



## SPECIFICATION FOR ELECTRICAL TRAINERS





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## 1 Auto Electrical Work Bench

### 1.1 Basic Indicative Diagram



### 1.2 General Features:

- 1.2.1 The readings can be read through digital meters
- 1.2.2 3 HP, 3 Phase, 1440 RPM motor induction motor suitable for 50 Hz / 415 V AC Supply
- 1.2.3 3HP, 3 Phase, Variable frequency drive for speed variation suitable for induction motor suitable for 50Hz / 415 V AC Supply
- 1.2.4 Alternator loading up to 100 A / 14 V & 60 A / 24 V
- 1.2.5 Heavy duty transformer for starter testing with light run test
- 1.2.6 Poly V / V groove / small pulley for alternator checking
- 1.2.7 Battery charging ammeter to read the battery current
- 1.2.8 Heavy duty rugged frame for mounting alternator & starter
- 1.2.9 Three phase 4 pole isolator switch
- 1.2.10 All tripping MCB's available
- 1.2.11 PCB / bat excitation available
- 1.2.12 Accessories like bulbs / fuses / belts and cables for test of alternator / starter/ continuity / battery along with manual & calibration certificates to be provided
- 1.2.13 Facility to check continuity test of excitation winding using 6 V - DC Output
- 1.2.14 Facility to check short circuit of starter / alternator- rotor using 40 / 80 V AC
- 1.2.15 Dimensions: Length X Width X Height: 800mm X 850mm X 650mm (Approx.)
- 1.2.16 Weight: 150 Kgs net (Approx.)
- 1.2.17 Facility to charge battery (Not in the scope of supply) using appropriate cable harness

### 1.3 Components of Auto Electrical Test Bench:

- |       |                                      |       |
|-------|--------------------------------------|-------|
| 1.3.1 | Volt Meter Digital, 0-30 V DC        | 1 No  |
| 1.3.2 | Ammeter Digital, 0-30 A              | 1 No  |
| 1.3.3 | Ammeter Digital, 0-200 A             | 2 Nos |
| 1.3.4 | Motor 5HP(3.7KW), 50 Hz, 415 Volt AC | 1 No  |
| 1.3.5 | Diode, 150 A, 400 V                  | 4 Nos |



**Government of Maharashtra**  
**Directorate of Vocational Education and Training, Maharashtra State**  
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**Version 4**  
**2019 - 20**

1.3.6	Transformer, 12V / 200 A, 24 V / 150 A	1 No
1.3.7	Transformer, 0-240 V Primary, 12-0-12 V Secondary	1 No
1.3.8	Transformer, 0-240 V Primary, 0-6V-40V-80V Secondary	1 No
1.3.9	Contactora, 25 A, 240V Coil	1 No
1.3.10	OLR, 9-14 A	1 No
1.3.11	Timer, Aux 240 V	1 No
1.3.12	Toggle Switch, Double Pole Double Throw 6 A 240 V	4 Nos
1.3.13	Shunt 30 A, 75 mV	1 No
1.3.14	Toggle Switch, Single Pole Single Throw 6 A 240 V	1 No
1.3.15	MCB Single Pole, 25 A 240 V, 50 Hz	2 Nos
1.3.16	Isolator Double Pole, 63 A 240 V, 50 Hz	1 No
1.3.17	40 A 4 Pole main switch isolator	1 No
1.3.18	Rotary Switch, 15 A, 220 V	8 Nos
1.3.19	Fuse Holder	2 Nos
1.3.20	Push Button, Green	2 Nos
1.3.21	Push Button, Red	1 No
1.3.22	Normally Open Element, Green 240 V, 10 A	3 Nos
1.3.23	Normally Closed Element, Red 240 V, 10 A	1 No
1.3.24	Indicator, 22.5 Mm R / Y / B	4 Nos
1.3.25	Reset Switch Pbs	1 No
1.3.26	Shunt, 200 A 75mv	2 Nos
1.3.27	Terminals: BTI-100, 100 A Red & Black	2 No Each
1.3.28	Terminals: BTI -30, 30 A Red & Black	1 No Each
1.3.29	Terminals: BS-5 Red	9 Nos
1.3.30	Terminals: BS-5 Black	6 Nos
1.3.31	Terminals: BS-5 Yellow	1 Nos
1.3.32	LED Holder / Led: 10 mm	4 Nos
1.3.33	Resister: 2.7 Ohm / 350 W	2 No
1.3.34	Resister: 1.4 Ohm / 350 W	11 Nos
1.3.35	Solenoid Switch: 12 V DC	2 Nos
1.3.36	Fan: 240 v, 4" Cooling Fan	2 Nos
1.3.37	Relay: 12V DC, 250 Ohm, 10 A	1 No
1.3.38	Single Phase Preventer: 415 V, 50 Hz	1 No
1.3.39	Bridge: 35 A	1 No
1.3.40	Mounting Bushes	4 Nos
1.3.41	Wires	As Required
1.3.42	Metal Chassis	
1.3.43	Mounting Vice (X-Y directional movement and V block with clamping arrangement)	1 No
1.3.44	Pulley 3speed, 28 Bore	1 Set
1.3.45	Vacuum Kit With Tank	1 No
1.3.46	PCBs: Power / Control	2 Nos
1.3.47	V Belt / Poly V Belt: A-52 / A42 / 6pk 1345	1 Each
1.3.48	6 SQ MM Terminal Block	1 No
1.3.49	Hylams (Different sizes)	05 Sizes
1.3.50	Front Plate	01 No

**1.4 Voltmeter**

- 1.4.1 Display Type Red LED Super Bright Display
- 1.4.2 Maximum Display 1999 Counts | Resolution 1 Count



- 1.4.3 Polarity Indication “ - ” is indicated for Negative Input
- 1.4.4 Over Range Indication “ 1 ” or “ -1 ”
- 1.4.5 Red Antiglare
- 1.4.6 Faceplate with Annunciators
- 1.4.7 Case / Housing DIN Black ABS, Dimension as per DIN (48 x96)
- 1.4.8 Mounting Clamps Sturdy, Moulded ABS with suitable Hardware
- 1.4.9 Connectors Terminal Block
- 1.4.10 Brass Terminals | Display Stability Within  $\pm 2$  Digits
- 1.4.11 0- 199.9 V voltage measurement range

#### 1.5 Ammeter

- 1.5.1 Display Type Red LED Super Bright Display
- 1.5.2 Maximum Display 1999 Counts | Resolution 1 Count
- 1.5.3 Polarity Indication “ - ” is indicated for Negative Input
- 1.5.4 Over Range Indication “ 1 ” or “ -1 ”
- 1.5.5 Faceplate Red Antiglare
- 1.5.6 Faceplate with Annunciators
- 1.5.7 Case Terminals
- 1.5.8 Case / Housing DIN Black ABS, Dimension as per DIN (48 x 96)
- 1.5.9 Mounting Clamps Sturdy, Moulded ABS with suitable Hardware
- 1.5.10 Connectors Terminal Block: Thermoplastic (UL 94V-0) with Tin Plated
- 1.5.11 Brass Terminals | Display Stability Within  $\pm 2$  Digits
- 1.5.12 0-1000 Amps current measurement range

#### 1.6 RPM meter

- 1.6.1 Display Type: Red LED Super Bright Display
- 1.6.2 Maximum Display 9999 Counts | Resolution 1 Count
- 1.6.3 High Indication Accuracy:  $\pm 0.25\%$ .
- 1.6.4 Accepts Sensor Inputs: Voltage
- 1.6.5 Display: 4 - digit (7 segment LED) 0.5" height Display Messages: “Or” - Appears when 1)
- 1.6.6 Measurement exceeds display scaling range (9999)
- 1.6.7 24 VDC Sensor Supply
- 1.6.8 Case Terminals
- 1.6.9 Case / Housing DIN Black ABS, Dimension as per DIN (48 x 96)
- 1.6.10 Mounting Clamps Sturdy, Moulded ABS with suitable Hardware
- 1.6.11 Connectors Terminal Block: Thermoplastic (UL 94V-0) with Tin Plated

#### 1.7 Motor

- 1.7.1 TEFC Class F Insulation foot mounted induction motor
- 1.7.2 AC Supply Voltage 415 V+ / -10%, 50 Hz+ / -5% class F insulation
- 1.7.3 4 pole motor with foot mounting 1440 RPM max
- 1.7.4 Frame Size: 100 S / M 4 pole

#### 1.8 5K/ Ten turns Potentiometer

- 1.8.1 Standard Resistance Range: 200 to 100 K Ohms, Total Resistance Tolerance:  $\pm 5\%$
- 1.8.2 Independent Linearity:  $\pm 0.25\%$
- 1.8.3 Effective Electrical Angle:  $360^\circ \pm 10\%$



- 1.8.4 Absolute Minimum Resistance: 1 Ohm or 0.1 % maximum (whichever is greater)
- 1.8.5 Noise: 100 ohms ENR maximum
- 1.8.6 Dielectric Withstanding Voltage (MIL-STD-202 Method 301)
  
- 1.9 **Diodes with Aluminium Heat Sink**
  - 1.9.1 Maximum Average forward current (T=130°): 150 A
  - 1.9.2 Maximum Peak forward voltage drop: 1.4 V
  
- 1.10 **Step Down Transformer**
  - 1.10.1 Copper wound foot mounted with CRNO core
  - 1.10.2 Step down type of winding
  - 1.10.3 2.8KVA rating
  - 1.10.4 AC Supply Voltage: 240 V +/-10%, 50Hz +/-5%, Class F Insulation
  - 1.10.5 Ambient Max Temperature of 120 deg
  - 1.10.6 Output Voltage: 15 V +/- 10%
  - 1.10.7 Output Current: 150 A max @ 15 V
  
- 1.11 **Contactor / Overload Relays**
  - 1.11.1 Contactor application: Motor control
  - 1.11.2 Poles description: 3P
  - 1.11.3 Pole contact composition: 3 NO
  - 1.11.4 Control Circuit Type: AC 50 Hz
  - 1.11.5 Control Circuit Voltage: 240 V AC 50 Hz
  - 1.11.6 Auxiliary contact composition: 1 NO + 1 NC
  
- 1.12 **Timer**
  - 1.12.1 ON Delay
  - 1.12.2 Dual supply voltage
  - 1.12.3 LED status indicator: Power ON, Relay ON
  - 1.12.4 DIN Rail / Back panel mount
  - 1.12.5 Finger safe terminals
  - 1.12.6 Supply Voltage 240V AC
  - 1.12.7 Power Consumption 6VA max
  
- 1.13 **Toggle Switch**
  - 1.13.1 Power Switch conforms to safety standards for electrical equipment
  - 1.13.2 Compact with a good space factor
  - 1.13.3 Item Standard Rating 6 A
  - 1.13.4 Terminal Types
  
- 1.14 **MCB**
  - 1.14.1 Rated current: 25 A
  - 1.14.2 Number of poles: 1P
  - 1.14.3 Rated operational AC Voltage: 240 V
  - 1.14.4 Frequency: 50 Hz
  - 1.14.5 Number of modules: 1
  
- 1.15 **Rotary Switch**
  - 1.15.1 DC switching: 40 A



- 1.15.2 Rear termination
- 1.15.3 Mountings: Standard Front Panel
- 1.15.4 Resistance loads application and Switching of resistive loads, including moderate overloads
- 1.15.5 Rated Operational Voltage: Max V DC 250

**1.16 Fuse Holder with Fuse**

- 1.16.1 Contact Finish: Silver Plated
- 1.16.2 Housing Material Phenolic
- 1.16.3 Terminals: Copper
- 1.16.4 Mounting Type: Panel Mounting
- 1.16.5 Fuse Link Size (mm): 6.3 X 32
- 1.16.6 Panel Thickness Max (mm): 3
- 1.16.7 Current Rating: 10 A 240 V AC

**1.17 Push Button / Indicator with Element Switches (Item 1.3.21 / 1.3.22 / 1.3.23 / 1.3.24 / 1.3.25 / 1.3.26)**



- 1.17.1 Operating positions: All positions
- 1.17.2 Contact: Block
- 1.17.3 Contact Operation: Slow Break NO or NC

**1.18 200 A / mV DC Shunt**

- 1.18.1 Operating Temperature: -10°C to 55°C
- 1.18.2 Maximum load: The load should not exceed 0.1% of the nominal current rating for specified accuracy.

**1.19 Terminals - Push Button / Indicator with Element Switches (Item No. 1.3.28 / 1.3.29 / 1.3.30)**



- 1.19.1 Mounting Arrangement: Panel Mounting
- 1.19.2 Rating: 100 A / 60 A / 30 A 240 V AC
- 1.19.3 Contact Material: Brass Nickel Plated
- 1.19.4 Insulation Material: Phenolic (Bakelite)
- 1.19.5 Color: Red / Black

### 1.20 LED Holder with LED



- 1.20.1 Metal holder of housing 10mm LED
- 1.20.2 Supply voltage: 240V MAX
- 1.20.3 Dimensions (L X Di): 15 X 14 mm
- 1.20.4 Peak Forward Current: 120 mA
- 1.20.5 Continuous Forward Current: 30 mA

### 1.21 Resistors (Item 1.3.32 & 1.3.33)



- 1.21.1 Power Rating full power dissipation at 70°C to 350°C
- 1.21.2 Temperature Range -55°C to 350°C
- 1.21.3 Voltage Rating / Limiting Voltage / Max working Voltage  $V = P \times R$
- 1.21.4 Voltage Proof / Dielectric Withstanding Voltage

### 1.22 Solenoid Switch

- 1.22.1 Inner Material: Copper and Steel
- 1.22.2 Outer Material: Copper and Steel
- 1.22.3 Voltage: 12 V

### 1.23 Cooling Fan

- 1.23.1 Operating Voltage: 240 V (185 – 245 VAC)
- 1.23.2 Insulation: Class B

### 1.24 DC Relay

- 1.24.1 Contact resistance: 50 mΩ max
- 1.24.2 Operate Time: 25 ms max
- 1.24.3 Release Time: 25 ms max

### 1.25 Contactor / Overload Relays (Item 36)

- 1.25.1 Output Contact Rating: 5 A, 240 V AC (Resistive)
- 1.25.2 Unbalance Trip Setting: 50 V ± 10 VAC
- 1.25.3 Trip Time Delay for unbalance: 3.5 Second, ±1.5 Second
- 1.25.4 Resetting: Auto Reset
- 1.25.5 Enclosure: HIP molded

### 1.26 Bridge

- 1.26.1 Maximum Repetitive Peak Reverse Voltage: 400 V





- 1.26.2 Maximum RMS Voltage: 280 V
- 1.26.3 Maximum DC Blocking Voltage: 400 V
- 1.26.4 Maximum Average Forward: 35 A
  
- 1.27 **Wires**
  - 1.27.1 Resistance as per: IS 8130
  - 1.27.2 Tensile strength / annealing as per: IS 8130
  - 1.27.3 Wrapping as per: IS 8130
  - 1.27.4 Diameter as per: IS 8130
  
- 1.28 **Chassis**
  - 1.28.1 Complete fabricated structure with laser cutting and Turret punching
  - 1.28.2 Angles and CRCA sheets
  - 1.28.3 Powder coated
  - 1.28.4 Heavy duty mounting flats at the corners for base mounting bush
  
- 1.29 **Standard Accessories**
  - 1.29.1 Accessories / Attachment Required for Auto Electrical Test bench
    - 1.29.1.1 Alternator cable
    - 1.29.1.2 Starter cable
    - 1.29.1.3 Battery cable
    - 1.29.1.4 Continuity Test cable 1
    - 1.29.1.5 Belts 2 sizes
    - 1.29.1.6 Bulbs / Fuses 1 each
  - 1.29.2 Operation Manual: 01 Nos.
  - 1.29.3 Maintenance Chart / Schedule: 01 Nos.
  
- 1.30 **Other Features**
  - Safety requirements: Emergency stop button
  
- 1.31 **Space Requirement for Installation**
  - Floor arrangement in mm: 1000 mm X 1000 mm (Approx.)
  
- 1.32 **Foundation / Installation Specification**
  - Mechanical and electrical and civil Installation and commissioning, loading and unloading will be done by bidder at site.
  
- 1.33 **Electric Supply Specification**
  - Mains Supply: 415 V AC, 3 Phase, 50 Hz AC Power supply



## 2 Electrical Machine Work Bench

### 2.1 Basic Indicative Diagram



- 2.2 An integrated workbench consisting of instrument panel and working table should be suitable for students to learn and perform various experiments of Electrical Machines. Measuring Instruments should be 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 2.5 mm thick CRC powder coated pipes with top made up of good quality 19 mm marine 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 helps students to control static discharge as static causes interference or damage to students, equipment and circuitry.
- 2.3 The basic structure should be made of 38 x 38 x 2.5 mm CRC powder coated pipes for sturdiness.
- 2.4 The overall dimensions of Workbench should be not less than Width = 1200 mm; Depth = 770 mm; Height = 1650 mm
- 2.5 MS drawers 03 numbers 415 X 290 X 133 mm (H X W X D) and thickness 1.2mm with handle & separate lock on each drawer should be provided
- 2.6 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.
- 2.7 Two Pole MCB (32A – Havells / Siemens) to be provided for safety of Workbench
- 2.8 Workbench should work on Mains Supply - 230V AC, 50 Hz
- 2.9 Equipped with measurement facilities for experimentation on AC Machines, DC Machines and Transformers: Separate AC and DC Measuring Sections
- 2.10 Diagrammatic representation of AC and DC Machines for better understanding
- 2.11 Rust Free Powder Coating
- 2.12 Standard BS-10 terminals, patch cords for safety purpose
- 2.13 Terminals provided to obtain Three Phase Fixed as well as Variable
- 2.14 AC and DC Supplies with suitable protection



- 2.15 High Quality Digital Tachometer for RPM Measurement
- 2.16 Durable good quality spring balance
- 2.17 Designed considering all safety measures
- 2.18 BS10 safety terminals must be in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab
- 2.19 Inbuilt 15A, 0 - 220V & 2A, 220V DC Regulated Power Supply
- 2.20 **AC Ammeter (4 Nos.)**
  - 2.20.1 Type: Digital
  - 2.20.2 Range: 10A
- 2.21 **AC Voltmeter (4 Nos.)**
  - 2.21.1 Type: Digital
  - 2.21.2 Range: 450V
- 2.22 **DC Ammeter (4 Nos.)**
  - 2.22.1 Type: Digital
  - 2.22.2 Range: 20A
- 2.23 **DC Voltmeter (4 Nos.)**
  - 2.23.1 Type: Digital
  - 2.23.2 Range: 300V
- 2.24 **Single Phase Wattmeter (2 Nos.)**
  - 2.24.1 Type: Digital
  - 2.24.2 Range: 4kW
- 2.25 **Protective Devices**
  - 2.25.1 Three Phase MCB (TPN): 1 Nos.
  - 2.25.2 Single Phase MCB (DP): 1 Nos.
- 2.26 **Interconnections:** 4mm BS-10 Safety Terminals
- 2.27 **Electrical Machine - Shunt**
  - 2.27.1 Power Rating: 1HP
  - 2.27.2 Voltage Rating: 220V DC  $\pm$  5%
  - 2.27.3 Rated Speed: 1500RPM  $\pm$  7.5%
  - 2.27.4 Insulation: Class 'B'
  - 2.27.5 Loading arrangement: Mechanical
  - 2.27.6 Spring Balance: 2Nos.(Tubular Type)
  - 2.27.7 Brake Drum/Pulley: Aluminum cast with heat suppression facility
  - 2.27.8 Machine Base: "C" Channel
  - 2.27.9 Protection: Fuses (mounted at the terminal box of the Machines)
- 2.28 **Electrical Machine - Series**
  - 2.28.1 Power Rating: 1HP
  - 2.28.2 Voltage Rating: 220V DC  $\pm$  5%
  - 2.28.3 Rated Speed: 1500RPM  $\pm$  7.5%
  - 2.28.4 Insulation: Class 'B'
  - 2.28.5 Loading arrangement: Mechanical
  - 2.28.6 Spring Balance: 2Nos. (Tubular Type)
  - 2.28.7 Brake Drum/Pulley: Aluminum cast with heat suppression facility
  - 2.28.8 Machine Base: "C" Channel
  - 2.28.9 Protection: Fuses (mounted at the terminal box of the Machines)
- 2.29 **Electrical Machine - Compound (six terminal machine)**
  - 2.29.1 Power Rating: 1HP



- 2.29.2 Voltage Rating: 220V DC  $\pm$  5%
- 2.29.3 Rated Speed: 1500RPM  $\pm$  7.5%
- 2.29.4 Insulation: Class 'B'
- 2.29.5 Loading arrangement: Mechanical
- 2.29.6 Spring Balance: 2Nos. (Tubular Type)
- 2.29.7 Brake Drum/Pulley: Aluminum cast with heat suppression facility
- 2.29.8 Machine Base: "C" Channel
- 2.29.9 Protection: Fuses (mounted at the terminal box of the Machines)

**2.30 Electrical Machine - PMDC (Permanent magnet DC Motor)**

- 2.30.1 Power Rating: 1HP
- 2.30.2 Voltage Rating: 220V DC  $\pm$  5%
- 2.30.3 Rated Speed: 1500RPM  $\pm$  7.5%
- 2.30.4 Insulation: Class 'B'
- 2.30.5 Loading arrangement: Mechanical
- 2.30.6 Spring Balance: 2Nos. (Tubular Type)
- 2.30.7 Brake Drum/Pulley: Aluminum cast with heat suppression facility
- 2.30.8 Machine Base: "C" Channel
- 2.30.9 Protection: Fuses (mounted at the terminal box of the Machines)

**2.31 AC Motors - Capacitor Start Induction Machine**

- 2.31.1 Power Rating: 1HP
- 2.31.2 Voltage Rating: 220V AC  $\pm$  5%, 50Hz
- 2.31.3 Rated Speed: 1440RPM  $\pm$  7.5%
- 2.31.4 Insulation: Class 'B'
- 2.31.5 Loading arrangement: Mechanical
- 2.31.6 Spring Balance: 2 Nos. (Tubular Type)
- 2.31.7 Brake Drum/Pulley: Aluminum cast with heat suppression facility
- 2.31.8 Machine Base: "C" Channel
- 2.31.9 Protection: Fuses (mounted at the terminal box of the Machines)

**2.32 Universal Motors - Universal Machine**

- 2.32.1 Power Rating: 1HP
- 2.32.2 Voltage Rating: 220V AC and DC  $\pm$  5%, 50Hz
- 2.32.3 Rated Speed: 1440RPM  $\pm$  7.5%
- 2.32.4 Insulation: Class 'B'
- 2.32.5 Loading arrangement: Mechanical
- 2.32.6 Spring Balance: 2 Nos. (Tubular Type)
- 2.32.7 Brake Drum/Pulley: Aluminum cast with heat suppression facility
- 2.32.8 Machine Base: "C" Channel
- 2.32.9 Protection: Fuses (mounted at the terminal box of the Machines)

**2.33 Squirrel Cage Induction Machine**

- 2.33.1 Power Rating: 1HP
- 2.33.2 Voltage Rating: 415V AC  $\pm$  5%, 50Hz
- 2.33.3 Rated Speed: 1440RPM  $\pm$  7.5%
- 2.33.4 Insulation: Class 'B'
- 2.33.5 Loading arrangement: Mechanical
- 2.33.6 Spring Balance: 2 Nos. (Tubular Type)
- 2.33.7 Brake Drum/Pulley: Aluminum cast with heat suppression facility



- 2.33.8 Machine Base: "C" Channel  
2.33.9 Protection: Fuses (mounted at the terminal box of the machines)
- 2.34 **Additional items which are required to be supplied to conduct lab experiments:**
- 2.34.1 10A, Three phase variac: 1 No.  
2.34.2 10A, Single phase variac: 1 No.  
2.34.3 2.8A, 110 Ohm rheostat: 1 No.
- 2.35 The Workbench should be supplied with online single user Classroom / laboratory teaching, learning and simulation software module with following key features:
- 2.35.1 The content should be designed by using platforms like Visual Basic, Dot Net, Flash etc and should be useful to understand the basic concepts of electrical and electronics. The software should comprise simulations, animations, videos, graphs, charts, along with mandatory rich content and theory to understand fundamental concepts, interactive learning objects, FAQ, MCQ etc following topics:
- 2.35.2 Modules on Basic Electrical and Electronics should have all the fundamental topics of electrical machines and should be designed to study the fundamentals and applications of electricity, magnetism, electronics: analog and digital, circuit analysis, network analysis, electromagnetism and electronic instruments, three phase circuits, Transformers, AC and DC Machines, Power electronics Semiconductor Devices.



**3 DC Generator - Compound and Shunt with Control Panel fitted with Rheostat, Voltmeter, Ammeter and Breaker, 2.5 KW, 240 V**

**3.1 Basic Indicative Diagram**



- 3.2 An integrated workbench consisting of instrument panel and working table should be suitable for students to learn and perform various experiments of DC Machines. Measuring Instruments should internally electrically connect 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 min 2.5 mm thick CRC powder coated pipes with top made up of good quality 19 mm thick marine 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 helps students to control static discharge as static causes interference or damage to students, equipment and circuitry.
- 3.3 The basic structure should be made of 38 x 38 x 2.5 mm CRC powder coated pipes for sturdiness.
- 3.4 The overall dimensions of Workbench should be not less than W = 1200 mm; D = 770 mm; H = 1650 mm
- 3.5 MS drawers 03 numbers 415X290X133 mm (HXWX D) and thickness 1.2mm with handle & separate lock on each drawer should be provided
- 3.6 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.
- 3.7 Two Pole MCB (32A – Havells / Siemens) to be provided for safety of Workbench
- 3.8 Workbench should work on Mains Supply - 230V AC, 50 Hz
- 3.9 Equipped with Measurement Facilities for Experimentation on DC Machines
- 3.10 Rust Free Powder Coating
- 3.11 Standard BS-10 terminals, patch cords for safety purpose
- 3.12 BS10 safety terminals in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab
- 3.13 Terminals should be provided to obtain three phase fixed as well as variable inbuilt DC Supplies with suitable protection
- 3.14 High Quality Digital Tachometer for RPM Measurement
- 3.15 Durable good quality spring balance
- 3.16 Designed considering all safety measures
- 3.17 Inbuilt 15A, 0 - 220V & 2A, 220V DC Regulated Power Supply



- 3.18 **AC Ammeter (4 Nos.)**  
3.18.1 Type: Digital  
3.18.2 Range: 10A
- 3.19 **AC Voltmeter (4 Nos.)**  
3.19.1 Type: Digital  
3.19.2 Range: 450V
- 3.20 **DC Ammeter (4 Nos.)**  
3.20.1 Type: Digital  
3.20.2 Range: 20A
- 3.21 **DC Voltmeter (4 Nos.)**  
3.21.1 Type: Digital  
3.21.2 Range: 300V
- 3.22 **Single Phase Wattmeter (2 Nos.)**  
3.22.1 Type: Digital  
3.22.2 Range: 4kW
- 3.23 **Protective Devices**  
3.23.1 Three Phase MCB (TPN): 1 Nos.  
3.23.2 Single Phase MCB (DP): 1 Nos.  
3.23.3 Interconnections: 4mm BS-10 Safety Terminals
- 3.24 **Technical Specifications (Set 1):**  
3.24.1 Both the Machines be flexibly coupled and mounted on a single "C" channel base  
3.24.2 Three Phase Squirrel cage Induction Motor (acts as prime mover)  
3.24.2.1 Type: Squirrel cage induction Motor  
3.24.2.2 Power Rating: 5HP  
3.24.2.3 Voltage Rating: 440V  $\pm$  10%  
3.24.2.4 Rated Speed: 1440 RPM  $\pm$  7.5%  
3.24.2.5 Insulation: Class 'B'  
3.24.3 DC Machine (acts as generator)  
3.24.3.1 Type: Shunt  
3.24.3.2 Power Rating: 2.5kW  
3.24.3.3 Voltage Generated Rating: 220V  $\pm$  10%  
3.24.3.4 Rated Speed: 1500RPM  $\pm$  7.5%  
3.24.3.5 Insulation: Class 'B'  
3.24.3.6 Loading Arrangement: Electrical  
3.24.3.7 Type of Coupling: Flexible "Lovejoy" Coupling  
3.24.3.8 Machine Base: "C" Channel  
3.24.3.9 Protection: Fuses (mounted at the terminal box of the Machines)



**3.25 Technical Specifications (Set 2):**

3.25.1 Both the Machines be flexibly coupled and mounted on a 'C' Channel base

3.25.2 Three Phase Squirrel cage Induction Motor (acts as prime mover)

3.25.2.1 Type: Squirrel Cage induction Motor

3.25.2.2 Rating: 5 HP

3.25.2.3 Voltage Rating: 415V AC

3.25.2.4 Speed: 1440 RPM  $\pm 5\%$

3.25.2.5 Insulation: Class 'B'

3.25.3 DC Machine (acts as generator)

3.25.3.1 Type: Compound

3.25.3.2 Rating: 2.5kW

3.25.3.3 Speed: 1500 RPM  $\pm 10\%$

3.25.3.4 Insulation: Class 'B'

**3.26 Following accessories should be provided with the training system as the same is required to conduct experiments**

3.26.1 Three Phase Variac: 10 A

3.26.2 Rheostat: 2200hm, 2.8A

3.26.3 Resistive Load: 3.5 kW

**3.27 The Workbench should be supplied with online single user Classroom / laboratory teaching, learning and simulation software module with following key features:**

3.27.1 The content should be designed by using platforms like Visual Basic, Dot Net, Flash etc and should be useful to understand the basic concepts of Electrical Machine Lab. The software should comprise simulations, animations, videos, graphs, charts, along with mandatory rich content and theory to understand fundamental concepts, interactive learning objects, FAQ, MCQ etc following topics:

3.27.2 This module on Electrical should have all the fundamental topics of electrical and electronics and should be designed to study the fundamentals and applications of electricity, magnetism, electronics: analog and digital, circuit analysis, network analysis, electromagnetism and electronic instruments, Three Phase Circuits, Transformers, AC and DC Machines, Power electronics Semiconductor devices.





#### 4 AC Motor Trainer

##### 4.1 Basic Indicative Diagram



- 4.2 Control Panel consisting of high grade FRP material for safety and in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab.
- 4.3 Rust free powder coated front panel
- 4.4 Micro-controller based highly accurate digital meters
- 4.5 Setup should be provided with Digital Tachometer
- 4.6 Machine have CE Marking.
- 4.7 Machine fitted with heavy duty channel with mechanical loading arrangements and Aluminum cast Brake-Drum/Pulley arrangements for heat suppression
- 4.8 Equipped with supply indication lamps
- 4.9 Good quality and durable spring balance for accurate results
- 4.10 Diagrammatic representation for the ease of connections so that students can easily understand the concept of machine.
- 4.11 Provided with suitable protection such as fuses, MCB, earthing provision
- 4.12 BS10 safety terminals in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab
- 4.13 Type: Three Phase Squirrel Cage Induction Motor (Havells or equivalent)
- 4.14 Power Rating: 5HP
- 4.15 Voltage Rating: 415V AC  $\pm$  5%, 50Hz
- 4.16 Rated Speed: 1440 RPM  $\pm$  7.5%
- 4.17 Insulation: Class 'F'
- 4.18 Loading arrangement: Mechanical
- 4.19 Spring Balance: 2 Nos. (Tubular Type)
- 4.20 Brake Drum/Pulley: Aluminum cast with heat suppression Facility
- 4.21 Machine Base: "C" Channel
- 4.22 Protection: Fuses (mounted at the terminal box of the Machines)
- 4.23 Measuring Unit:
  - 4.23.1 Voltmeter: 500V (1No.)
  - 4.23.2 Ammeter: 10A (1No.)
  - 4.23.3 Wattmeter: 4500W (2Nos.)
- 4.24 Protection Unit:
  - 4.24.1 MCB: 10A
  - 4.24.2 Three Phase Variac: 10A, Closed Type (connected externally)



- 4.25 The training setup should include online single user Classroom / laboratory teaching, learning and simulation software module with following key features:
- 4.25.1 The content should be designed by using platforms like Visual Basic, Dot Net, Flash etc and should be useful to understand the basic concepts of various technologies in electronics including advanced technologies. The software should comprise of simulations, animations, videos, graphs, charts, along with mandatory rich content and theory to understand fundamental concepts, interactive learning objects, FAQ, MCQ etc following topics:
- 4.25.2 Basic Electrical and Electronics should have all the fundamental topics of electrical and electronics and should be designed to study the fundamentals and applications of electricity, magnetism, electronics: analog and digital, circuit analysis, network analysis, electromagnetism and electronic instruments, Three Phase Circuits, Transformers, AC and DC Machines, Power electronics Semiconductor Devices.



5 **Motor Generator (DC to AC) set consisting of Shunt Motor Rating - 5 HP, 440V AC Generator Rating - 3 Phase, 4 Wire, 3.5 KVA, 400/230 Volts, 0.8 pf, 50 Cycles**

5.1 Basic Indicative Diagram



5.2 The training system should have motor & generator on a common rail & should be directly coupled with flexible coupling. The trainer should be provided with control panel and measurement unit. The training setup be supplied with BS10 safety terminals in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab and Control Panel consist of high grade FRP material for better safety and in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab.

5.3 **Motor:**

- 5.3.1 Type: DC Shunt
- 5.3.2 Capacity: 5 HP
- 5.3.3 Arm Voltage: 220 V DC
- 5.3.4 Field Voltage: 220VDC

5.4 **Generator:**

- 5.4.1 Type: Synchronous Type
- 5.4.2 Capacity: 3.5KVA, 3 $\phi$
- 5.4.3 Output Voltage: 400V AC (line to line), 3 Phase, 4 wire system 50 Hz

5.5 **Control Board:**

- 5.5.1 Rust free power coated Control board made up of high grade Fibre moulded body (FRP) which prevent from any abnormal electrical hazards.
- 5.5.2 The Control panel should be provided to fit the instruments mentioned below
  - 5.5.2.1 Micro-controller based digital meters of size 72mm x 72mm (1 No. 300V DC Voltmeter, 2No. 20A DC Ammeter., 1No. 450V AC Voltmeter, 1No. 10AAC Ammeter, 1No
  - 5.5.2.2 Shock proof banana jack terminal (BS-10)
  - 5.5.2.3 Provided with digital tachometer
  - 5.5.2.4 Screen printed diagrammatic connections
  - 5.5.2.5 Patch cords of different sizes and color for easy and safe connections
  - 5.5.2.6 Separate single phase socket for auxiliary supply
  - 5.5.2.7 Mandatory Items (connected externally) required to conduct experiment
  - 5.5.2.8 25A, 0 - 220V & 2A, 220V DC Regulated Power Supply
  - 5.5.2.9 DC Excitation Unit, 2A, 300V – 1 No.



- 5.6 The training setup should include online single user Classroom / laboratory teaching, learning and simulation software module with following key features:
- 5.6.1 The content should be designed by using platforms like Visual Basic, Dot Net, Flash etc and should be useful to understand the basic concepts of various technologies in electronics including advanced technologies. The software should comprise of simulations, animations, videos, graphs, charts, along with mandatory rich content and theory to understand fundamental concepts, interactive learning objects, FAQ, MCQ etc following topics:
- 5.6.2 Basic Electrical and Electronics should have all the fundamental topics of electrical and electronics and should be designed to study the fundamentals and applications of electricity, magnetism, electronics: analog and digital, circuit analysis, network analysis, electromagnetism and electronic instruments, Three Phase Circuits, Transformers, AC and DC Machines, Power electronics Semiconductor Devices.



## 6 Servo Motor Drive Trainer

### 6.1 Basic Indicative Diagram



- 6.2 Closed loop and Open loop speed control of AC Servo motor
- 6.3 Slotted disk for speed measurement
- 6.4 Separate unit for Motor in a see through cabinet
- 6.5 DPM for speed and voltage display
- 6.6 Precise signal conditioning
- 6.7 Instrumentation Power supply with DPM panel:
  - 6.7.1 +/-12 V, 500 mA
  - 6.7.2 +5V, 300mA
  - 6.7.3 Unregulated DC supply
  - 6.7.4 Line synchronizing signal.
  - 6.7.5 DPM for digital display of speed, etc.
- 6.8 SCR Actuator/ Drive based (variable DC):
  - 6.8.1 Full bridge SCR based 0V-195V / 12 Amp with linear characteristics.
  - 6.8.2 Supports signal conditioning circuit for speed to give output 0-2.5Vdc (FS). This supply is required for DC Armature.
  - 6.8.3 IGBT/MOSFET based Panel for variable PWM controlled power for armature supply.
- 6.9 DC voltmeter and DC ammeter panel
  - 6.9.1 DC voltmeter (0-300V)
  - 6.9.2 DC Ammeter 0-2A) with polarity protection diode
  - 6.9.3 Field failure relay to control Armature supply.
- 6.10 A.C. servo Motor with process setup.
- 6.11 The trainer should support to perform following experiments:
  - 6.11.1 Effect of loading on the speed of the Motor in the open loop
  - 6.11.2 Effect of loading on the speed of the Motor in the closed loop
  - 6.11.3 Speed control of a AC Servo Motor



## 7 Stepper Motor Trainer

### 7.1 Basic Indicative Diagram



- 7.2 Different modes of operation
- 7.3 Half and Full step angle
- 7.4 Visual indication of the coil excitation
- 7.5 External connector for programming with different controllers
- 7.6 Separate unit for Motor in a see through cabinet.
- 7.7 Motor Type: Unipolar
- 7.8 Torque: 6 Kg-cm
- 7.9 Phase Current: 0.8 Amp.
- 7.10 Stepping Angle:  $1.8^\circ / 0.9^\circ$
- 7.11 Operating Voltage: 12 V DC
- 7.12 Input Pulse: 5V TTL Compatible
- 7.13 Test Points: 20
- 7.14 Cabinet for Motor
- 7.15 Power Supply: 110 / 230V, 50Hz
- 7.16 Operating Conditions: 0-40° C, 80% RH
- 7.17 Learning Material: Online learning material including Theory, procedure, reference results, etc.)
- 7.18 **The trainer should support to perform the following experiments:**
  - 7.18.1 Study and use of Stepper Motor in Wobble Mode
  - 7.18.2 Study of Stepper Motor in Full Step, Single Phase, Free Running Mode
  - 7.18.3 Study of Stepper Motor in Full Step, Single Phase, Step Running Mode
  - 7.18.4 Study of Stepper Motor in Full Step, Two Phase, Free Running Mode
  - 7.18.5 Study of Stepper Motor in Full Step, Two Phase, Step Running Mode
  - 7.18.6 Study of Stepper Motor in Half Step, Free Running Mode
  - 7.18.7 Study of Stepper Motor in Half Step, Step Running Mode