Government of Maharashtra

Directorate of Vocational Education and Training

Craftsman Training Scheme

SPECIFICATION FOR ELECTRICAL TRAINER

Version 4, 2024

TABLE OF CONTENTS

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

1.1 Basic Indicative Diagram

1.2 An integrated workbench consisting of instrument panel and working table should 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 help students to controls static discharge as static cause interference or damage to students, equipment and circuitry.

1.3 The basic structure should be made of 38 x 38 x 2.5 mm CRC powder coated pipes for sturdiness.

1.4 The overall dimensions of Workbench should be not less than W = 1200 mm; D = 770 mm; H = 1650 mm

1.5 MS drawers 03 numbers 415 X 290 X 133 mm (H X W X D) and thickness 1.2 mm with handle and separate lock on each drawer should be provided

1.6 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.

1.7 Two Pole MCB (32A - Havells / Siemens) to be provided for safety of Workbench

1.8 Workbench should work on Mains Supply - 230V AC, 50 Hz

1.9 Equipped with Measurement Facilities for Experimentation on DC Machines

1.10 Rust Free Powder Coating

1.11 Standard BS-10 terminals, patch cords for safety purpose

1.12 BS10 safety terminals in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab

1.13 Terminals should be provided to obtain three phase fixed as well as variable inbuilt DC Supplies with suitable protection

1.14 High Quality Digital Tachometer for RPM Measurement

1.15 Durable good quality spring balance

1.16 Designed considering all safety measures

1.17 Inbuilt 15A, 0 - 220V and 2A, 220V DC Regulated Power Supply

1.18 AC Ammeter (4 Nos.)
- 1.18.1 Type: Digital
- 1.18.2 Range: 10A

1.19 AC Voltmeter (4 Nos.)
- 1.19.1 Type: Digital
- 1.19.2 Range: 450V

1.20 DC Ammeter (4 Nos.)
- 1.20.1 Type: Digital
- 1.20.2 Range: 20A

1.21 DC Voltmeter (4 Nos.)
- 1.21.1 Type: Digital
- 1.21.2 Range: 300V

1.22 Single Phase Wattmeter (2 Nos.)
- 1.22.1 Type: Digital
- 1.22.2 Range: 4kW

1.23 Protective Devices
- 1.23.1 Three Phase MCB (TPN: 1 Nos.
- 1.23.2 Single Phase MCB (DP): 1 Nos.
- 1.23.3 Interconnections: 4mm BS-10 Safety Terminals

1.24 Technical Specifications (Set 1):
- 1.24.1 Both the Machines be flexibly coupled and mounted on a single “C” channel base
- 1.24.2 Three Phase Squirrel cage Induction Motor (acts as prime mover)
  - 1.24.2.1 Type: Squirrel cage induction Motor
  - 1.24.2.2 Power Rating: 5HP
  - 1.24.2.3 Voltage Rating: 440V ± 10%
  - 1.24.2.4 Rated Speed: 1440 RPM ± 7.5%
  - 1.24.2.5 Insulation: Class 'B’
- 1.24.3 DC Machine (acts as generator)
  - 1.24.3.1 Type: Shunt
  - 1.24.3.2 Power Rating: 2.5kW
  - 1.24.3.3 Voltage Generated Rating: 220V ± 10%
  - 1.24.3.4 Rated Speed: 1500RPM ± 7.5%
  - 1.24.3.5 Insulation: Class 'B’
  - 1.24.3.6 Loading Arrangement: Electrical
  - 1.24.3.7 Type of Coupling: Flexible “Lovejoy” Coupling
  - 1.24.3.8 Machine Base: “C” Channel
  - 1.24.3.9 Protection: Fuses (mounted at the terminal box of the Machines)

1.25 Technical Specifications (Set 2):
- 1.25.1 Both the Machines be flexibly coupled and mounted on a ‘C’ Channel base
- 1.25.2 Three Phase Squirrel cage Induction Motor (acts as prime mover)
  - 1.25.2.1 Type: Squirrel Cage induction Motor
  - 1.25.2.2 Rating: 5 HP
  - 1.25.2.3 Voltage Rating: 415V AC
  - 1.25.2.4 Speed: 1440 RPM ±5%
  - 1.25.2.5 Insulation: Class ‘B’
- 1.25.3 DC Machine (acts as generator)
  - 1.25.3.1 Type: Compound
  - 1.25.3.2 Rating: 2.5kW
  - 1.25.3.3 Speed: 1500 RPM ±10%

1.25.3.4 Insulation: Class 'B'

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

1.26.1 Three Phase Variac: 10 A

1.26.2 Rheostat: 220Ohm, 2.8A

1.26.3 Resistive Load: 3.5 kW

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

1.27.1 The content should 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:

1.27.2 This module on Electrical should have all the fundamental topics of electrical and electronics and should 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.

2 AC Motor Trainer

2.1 Basic Indicative Diagram

2.2 Control Panel consisting of high grade FRP material for safety and in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab.
2.3 Rust free powder coated front panel
2.4 Micro-controller based highly accurate digital meters
2.5 Setup should be provided with Digital Tachometer
2.6 Machine have CE Marking.
2.7 Machine fitted with heavy duty channel with mechanical loading arrangements and Aluminum cast Brake-Drum/Pulley arrangements for heat suppression
2.8 Equipped with supply indication lamps
2.9 Good quality and durable spring balance for accurate results
2.10 Diagrammatic representation for the ease of connections so that students can easily understand the concept of machine.
2.11 Provided with suitable protection such as fuses, MCB, earthling provision
2.12 BS10 safety terminals in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab
2.13 Type: Three Phase Squirrel Cage Induction Motor
2.14 (Havells or equivalent)
2.15 Power Rating: 5HP
2.16 Voltage Rating: 415V AC ± 5%, 50Hz
2.17 Rated Speed: 1440 RPM ± 7.5%
2.18 Insulation: Class 'F'
2.19 Loading arrangement: Mechanical
2.20 Spring Balance: 2 Nos. (Tubular Type)
2.21 Brake Drum/Pulley: Aluminum cast with heat suppression Facility
2.22 Machine Base: "C" Channel
2.23 Protection: Fuses (mounted at the terminal box of the Machines)
2.24 Measuring Unit:
- 2.24.1 Voltmeter: 500V (1No.) use selector switch for Three Phase
- 2.24.2 Ammeter: 20 A (1No.)
- 2.24.3 Wattmeter: 4500W (2Nos.)

2.25 Protection Unit:
- 2.25.1 MCB: 16 A
- 2.25.2 Three Phase Variac: 10 A, Closed Type (connected externally)

2.26 The training setup should include online single user Classroom / laboratory teaching, learning and simulation software module with following key features:

2.26.1 The content should 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 advance technologies. The software should comprises 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:

2.26.2 Basic Electrical and Electronics should have all the fundamental topics of electrical and electronics and should 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 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

3.1 Basic Indicative Diagram

3.2 The training system should have motor and generator on a common rail and 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.

3.3 Motor:

3.3.1	Type:	DC Shunt
3.3.2	Capacity:	5 HP
3.3.3	Arm Voltage:	220 V DC
3.3.4	Field Voltage:	220VDC

3.4 Generator:

3.4.1	Type:	Synchronous Type
3.4.2	Capacity:	3.5KVA, 3ø
3.4.3	Output Voltage:	400V AC (line to line), 3 Phase, 4 wire system 50 Hz

3.5 Control Board:

3.5.1 Rust free power coated Control board made up of high grade Fibre moulded body (FRP) which prevent from any abnormal electrical hazards.

3.5.2 The Control panel should be provided to fit the instruments mentioned below

- 3.5.2.1 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
- 3.5.2.2 Shock proof banana jack terminal (BS-10)
- 3.5.2.3 Provided with digital tachometer
- 3.5.2.4 Screen printed diagrammatic connections
- 3.5.2.5 Patch cords of different sizes and color for easy and safe connections
- 3.5.2.6 Separate single phase socket for auxiliary supply
- 3.5.2.7 Mandatory Items (connected externally) required to conduct experiment
- 3.5.2.8 25A, 0 - 220V and 2A, 220V DC Regulated Power Supply
- 3.5.2.9 DC Excitation Unit, 2A, 300V - 1 No.

3.6 The training setup should include online single user Classroom / laboratory teaching, learning and simulation software module with following key features:

3.6.1 The content should 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 advance 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:

3.6.2 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.

4 Servo Motor Drive Trainer

4.1 Basic Indicative Diagram

4.2 Closed loop and Open loop speed control of AC Servo motor
4.3 Slotted disk for speed measurement
4.4 Separate unit for Motor in a see through cabinet
4.5 DPM for speed and voltage display
4.6 Precise signal conditioning
4.7 Instrumentation Power supply with DPM panel:
- 4.7.1 +/-12 V, 500 mA
- 4.7.2 +5V, 300mA
- 4.7.3 Unregulated DC supply
- 4.7.4 Line synchronizing signal.
- 4.7.5 DPM for digital display of speed, etc.

4.8 SCR Actuator/ Drive based (variable DC):
- 4.8.1 Full bridge SCR based 0V-195V / 12 Amp with linear characteristics.
- 4.8.2 Supports signal conditioning circuit for speed to give output 0-2.5Vdc (FS). This supply is required for DC Armature.
- 4.8.3 IGBT/MOSFET based Panel for variable PWM controlled power for armature supply.

4.9 DC voltmeter and DC ammeter panel
- 4.9.1 DC voltmeter (0-300V)
- 4.9.2 DC Ammeter 0-2A) with polarity protection diode
- 4.9.3 Field failure relay to control Armature supply.

4.10 A.C. servo Motor with process setup.
4.11 The trainer should support to perform following experiments:
- 4.11.1 Effect of loading on the speed of the Motor in the open loop
- 4.11.2 Effect of loading on the speed of the Motor in the closed loop
- 4.11.3 Speed control of a AC Servo Motor

5 Stepper Motor Trainer

5.1 Basic Indicative Diagram

5.2 Different modes of operation
5.3 Half and Full step angle
5.4 Visual indication of the coil excitation
5.5 External connector for programming with different controllers
5.6 Separate unit for Motor in a see through cabinet.
5.7 Motor Type: Unipolar
5.8 Torque: 6 Kg-cm
5.9 Phase Current: 0.8 Amp.
5.10 Stepping Angle: 1.8° /0.9°
5.11 Operating Voltage: 12 V DC
5.12 Input Pulse: 5V TTL Compatible
5.13 Test Points: 20
5.14 Cabinet for Motor
5.15 Power Supply: 110 / 230V, 50Hz
5.16 Operating Conditions: 0-40° C, 80% RH
5.17 Learning Material: Online learning material including Theory, procedure, reference results, etc.)
5.18 The trainer should support to perform the following experiments:
- 5.18.1 Study and use of Stepper Motor in Wobble Mode
- 5.18.2 Study of Stepper Motor in Full Step, Single Phase, Free Running Mode
- 5.18.3 Study of Stepper Motor in Full Step, Single Phase, Step Running Mode
- 5.18.4 Study of Stepper Motor in Full Step, Two Phase, Free Running Mode
- 5.18.5 Study of Stepper Motor in Full Step, Two Phase, Step Running Mode
- 5.18.6 Study of Stepper Motor in Half Step, Free Running Mode
- 5.18.7 Study of Stepper Motor in Half Step, Step Running Mode