be demonstrated using Direction control valve. Oil tank to be mounted under the table top. All hose pipes should be provided with quick change coupling.

3.2.2 All valves and cylinders should be of reputed make like Bosch Rexroth, Eaton, Hydec, Parker, Yuken etc.

3.2.3 Power pack Unit: 1 No.

- 3.2.3.1 Electric Motor: 0.5 HP, Single Phase, flange mounted
- 3.2.3.2 Pressure: 70 Bar (max)
- 3.2.3.3 Operating Pressure: 35 Bar
- 3.2.3.4 Tank: 10 liter capacity
- 3.2.3.5 Top mounted electrical motor design
- 3.2.3.6 Pressure relief valve, pressure gauge, level gauge
- 3.2.3.7 Hydraulic Oil
- 3.2.3.8 Gear Pump

3.2.4 Double Acting Cylinder: 2 No.

- 3.2.4.1 Bore: 40 mm X 18
- 3.2.4.2 Stroke: 100 mm
- 3.2.4.3 With mounting Bracket
- 3.2.4.4 1/4" BSP connection
- 3.2.4.5 Operating pressure: 30 Bar

3.2.5 Valve: 4/3 Hand-lever operated Valve, spring return centered with sub plate.

3.3 Pneumatic Actuators

3.3.1 Floor standing powder coated MS Structure on which cylinder, Pneumatic Compressor and with PVC piping Connected. PVC Piping should be used to make a circuit such that Double Acting Cylinder operation can be demonstrated using Direction control valve and Pressure Gauge Mounted.

3.3.2 All Valves and Cylinders should be of reputed make such as Bosch Rexroth, Festo, Janatics, SMC, Emerson etc.

3.4 Air Compressor Unit: 1 No.

3.4.1 10 Bar gage and shut off valve with 8 mm Brass male connector hose

3.4.2 Displacement:3 cfm or more

3.4.3 FRL unit

3.4.4 Working pressure: 7 Kg/cm^2 (7 Bar)

3.4.5 Electric Motor: 0.5HP or more, 1440 RPM, 230V, 50Hz, Single Phase

3.4.6 Safety Valve

3.4.7 Pressure Switch

3.4.8 Storage Tank: 35 to 50 liters

3.4.9 Pressure Gauge

3.4.10 Double Acting Cylinder: 2 No.

3.4.10.1 Bore: 32 mm

3.4.10.2 Stroke: 250 mm

3.4.10.3 With mounting Bracket

3.4.11 Valve

3.4.11.1 5/3 way directional control valve mid position closed, hand-lever operated

4 Hydraulic Training Work Bench

4.1 Basic Indicative Diagram

4.2 Use of anodized extruded aluminum profile (40 X 40 mm) table with shelves (3 Nos.) to store components when not in use Mounted on 4 Nos. of caster wheels for free movement. Work station with vertically mounted Frame unit (made of aluminum profiles).

4.2.1	Overall occupied Size (W X H X D):	1000 mm X 1300 mm X 800 mm
4.2.2	Working area Frame dimensions:	1000 mm X 700 mm
4.2.3	Working area grid:	50mm X 50 mm
4.2.4	Material:	SS, 5 mm Diameter

4.3 Oil Collection Tray: 2 Nos. + (01 no for hydraulic power pack of SS material)

4.4 Mounted on the horizontal plane of the work station, Made of Stainless Steel, 14 SWG with oil drain arrangement.

4.5 Quick release socket plug arrangement for building circuits, All hydraulic components are mounted using lever operated moulded adapters or hook-in type adapters for quick release and placement.

4.6 Industrial standard Valves and all components of reputed make like Bosch Rexroth, Eaton, Hydec, Parker, Yuken etc. should be used for the trainer kit.

4.7 All the components are fixed with QRC for easy and quick hydraulic connections.

4.8 All Quick Release Fittings used are with double check valve, ¼" BSP connection

4.9 Quick Release Male Adaptors as per the QRC required on the following components

4.10 Oil Distribution: Manifold: Sub plate (1 station manifold) with 4 ports: 2 Nos.

4.11 Pressure relief valve (sub plate mounted) with 40 Bar: 1 No.

4.12 Pressure relief valve (in-line type) with 40 Bar: 1 No.

4.13 Glycerine filled pressure gauge with facility to connect to A, B, P or T ports: 1 No.

4.14 Throttle cum check valve sub plate mounted: 1 No.

4.15 Throttle cum check valve in-line mounted: 1 No.

4.16 Direction Control Element:

- 4.16.1 4/2 way DC valve lever operated spring return, sub plate mounted: 2 Nos.
- 4.16.2 4/3 way DC valve, lever operated spring return, sub plate mounted: 1 No.
- 4.16.3 4/3 way DC valve lever operated detented, sub plate mounted: 1 No.
- 4.16.4 3/2 Stem actuated valve, sub plate mounted: 2 Nos.
- 4.16.5 4/2 way DC valve, 24VDC solenoid operated spring return: 1 No.
- 4.16.6 4/3 way DC valve, 24VDC, Spring Centered, Closed center, solenoid operated spring return: 1 No.
- 4.16.7 4/3 way DC valve, 24VDC, Spring Centered, Tandem Centre, solenoid operated spring return: 1 No.

4.17 Actuating Devices (Output)

- 4.17.1 Double acting cylinder 40mm X 150 mm stroke: 2 Nos.

4.17.2 Bi directional Hydraulic motor: 1 No.

4.18 Pressure control and Other Valves

4.18.1 Non Return Valve: 1 No.

4.18.2 Inline Type, Size ¼": 1 No

4.18.3 Non Return Valve: 1 No.

4.18.4 Sub-plate mounting type: 1 No

4.18.5 Pressure Sequence Valve, Max operating Pressure: 40 Bar, Sub-plate mounting type: 2 Nos.

4.18.6 Pressure Relief Valve, Max. Pressure 100 Bar, Knob/screw operated, Size: ¼", Inline type, with QRC, Vendor should be able to demonstrate the operation of this valve from 20 bar to 80 bar at different settings.

4.18.7 Pressure Reducing Valve, Max operating Pressure: 40 bar, Sub-plate mounting type: 2 Nos.

4.18.8 Flow divider Valve, Threaded body, Pressure compensated spool, 50:50 ratio, Inlet flow 10 lpm (max): 1 No.

4.19 Accessories

4.19.1 Weight + Protection Hood, 10 kg, to suit hydraulic cylinder: 1 No.

4.19.2 Accumulator: 1 No.

4.19.2.1 Should be of reputed Make like Bosch Rexroth, Eaton, Hydec, Parker, Yuken etc.

4.19.2.2 Diaphragm type, Capacity: 1 liter

4.19.2.3 Working pressure: 20 kg/cm2

4.19.2.4 Pre-charge pressure: 35 kg/cm2, Nitrogen gas, With Safety Block With valve and QRC

4.20 Connections

4.20.1 Flexible hoses, R1 type ¼" ID with Quick release sockets on both ends

4.20.2 Length 1000 mm: 8 Nos.

4.20.3 Length 1500 mm: 2 Nos.

4.20.4 T-Connector with one Female QRC socket and two male QRC plugs: 2 Nos.

4.21 Electrical Connection

4.21.1 Mains cord for 230 VAC

4.21.2 Solenoid Cables: 5 Nos.

4.22 Electronic Control Unit

4.22.1 Should comprise of 24 V DC power supply with current rating of minimum 4.5 Amps, Distributor for 24 V and GND (minimum 6 points each), 1 X toggle switch with 1 NO and 1 NC contacts, 3 X push button switch with 1 NO and 1 NC contacts, 2 X LED Indicators for connecting outputs of the circuit, 1 X buzzer for connecting outputs of the circuit, 5 X 3 change over relays, 1 X 1 change over relay, 1 X On delay timer with 1 NO and 1 NC contact, 1 X OFF delay timer with 1 NO and 1 NC contact.

4.23 Power Generation

4.23.1 Power pack (50 Bar) consist of

4.23.1.1 Variable Vane Pump with minimum 10 LPM

4.23.1.2 Relief valve

4.23.1.3 Electric Motor: 1.0 HP 1440 RPM 230VAC

4.23.1.4 Cast Aluminium Tank: 40 liters

4.23.1.5 Oil Breather

4.23.1.6 Oil level indicator

4.23.1.7 Suction filter / Strainer

4.23.2 Variable Vane Pump and Relief valve

4.24 Cut section components

The cut section of following components should be supplied. All the components should be sectioned out of actual industrial components.

4.24.1 4/3 Way lever Operated 3 position Valve,
4.24.2 4/3 Solenoid Operated NG06/ Cetop 3 valve
4.24.2.1 Closed Centered
4.24.2.2 Tandem Center
4.24.3 Non Return Valve
4.24.4 Pressure Relief Valve, sub plate mounted type with knob to set pressure
4.24.5 Shut off valve,
4.24.6 External Gear Pump
4.24.7 Diaphragm Accumulator: 1 liter
4.24.8 Flow control Valve
4.24.9 Line operated Check valve

4.25 List of Experiments
4.25.1 Study of Hydraulic Power Pack
4.25.2 Study of Pressure Relief valve
4.25.3 Study of Directional control valve
4.25.4 Study of D.A. Cylinder
4.25.5 Study of S.A. cylinder
4.25.6 Study of Meter in/out flow control
4.25.7 Study of Regenerative circuit
4.25.8 Study of Bleed of Circuit
4.25.9 Study of direct operated pressure relief valve

4.26 Training Material
4.26.1 Suitable Training Manual must be supplied

5 Pneumatic Training Work Bench

5.1 Basic Indicative Diagram

5.2 All valves and other components should be mounted on FRP/Plastic plate (of 80 mm X 130 mm size) fitted with plastic base (to avoid scratching on the Aluminum anodized work table) and with inbuilt button operated Push-to-lock/ unlock mechanism for easy clamping and unclamping with the work table

5.3 Should use actual new industrial standard valves and components like Air Distribution and Manual control, Control Element, Actuating devices, Logic Control, Flow control and Accessories should be of reputed make like Bosch Rexroth, Festo, SMC, Janatics, Emerson etc.

5.4 Profile plate: 1 No.

- 5.4.1 Work station with vertically mounted Frame unit (made of extruded aluminum profiles) with provision to work on both sides of the work station
- 5.4.2 Overall occupied Size (W X H X D): 800 mm X 1300 mm X 750 mm
- 5.4.3 Effective work area per side on the Frame unit: 800 mm X 700 mm
- 5.4.4 Profile groove width: 10.2 mm
- 5.4.5 Groove to groove distance: 20 mm
- 5.4.6 Material: Aluminium, anodized finish
- 5.4.7 Foot base: Wheel with locking arrangement

5.5 Air distribution and manual control

- 5.5.1 Flow and Pressure Regulator (FRL) unit with pressure gauge (10 bar), 1/4" 9BSP(F): 1 No.
- 5.5.2 Manifold 4 way, ¼" BSP (F) with 4 ball on/off valve: 1 No.
- 5.5.3 One-way flow control adjustable valve: 1 No.
- 5.5.4 Ball valve ¼" BSP for ON-OFF [M-F]: 1 No.
- 5.5.5 Silencer: 1 No.

5.6 Control Element

- 5.6.1 3/2 way directly actuated valve with push button, M5, 1/8 or 1/4 " BSP (F)
- 5.6.2 3/2 way single pilot valve, M5, 1/8 or ¼" BSP (F)
- 5.6.3 5/2 way valve with roller lever valve, M5, 1/8 or ¼" BSP (F)
- 5.6.4 5/2 way pilot operated spring return valve, M5, 1/8 or ¼" BSP (F)
- 5.6.5 5/3 way double pilot valve (with manual override), M5, 1/8 or ¼" BSP (F)
- 5.6.6 3/2 way roller lever valve, M5, 1/8 or ¼" BSP (F)

5.6.7 3/2 way directional control valve with 24V DC operated.
5.6.8 5/3 way directional control valve mid position closed, hand-lever operated
5.6.9 5/2 way directional control valve, hand-lever operated
5.6.10 5/2 way directional control valve with 24V DC operated, spring return

5.7 Actuating Devices (O/P)
5.7.1 Single acting cylinder - Bore 25 mm, Stroke 100mm: 1 No.
5.7.2 Double acting cylinder Bore 25 mm, Stroke 150mm: 1 No.
5.7.3 Pneumatic motor: The component should be an application of pneumatic motor in an industry, Maximum pressure - 10 Bar: 1 No.

5.8 Logic Control
5.8.1 OR gate / shuttle valve 1/8" BSP (F): 1 No.
5.8.2 AND gate 1/8" BSP (F): 1 No.

5.9 Flow Control
5.9.1 One way flow control valve, inline type: 2 Nos.
5.9.2 Non return valve, Brass/Aluminium body: 1 No.

5.10 Accessories.
5.10.1 Pneumatic Counter Balance Valve, The counterbalance valve will hold a load in position until pressure is applied to move the load, Turning the adjusting screw clockwise will increase the load carrying capacity of the valve, Pressure Range: 1 to 8 bar, Max. Pilot Pressure: 7 bar: 1 No.
5.10.2 Weight + Protection Hood, To suit double acting pneumatic cylinder, With weight, 5 Kg.: 1 No.
5.10.3 PU tube, Red Blue and Yellow colour, 20 meter each
5.10.4 T-Connector: 2 Nos.
5.10.5 Pneumatic Quick change couplers (one touch fittings) mounted on each pneumatic component. The fittings should be suitable for 4 mm/ suitable OD PU tube

5.11 Electrical connections
5.11.1 Mains cord with stackable connection

5.12 Air Compressor
5.12.1 Air Compressors Displacement: 3 cfm or more
5.12.2 Working Pressure: 7 kg/cm^2 (7 Bar)
5.12.3 Electric Motor: 0.5 HP or more, 1440 RPM, 230 V/ 50Hz, Single Phase
5.12.4 10 Bar gage and shut off valve with 8 mm Brass male connector hose
5.12.5 Safety Valve
5.12.6 Pressure Switch
5.12.7 Storage Tank: 35-50 liter

5.13 Cut section components
The cut section of following components should be supplied. All the components should be sectioned out of actual industrial components.
5.13.1 5/2 way Hand Lever Operated Valve
5.13.2 3/2 way Roller Lever Actuated Valve
5.13.3 5/2 way Solenoid Operated Spring Return
5.13.4 5/2 way Double pilot Valve
5.13.5 Quick Exhaust Valve
5.13.6 One-Way Flow Control Adjustable Valve
5.13.7 OR Function valve

5.14 List of Experiments
5.14.1 Working of Air filter, Lubricator and Regulator
5.14.2 Use of manifold block
5.14.3 Working of Single acting cylinder
5.14.4 Working of Double acting cylinder

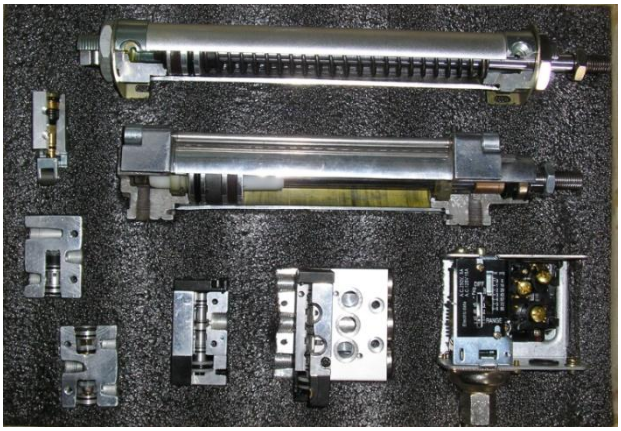
5.14.5 Working of 5/2 way valve
5.14.6 Working of 5/3 way mid position closed
5.14.7 Working of 5/2 way double pilot valve air operated with manual override
5.14.8 Working of one way flow control valve
5.14.9 Working of 5/2 way valve solenoid operated
5.14.10 Working of OR gate / Shuttle valve
5.14.11 Working of and gate
5.14.12 Working of counter balance circuit
5.14.13 Working of silencer
5.14.14 Working of Indirectly actuation of single acting single

5.15 Manual

5.15.1 Instructional Manuals and an Exercise Manual should be provided with each system. Detailed theory and practical exercises should be included in the Exercise Manual.

6 Cut Section Model - Pneumatic Valves

6.1 Basic Indicative Diagram

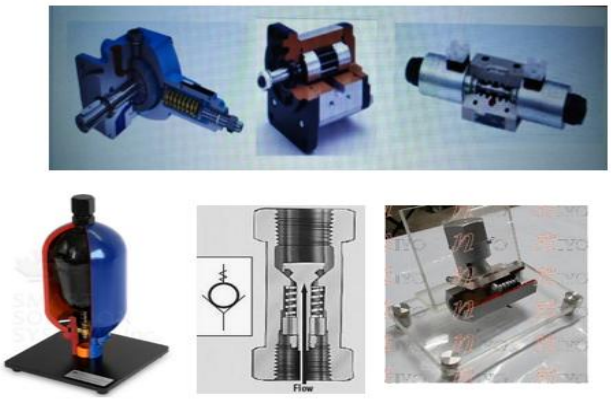


6.2 The cut section of following components should be supplied. All the components should be sectioned out of actual industrial components.

- 6.2.1 5/2 way Hand Lever Operated Valve
- 6.2.2 3/2 way Roller Lever Actuated Valve
- 6.2.3 5/2 way Solenoid Operated Spring Return
- 6.2.4 5/2 way Double pilot Valve
- 6.2.5 Quick Exhaust Valve
- 6.2.6 One-Way Flow Control Adjustable Valve
- 6.2.7 OR Function valve
- 6.2.8 FRL Unit
- 6.2.9 Single acting Cylinder
- 6.2.10 Double acting Cylinder
- 6.2.11 Quick change couplings

7 Cut Section Model - Hydraulic Valves

7.1 Basic Indicative Diagram



7.2 The cut section of following components should be supplied. All the components should be sectioned out of actual industrial components.

- 7.2.1 4/3 Way lever Operated 3 position Valve
- 7.2.2 4/3 Solenoid Operated NG06/ Cetop3 valve
- 7.2.3 Closed Centre
- 7.2.4 Tandem Center
- 7.2.5 Non-Return Valve
- 7.2.6 Pressure Relief Valve, sub plate mounted type with knob to set pressure
- 7.2.7 Shut off valve,
- 7.2.8 External Gear Pump
- 7.2.9 Diaphragm Accumulator (1 liter)
- 7.2.10 Flow control Valve
- 7.2.11 Line operated Check valve
- 7.2.12 Single acting Cylinder
- 7.2.13 Double acting Cylinder
- 7.2.14 Quick change couplings
- 7.2.15 Pressure gauge
- 7.2.16 Vane Pump

8 Calibration Test Bench for AC and DC Voltmeter, AC and DC Ammeter, Ohmmeter, Digital Type

8.1 Basic Indicative Diagram

8.2 Workbench

- 8.2.1 Frame of the workbench should be of cold rolled seamless 18G rectangle tube sections with rust preventive coat and powder coating
- 8.2.2 Caster wheel: 4 nos. (2 with lock), 2 (without lock) Size: 4”
- 8.2.3 MCB for ON/ OFF control and over load protection
- 8.2.4 Drawer for necessary cables and accessories storage
- 8.2.5 Should consists of Calibrator, Multimeter, Oscilloscope, Soldering and De-soldering Station.

8.3 4½ Multifunction Site Calibrator

- 8.3.1 Input Power Supply: 230 V AC, ±5% @ 50 Hz
- 8.3.2 Input Protection: Protected by I/P OV (Over Voltage) and I/P UV (Under Voltage)
- 8.3.3 Display: 4½ Digit 7 segment red LED display for Voltage and Current, 4 Digit 7 segment red LED display for Frequency
- 8.3.4 Operating Temperature: 15°C to 50°C
- 8.3.5 Power OFF Storage Temperature: 10°C to 70°C
- 8.3.6 Output Ranges
  - 8.3.6.1 DC Voltage: 200 mV, 2 V, 20 V, 200 V, 1000 V
  - 8.3.6.2 AC Voltage (45 Hz to 1 kHz): 200 mV, 2 V, 20 V, 200 V, 1000 V
  - 8.3.6.3 DC Current: 2 mA, 20 mA, 200 mA, 2 A, 10 A
  - 8.3.6.4 AC Current (45 Hz to 1kHz): 2 mA, 20 mA, 200 mA, 2 A, 10 A
  - 8.3.6.5 Frequency: 45 Hz to 1 kHz
  - 8.3.6.6 Fixed Resistance: 1 Ω, 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ, 100 MΩ
  - 8.3.6.7 Fixed Inductance: 10 µH, 100 µH, 1 mH, 10 mH, 100 mH
  - 8.3.6.8 Fixed Capacitance: 1 nF, 10 nF, 100 nF, 1 µF, 10 µF
  - 8.3.6.9 RPM (Non Contact Type): 2700 to 60, 000 RPM
- 8.3.7 Accuracy (@ 20°C to 28°C, RH<75%)

8.3.7.1 AC Voltage and Current: ±0.3% ±10 Digit
8.3.7.2 DC Voltage and Current: ±0.2% ±5 Digit
8.3.7.3 Frequency: ±0.1 Hz
8.3.7.4 Resistance: ±1%
8.3.7.5 Capacitance: ±5%
8.3.7.6 Inductance: ±5%
8.3.7.7 RPM (Non Contact Type): ±0.1%, ±5 digit

8.3.8 Features
8.3.8.1 Pure Sine wave with variable frequency
8.3.8.2 Input supply Under Voltage and Over Voltage Protection
8.3.8.3 Overload and short circuit protection
8.3.8.4 Setting by Decade switches for V/A in 4½ digit
8.3.8.5 Frequency setting by multi turn potentiometer
8.3.8.6 Selection of AC/DC parameter by toggle switch
8.3.8.7 Selection of ranges by rotary switch
8.3.8.8 Separate output ports used for V(Hi), mA(Hi), 10A(Hi) and Com
8.3.8.9 Separate output ports used for R / L / C

8.3.9 Should be able to calibrate the following equipment
8.3.9.1 Digital Multi Meters
8.3.9.2 Clamp Meters
8.3.9.3 Digital Panel Meters
8.3.9.4 Analog Panel Meters
8.3.9.5 LCR Meters
8.3.9.6 Non-Contact Type Tachometers

8.4 100 MHz Mixed Signal Oscilloscope (4 Analog + 16 Digital Channel)
100MHz 4 analog Channel and 16 digital channels oscilloscope, the oscilloscope should support 1GSa/s sampling for analog channel and 1GSa/s / 500MSa/s for digital channels, Memory Depth should be more than 20 Mpts, vertical rage 1mV/div -10V / div, horizontal range 5ns/div to 50 s/div. It should also have at least 26 nos automatic measurements and 6 bits hardware counter, advance serial bus trigger and decoding functions including RS232/UART, I2C and SPI, multi triggering facility, Math functions like A+B, A-B, A×B, A/B, FFT, A&&B, A||B, A^B, !A, Intg, Diff, Sqrt, Lg, Ln, Exp, Abs.7 inches WVGA TFT Display, Computer Interface USB host and device and LAN.

8.5 Multimeter:
8.5.1 Display: 6000 counts backlit LCD with 61 segment analog bar-graph
8.5.2 Auto-ranging: Yes
8.5.3 True RMS: Yes
8.5.4 Safety rating: CAT III 1000V, CAT IV 600V
8.5.5 Water/dust resistance: IP67
8.5.6 Battery: One 9 Volt (NEDA 1604) battery
8.5.7 Low battery indication: "+" icon displayed
8.5.8 Auto power-off: Yes
8.5.9 Operating temperature: 5°C to 40°C (41°F to 104°F)
8.5.10 Storage temperature: -20°C to 60°C (-4°F to 140°F)
8.5.11 Operating humidity: Max 80% up to 31°C, decreasing to 50% at 40°C
8.5.12 Storage humidity: <80%
8.5.13 Operating altitude: Up to 2000 meters (7000 ft)
8.5.14 DC Voltage
8.5.14.1 Ranges: 60.00mV, 600.0mV, 6.000V, 60.00V, 600.0V, 1000V
8.5.14.2 Resolution: 0.01mV to 1V
8.5.14.3 Accuracy: ±(0.5% + 5 digits) to ±(0.9% + 9 digits)
8.5.15 AC Voltage (45 Hz to 1 kHz)

8.5.15.1 Ranges: 60.00mV, 600.0mV, 6.000V, 60.00V, 600.0V, 1000V
8.5.15.2 Resolution: 0.01mV to 1V
8.5.15.3 Accuracy: ±(0.8% + 3 digits) to ±(0.9% + 9 digits)
8.5.15.4 Bandwidth: 45 Hz to 1 kHz (sine wave), 45 Hz to 60 Hz (all waves)

8.5.16 LoZ AC/ DC Voltage
8.5.16.1 Ranges: 6.000V, 60.00V, 600.0V
8.5.16.2 Resolution: 0.001V to 0.1V
8.5.16.3 Accuracy: ±(3.0% + 30 digits)
8.5.16.4 Input impedance: Approx. 3 kΩ

8.5.17 VFD (Variable Frequency Drive)
8.5.17.1 Range: 150.0 to 700V
8.5.17.2 Resolution: 0.1V/1V
8.5.17.3 Accuracy: ±(4% + 3 digits)

8.5.18 DC Current
8.5.18.1 Ranges: 600.0µA, 6000µA, 60.00mA, 600.0mA, 6.000A, 10.00A
8.5.18.2 Resolution: 0.1µA to 0.01A
8.5.18.3 Accuracy: ±(1.0% + 3 digits) to ±(1.5% + 3 digits)

8.5.19 AC Current (45 Hz to 1 kHz)
8.5.19.1 Ranges: 600.0µA, 6000µA, 60.00mA, 600.0mA, 6.000A, 10.00A
8.5.19.2 Resolution: 0.1µA to 0.01A
8.5.19.3 Accuracy: ±(1.5% + 3 digits) to ±(2.0% + 3 digits)

8.5.20 Resistance
8.5.20.1 Ranges: 600.0Ω, 6.000kΩ, 60.00kΩ, 600.0kΩ, 6.000MΩ, 60.00MΩ
8.5.20.2 Resolution: 0.1Ω to 0.01MΩ
8.5.20.3 Accuracy: ±(0.8% + 2 digits) to ±(1.2% + 2 digits)

8.5.21 Capacitance
8.5.21.1 Ranges: 99.99nF to 99.99mF
8.5.21.2 Resolution: 0.01nF to 0.01mF
8.5.21.3 Accuracy: ±(4.0% + 5 digits) to ±10% reading

8.5.22 Frequency
8.5.22.1 Electronic: 9.999Hz to 9.999MHz
8.5.22.2 Electrical: 10.00Hz to 1kHz
8.5.22.3 Resolution: 0.001Hz to 0.001MHz
8.5.22.4 Accuracy: ±(0.1% + 4 digits) for electronic, ±0.5% reading for electrical

8.5.23 Temperature (Type-K)
8.5.23.1 Range: -40°C to 1000°C (-40°F to 1832°F)
8.5.23.2 Resolution: 1°C/1°F
8.5.23.3 Accuracy: ±(3.0% + 3°C/5°F digits)

8.5.24 Additional Functions
8.5.24.1 Duty Cycle: 0.1% to 99.9%, ±(1.2% + 2 digits)
8.5.24.2 Diode Test: Yes
8.5.24.3 Continuity: Yes
8.5.24.4 Data Hold: Yes
8.5.24.5 Peak Hold: Yes
8.5.24.6 Relative Measurement: Yes

8.5.25 Protection
8.5.25.1 Input protection: Various limits for different functions, up to 1000V AC RMS/1000V DC
8.5.25.2 Surge protection: 8kV peak per IEC 61010
8.5.25.3 Fuses: 0.8A/1000V for mA/µA ranges, 10A/1000V for A range

8.6 SMD Soldering and Desoldering Station with accessories

8.6.1 Hot Air Blower: Qty 1 No.

8.6.1.1 Working Voltage: AC220-240V OR AC100-130V

8.6.1.2 Frequency: 50Hz/60Hz

8.6.1.3 Output Power: 750W

8.6.1.4 Temperature Range: 100°C~480°C

8.6.1.5 Blower speed : 1 To 10 Digitaly Controlled

8.6.1.6 Temperature Stability:±2℃

8.6.1.7 Air Flow: 150L/min (max)

8.6.2 Soldering Iron: Qty 1 No.

8.6.2.1 Working Voltage: AC220-240V OR AC100-130V

8.6.2.2 Output Power: 80W

8.6.2.3 Frequency: 50Hz/60Hz

8.6.2.4 Temperature Range: 180°C-500°C

8.6.2.5 Temperature Stability: ±1°C

8.6.2.6 Soldering Iron : ESD design

8.6.2.7 Heater Material : Ceramics

8.6.2.8 Black Ceramic Coated Deluxe Fine Needle Bit

8.6.3 Desoldering Pump: Qty 1 No.

8.6.3.1 Should be used to remove heated solder from a PCB

8.6.3.2 Material - High grade aluminium for light weight and airtight function

8.6.3.3 Mechanism should be a piston which sucks air and solder from the tip at the press of a button.

8.6.3.4 High temperature resistant teflon tip

8.6.4 Consumables

8.6.4.1 Square Sponge: Qty 2 Nos.

8.6.4.2 Solder Wire - 100 grams: Qty 4 Nos.

8.6.4.3 Soldering Flux Paste: Qty 4 Nos.

8.6.5 Accessories and spares

8.6.5.1 Tweezer Set: Qty 1 No.

- 6 various sizes and type of Tweezers
- Should be ESD safe and Non magnetic
- Material - Stainless steel
- Should be supplied with cutter

8.6.5.2 Blower Nozzle Set: Qty 2 Nos.

- Hot Air Blower's Nozzles
- Should be compatible with Hot Air Blower

9 Multifunction Process Work Bench (Flow, Level, Temperature and Pressure)

9.1 Basic Indicative Diagram.

9.2 Features

9.2.1 Trainer should be modular panels for easy site servicing not close control; panel box no wiring should not be there and shrouded 4 mm banana patch cords and shrouded sockets arrangements for the safety of the students.

9.2.2 Lightweight, yet sturdy, tabletop, Aluminium profile flat panel setup, with SS (304/316) piping for and wide angle view of every component in process.

9.2.3 Individual control loops as well as Advance control schemes like Ratio, Cascade, Feed forward, coupled tank made easy for student.

9.2.4 Connection through polarized, sturdy 4mm Banana sockets and Patch cords enabling quick setting up of variety of process control experiments.

9.2.5 Windows10 based PID controller software package with P, PI and PID control, Ratio and cascade control, three operating modes, Online graph drawing and data acquisition modes (SCADA).

9.3 Technical Specifications (Controller Section)

9.3.1 Computer Interface panel

9.3.1.1 4 ADC channels I/P: 0 to 2.5V FS with 1no input simulation pot. 1 DAC channel O/P 2.5V FS.

9.3.1.2 V to I function block: I/P 0 to 2.5V and O/P 0-20 or 4-20mA (100W load) switch settable.

9.3.1.3 I to V function block: I/P 4 to 20mA and O/P 0 - 2.5V

9.3.1.4 USB converter to interface connector on computer interface panel to USB using PIC18F microcontroller shell using Type A to mini B cable.

9.3.2 Power supply with Digital panel meter.

9.3.2.1 ±12V/500 mA, +5V/300mA, Unregulated 17V dc/750 mA, line synchronizing signal.

9.3.2.2 Multi channel Digital Panel Meter for digital display of process parameters.

9.3.2.3 20 pin FRC power bus to supply power to neighboring panels.

9.3.3 Thyristor Actuator cum signal conditioning panel

9.3.3.1 Thyristor bridge based 0-200V/3A using cosine firing circuit, Input 0 to 2.5Vdc.

9.3.3.2 Supports signal conditioning for RTD, Pressure sensor with Instrumentation Amplifier and flow sensor (water / air) with F to V converter to generate 0-2.5 V DC.

9.3.3.3 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.

9.3.4 PC (Windows 10) based digital PID controller

9.3.4.1 Online monitoring/ Data acquisition/ PID Software on Installable (Pen drive).

9.4 Operating modes

9.4.1 Simulator Mode: Tests data stored in files (*.txt) Draw graph for all P, PI, PD and PID modes.

9.4.2 Process Monitoring Mode: Draw graphs of analog data presented at Channel 0 and Channel 1 of Computer Interface Panel. Cursors for X and Y axis for measurement and online graphs saving for reproduction.

9.4.3 PID controller Mode:

9.4.3.1 PID controller with parameter like Integral Time Ti (0.01-64000), Sampling Time Ts (0.1-99.9), Derivative Time Td (0-99.9), 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).

9.4.3.2 Facility to set units for output viz. (%), RPM, V, mm, LPH, kg/cm², msi/cm, Degree. experiments with advance process control scheme viz; Ratio, Cascade, feedforward with Aux PID, Ratio station and FF transfer function calculator, Alarm setting, ON/OFF control, square root extractor for Orifice.

9.4.3.3 Function Generator: Sine/ Triangular/ Square wave generator with frequency 0.01 Hz to 1 Hz, Amplitude is 0 to 2.5 V i.e. 0 - 100%.

9.5 Advance control Experiment

9.5.1 Parameters: Pressure/ Temperature/Flow Model

9.5.2 Controlled Medium: Air for pressure / Flow, Water for temp. and air (air bubbler) for Cooling

9.5.3 Storage tank material/Capacity: 1 No., 10 litre plexiglass tank for water

9.5.4 Process tank capacity/material: 1 No. 5 liter, stainless steel tank with temp, pressure sensors attachment. Pressure relief valve (10 Bar)

9.5.5 Electronic sensor Type/ Output/ Range: Pressure: piezo-resistive pressure sensor 0 to 30PSI, O/P = 0 to 2.5V

9.5.6 Temp: PT100, O/P =0 to 2.5V, ambient to 1000C

9.5.7 Flow: Turbine flow sensor 1No. OP=0 to 2.5V, 0-150LPM

9.5.8 Control Valve: Pneumatically operated air to close, linear type, ½ " Size

9.5.9 Diaphragm operated, C=0.4 with I to P Converter I/P 4 to 20mA O/P 4 to20 mA O/P 3 to 15 psi.

9.5.10 SCR controlled full bridge (200Vdc) for 750 for temp. control Input 0 to 2.5Vdc.

9.5.11 Rotameter: 2 Nos. Acrylic body ½ " size 0 to 50LPM

9.5.12 Generation and Distribution Pump: 230VAC 10W submersible water pump with ¼" PVC pipe to fill in process vessel for temp. control expt.

9.5.13 Bourdon Gauges: 2 Nos. 0 to 2 bars, 2 Nos. 0 to 10 bar 0-1000C gauge thermometer

9.5.14 Manual SS valves: 1/4" size = 7 Nos.

9.5.15 Piping material/size: Stainless steel, 1/4" for air

9.5.16 Air filter and regulators OR accessories: 3 Nos, 0 to 10 bars size 1/4" Oil catcher (1/4" size max. pressure = 10 bars) - 1No.

9.5.17 Air compressor: 0 to 10 bars, 2 HP, 230VAC supply Tank Capacity: 110 liters.

9.5.18 Ratio: Between 2 water flows
9.5.19 Cascade: Inner (fast) loop flow. Outer loop temp.
9.5.20 Feed forward: Air Flow/ temp loop.

9.6 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 table top panel.

9.7 List of experiments:

9.7.1 Study of temperature control loop open loop response and close loop response with P, PI, PID
9.7.2 Study of pressure control loop open loop response and close loop response with P, PI, PID
9.7.3 Study of Air Flow control loop open loop response and close loop response with P, PI, PID
9.7.4 Study of ratio control loop
9.7.5 Study of cascade control loop
9.7.6 Study of ON-OFF control loop
9.7.7 Study of feed forward control loop
9.7.8 Study of control valve (Gain scheduler Hysterisis) V to I converter, I to P converter.

10 PLC and SCADA Trainer

10.1 Basic Indicative Diagram

10.2 Technical Specifications of interfacing panels

- 10.2.1 Electronic desk with ergonomically designed ABS Molded for safety of the students enclosure with replaceable experimental panel.
- 10.2.2 Simulation Extension Panels to provide input switches, push buttons, Output LED
- 10.2.3 Analog Input with potentiometer for Analog Input simulation and Bar graph for Analog Output simulation.
- 10.2.4 Connection through sturdy 4mm Banana sockets and Patch cords.
- 10.2.5 Student's workbook and Instructor's Guide should be provided.

10.3 CPU: Model S7-200/ equivalent

10.4 Digital Input: 24 Digital Input, 16 Digital Output

10.5 Analog Input

- 10.5.1 4 Analog Input, 2 Analog Output
- 10.5.2 Input range - +10V, Resolution- 10 bit

10.6 Software: STEP 7 - Micro WIN SMART support Ladder/ Function Blocks Diagram Programming and monitoring trouble shotting and instruction set, Simulation Software.

10.7 Com Ports: Ethernet Port (RJ45) for Ladder Programing, RS485

10.8 Converter cum Distribution Panel

- 10.8.1 Converts screw driver terminal strip of PLC into 4mm sockets total 16 nos.
- 10.8.2 Provided for Analog input panel located on top board.

10.9 Simulation cum Extension Panel:

- 10.9.1 Located on left side panel, consisting of 16 nos. of digital inputs. (8 slider switches + 8 push to ON switches, No. of 4mm banana sockets=16.
- 10.9.2 16 nos. of output LED indications, 4 nos. of relay panel with coil rating 24V and contact rating of 230VAC /5A, no. of 4mm banana sockets =20, shrouded sockets for relay contact = 8 nos.
- 10.9.3 4 nos. of simulation pots and 4 nos. of Analog Input, 2 nos. of analog outputs, Led bar graph of 10 leds for Analog Output simulation, settable range 5V/10V. with 4mm banana sockets.

10.10 Operating voltage

- 10.10.1 SMPS Power Supply with Power ON /OFF switch.
- 10.10.2 SMPS I/P: 110/20/230Vac + 10% 50/60 Hz, O/P: 24V / 2 A
- 10.10.3 6 Nos. of 4mm Banana Sockets (3nos. for +24V, 3nos. for common) for extension provided.

10.11 Static Application Panels

- 10.11.1 Common Base Board consisting of 54 LEDs, with 10 LEDs for Bar Graph for Analog Output. No. of 4mm banana sockets = 32

10.11.2 Replaceable 19 Nos. of Static Application Panel which can be inserted onto common baseboard panel with selectively LEDs exposed:

- 10.11.2.1 Door Bell Operation
- 10.11.2.2 Switching of lights
- 10.11.2.3 Silo Control
- 10.11.2.4 Seven Segment Display
- 10.11.2.5 Starter Control
- 10.11.2.6 Sequential Control of Motors
- 10.11.2.7 Star Delta Control
- 10.11.2.8 Resistance Welding
- 10.11.2.9 Tank Level Control
- 10.11.2.10 Traffic Light Control
- 10.11.2.11 Bottling Plant
- 10.11.2.12 Drink Dispenses
- 10.11.2.13 Reaction Vessel
- 10.11.2.14 Oven
- 10.11.2.15 Parking Garage
- 10.11.2.16 Combination Lock
- 10.11.2.17 Elevator Simulator
- 10.11.2.18 Process Control Trainer
- 10.11.2.19 Washing Machine

10.12 Accessories: Mains cord, Ethernet cable 1.5m, Patch cords Red and Black 600mm length - Qty 15nos. each

10.13 SCADA Trainer: SCADA software development suite supplied on installable DVD. Supports 2048 tags, with USB hardware lock provided 19 projects for 19 SAPs. Interfaces with PLC through RJ 45 ethernet comport.

11 PLC Trainer

11.1 Basic Indicative Diagram

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- 11.5.2 Input range - +10V, Resolution - 10 bit

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- 11.9.3 4 Nos. of simulation pots and 4 Nos. of Analog Input, 2 Nos. of analog outputs, Led bar graph of 10 LEDs for Analog Output simulation, settable range 5V/10V. with 4mm banana sockets.

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- 11.10.2 SMPS I/P: 110/20/230V AC + 10% 50/60 Hz, O/P: 24V / 2 A
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- 11.11.2.9 Tank Level Control
- 11.11.2.10 Traffic Light Control
- 11.11.2.11 Bottling Plant
- 11.11.2.12 Drink Dispenses
- 11.11.2.13 Reaction Vessel
- 11.11.2.14 Oven
- 11.11.2.15 Parking Garage
- 11.11.2.16 Combination Lock
- 11.11.2.17 Elevator Simulator
- 11.11.2.18 Process Control Trainer
- 11.11.2.19 Washing Machine

11.12 Accessories: Mains cord, Ethernet cable 1.5m, Patch cords red and black 600mm length 15 Nos. each

12 Real Time PID Controller Trainer

12.1 Basic Indicative Diagram

12.2 Features

12.2.1 Student should be able to learn how an Analog as well as Digital PID works.

12.2.2 Facility to monitor behavior of the controller output (Un) and process variable either on PC screen.

12.2.3 Windows 10 based PID controller software package with P, PI and PID control,

12.2.4 Ratio and cascade control, three operating modes, Online graph drawing and data acquisition modes (SCADA).

12.2.5 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.

12.2.6 Graph printing facility for laboratory journal entries.

12.2.7 Aesthetically designed injection molded electronic desk carrying useful experiment resources like Power supplies, Digital Panel Meters, Computer Interface, Analog PID controller.

12.2.8 Connection through sturdy 4mm Banana sockets and Patch cords.

12.2.9 Students workbook and Instructor's Guide should be provided.

12.3 Basic Resources on Top board

12.3.1 Built in power supply

12.3.2 DC supply +12V, 500mA.

12.3.3 1phase sine reference for cosine firing 30Vpp max.

12.3.4 17V DC, 500mA unregulated for driving pulse X'mer

12.3.5 Variable DC power supply: 7 to 14V/3A

12.4 Display

12.4.1 Digital Panel Meters - 2 Nos.

12.4.2 For Temp. upto 1000C and intensity in LUX (2000)

12.4.3 For speed 2000 RPM and voltage upto 20 V.

12.4.4 Analog Meter - 2 Nos.

12.4.5 Centre zero for display of process error (+9V)

12.4.6 For MV/SP (0-2.5V)

12.5 Operating voltage: Switch selectable 220-240Vac, ±10%, 50Hz, 75VA

12.6 PC (WIN7/8/10) based PID controller: Online monitoring/ Data acquisition/ PID Software: works under Windows 10 PC USB port.

12.7 Operating modes

12.7.1 Simulator Mode: Tests data already stored in files (*.txt) and Drawing graph for all P, PI, PD and PID modes.

12.7.2 Process Monitoring Mode: Drawing graphs of analog data presented at CH 0 and =CH of Computer Interface. Cursors for X and Y axis for measurement and online graphs savings for reproduction

12.7.3 PID controller Mode

12.7.3.1 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).

12.7.3.2 Facility to set units for output viz. Percentage (%), oC, RPM, Voltage(V), mm, LPH, kg/cm2, si/cm, degree.

12.7.3.3 Supports experiments with advance process control scheme viz; Ratio, Cascade, feed forward with user selectable Aux PID, Ratio station and programmable FF transfer function calculator, selective and split control strategies, Multi Digital Panels Meters Screen.

12.8 Computer Interface Adapter

12.8.1 Opto isolated Adaptor to prevent damage to PC parallel port due to wrong connections.

12.8.2 4 ADC channels: 0 to 2.5V full scale.

12.8.3 1 DAC channel: O/P 2.5 V FS.

12.8.4 V to I Function block: Input: 0-2.5V DC

12.8.5 O/p: 0-20 or 4-20mA, in 100E load Max

12.8.6 USB IO module to interface 25 pin D connector on Computer interface panel to USB PC port.

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

12.8.8 Analog PID (APID) controller with built in low freq. function generator

12.8.9 Controller selection P, PI, PD, PID with slide switch

12.8.9.1 Parameter settings: Integral Time Ti (0.5-25Sec)

12.8.9.2 Derivative Time Td (0-2Sec)

12.8.9.3 Proportional Band Pb (5- 200%)

12.8.9.4 Set point (-9V- +9V)

12.9 Sampling modes

12.9.1 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 and Actuator panel Test points for Process Error, Set Point (Rn), Measured Value (Cn), Controller output (Un). Built in function generator

12.9.2 O/p waveform selectable sine, triangular and square.

12.9.3 O/p freq. range from 0.016Hz to 166Hz, 4 steps and fine control pot.

12.9.4 Variable amplitude control 0 to +9V.

12.10 Process Simulator Panel:

12.10.1 Functional blocks for Lag (3 Nos.), Integrator (3 Nos.), Transport Lag (1 No.), Summer (2 Nos.), Gain (1 No.), Inverter (2 Nos.) for constructing simulated Type 0, 1, 2, 3 and 1st, 2nd, 3rd Order processes to work under PID.

12.10.2 Experiments with Lead / Lag / Lead - Lag compensators to control behaviour of matching processes using above function blocks.

12.10.3 Open loop and close loop response of processes under different P, PI,

12.10.4 PID - Analog or Digital controllers. Experimental verification of PID Controller settings (Pb, Ti, Td)

12.10.5 Auto Tuning explained using Ziegler Nicolas I and II.

12.10.6 Fast (10mS) and slow (1sec) mode selection for all processes to observe response on computer.

12.10.7 Drawing Bode plot and Nyquist plots, transfer function determination.
12.10.8 Advance process control scheme viz; Ratio, Cascade, feed forward.
12.10.9 Level shifters (2No) +9V to 0-2.5V and 0-2.5V to +9V to match voltage levels of PC (2.5V) and opamps (+9V).

12.11 Real life process control panel (Thyristor Actuator panel):
Thyristor bridge based 0-200V/3A cosine firing circuit. Supports signal conditioning of RTD (PT100), Thermocouple K type, Solenoid Value, Level Transmitor and Photodiode to output 0-2.5Vdc (FS). Should 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.

12.12 Should have following real life process
12.12.1 Process Temp/ Light
12.12.2 Process box contains 3 high wattage (60W) bulbs under aluminum plate heater.
12.12.3 Built in fan, lamp as disturbance generator.
12.12.4 Sensor RTD for temperature control upto 100 degree C with built in Calibration facility, Photodiode for light intensity control upto 2000 LUX

12.13 List of Experiments:
12.13.1 PID tunning by Ziegler - Nichols
12.13.2 Transfer function determination
12.13.3 Operation under various PID
12.13.4 Open loop response to step input (transfer function determination)
12.13.5 Close loop control with Analog PID
12.13.6 Close loop control with Digital PID
12.13.7 Close loop control with built in Proportional controller / lag compensator (PI
12.13.8 controller) PID control with PWM O/P

13 RS485 to RS232 Converter Trainer

13.1 Basic Indicative Diagram

13.2 Aesthetically designed Injection moulded Plastic enclosure.

13.3 Supports use of 5V tolerant ICs obviating need of special precautions by students. Set of Users Guide provided with each unit with emphasis on C Programming as well as assembly language programming.

13.4 In circuit system programming (ICSP) supported through PC ports of COM/LPT (JTAG).

13.5 I2C, SPI bus interface.

13.6 Onboard Resources: Following Onboard Resources are offered for experimentation.

- 13.6.1 Speed: 16 MHz crystal operated multi-output clock source to operate various resources on Mother Board like CPU, Baud rate, T/C etc.
- 13.6.2 I/O Pins: 48 I/O lines through 2 Nos. of 26 pin FRC header.
- 13.6.3 Serial Interface: RS-232c serial interface using RS232 driver IC through 9 Pin male D connector.
- 13.6.4 Parallel Interface: 25 pin male D connector for Parallel interface for JTAG based programming.
- 13.6.5 Display: 16 X 2 LCD (Backlit)
- 13.6.6 Key Board: Keyboard interface to support 101 keys PC AT/PS2 keyboard.
- 13.6.7 Battery Backup: Lithium battery (3V/48mAH) provided to supply power to RTC.

13.7 Additional Resources:

- 13.7.1 Ext. L/S (8 Ohm/0.5W) I/F for experiments on frequency synthesis.
- 13.7.2 Reset push button.
- 13.7.3 Variable Slow CLK (2Hz-64Hz) provided for internal timers/ counter functions applications.
- 13.7.4 Variable Pot (0-5V) to stimulate analog I/P for built in ADC wherever applicable.
- 13.7.5 General purpose bicolor (green, red) 8 X 2 LEDs and 8 Push Button Switches and DIP switches.
- 13.7.6 I2C based 24C512 (EEPROM), DS1307 and SPI based 93C46 [EEPROM]

13.8 Power Supply: SMPS

- 13.8.1 5V/2.5Amp. With RCA plug +12V/850mA, -12V/250mA with 4 pin reliamate SMPS. AC P230Vac +/-10% / 50Hz.

13.9 ISP Cables

- 13.9.1 9 pin Female to 9 pin male RS-232C cable
- 13.9.2 26 pin FRC IO cable
- 13.9.3 25 pin female to 25 pin male for Parallel Interface

13.10 89C51RD2
- 13.10.1 Manufacture Model: ATMEL/Phillips/ NXP
- 13.10.2 Package: 40 Pin DIP Package
- 13.10.3 Capacity on Chip RAM Flash/ EEPROM: 256 Bytes (1KB) (8KB) (64KB)
- 13.10.4 Operating Frequency: 16 MHz
- 13.10.5 I/O Capacity ; 4X8 I/O ports. (32)
- 13.10.6 Operating System ICSP S/W PC Port: Window/ XP Flash Magic (winlsp) Comp Port
- 13.10.7 Special Purpose IOs: 7 interrupt sources, depending on device.
- 13.10.8 Execution Method: From Flash
- 13.10.9 Programming Language: C Language Assembly Language

13.11 RS485 Interface:
- 13.11.1 Input: TTL RS232
- 13.11.2 Output RS485 differential
- 13.11.3 Power supply: +5V
- 13.11.4 Uses IC MAX 485 and communicates with PC using MODSCAN
- 13.11.5 LAN topology: MODBUS (half duplex)
- 13.11.6 RS232 to RS485 converter at PC side