7. TRADE SYLLABUS

SYLLABUS FOR ELECTRICIAN – POWER DISTRIBUTIONTRADE			
DURATION - FIRST YEAR			
Duration	**Reference Learning outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 95 Hrs; Professional Knowledge 21 Hrs	Prepare profile with an appropriate accuracy as per drawing following safety precautions. (Mapped NOS: PSS/N2001)	1. Visit various sections of the institutes and location of electrical installations. (05 hrs) 2. Identify safety symbols and hazards. (05 Hrs) 3. Preventive measures for electrical accidents and practice steps to be taken in such accidents. (05 hrs) 4. Practice safe methods of fire fighting in case of electrical fire. (05 hrs) 5. Use of fire extinguishers. (05 Hrs) 6. Practice elementary first aid. (05 hrs) 7. Rescue a person and practice artificial respiration. (05 Hrs) 8. Disposal procedure of waste materials. (05 Hrs) 9. Use of personal protective equipments. (05 hrs) 10. Practice on cleanliness and procedure to maintain it. (05 hrs)	Scope of the "Electrician – Power Distribution" Trade. Power sector scenario in India. Safety rules and safety signs. Introduction to Electricity Act-2003, CERC, SERC. First aid safety practice. Hazard identification and prevention. Personal safety and factory safety. Response to emergencies e.g. power failure, system failure and fire etc. Types and working of fire extinguishers. Standard distance for safe working zone, clearance from live HV electrical system. (09 hrs.)
		11. Identify trade tools and machineries. (10 Hrs) 12. Practice safe methods of lifting and handling of tools & equipment. (10 Hrs) 13. Select proper tools for operation and precautions	Concept of Standards and advantages of BIS/ISI. Trade tools specifications. Introduction to National Electrical Code-2011. Store keeping of equipments

		in operation. (05 Hrs) 14. Care & maintenance of trade tools. (05 Hrs)	for Repair works. (05 hrs.)
		15. Workshop practice on filing and hacksawing. (15 Hrs)	Description of files, hammers, chisels, hacksaw frames, blades, their specification and grades. (07 hrs.)
Professional Skill 40 Hrs; Professional Knowledge 07Hrs	Prepare profile with an appropriate accuracy as per drawing following safety precautions. (Mapped NOS: PSS/N2001)	16. Practice in marking and cutting of straight and curved pieces in metal sheets. (10 Hrs) 17. Workshop practice on drilling, chipping, internal and external threading of different sizes. (15Hrs) 18. Practice of making square and round holes, securing by screw and riveting. (06Hrs) 19. Prepare an open box from metal sheet. (09 Hrs)	Marking tools; Introduction to fitting tools, calipers, Dividers, Surface plates, Angle plates, Scribers, punches, surface gauges Types, Uses, Care and maintenance. Sheet metal tools: Description of marking & cutting tools. Types of rivets and riveted joints. Use of thread gauge. Care and maintenance of tools. (07 hrs.)
Professional Skill 56Hrs; Professional Knowledge 10Hrs	Prepare electrical wire joints, carry out soldering and crimping. (Mapped NOS: PSS/N0108)	20. Prepare terminations of cable ends (02 hrs) 21. Practice on skinning, twisting and crimping. (10 Hrs) 22. Identify various types of cables and measure conductor size using SWG and micrometre. (8 Hrs) 23. Make simple twist, married, Tee and western union joints. (13 Hrs) 24. Make Britannia straight, Britannia Tee and rat tail joints. (13 Hrs) 25. Practice in Soldering of joints / lugs. (10 Hrs)	Fundamentals of electricity, definitions, units & effects of electric current. Conductors and insulators. Conducting materials and their comparison. Joints in electrical conductors, contact resistance measurement and required pressure. Techniques of soldering. Types of solders and flux. (10 hrs.)
Professional Skill 60Hrs; Professional Knowledge	Verify basic characteristics of electrical and magnetic circuits and perform	26. Practice on measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor	Ohm's Law; Simple electrical circuits and problems. Kirchhoff's Laws and applications. Series and parallel circuits.

10Hrs	measurements using analog / digital instruments. (Mapped NOS: PSS/N1707)	values and voltage sources. (04 Hrs) 27. Measure current and voltage in electrical circuits to verify Kirchhoff's Law (03 Hrs) 28. Verify laws of series and parallel circuits with voltage source in different combinations. (03 Hrs) 29. Measure voltage and current against individual resistance in electrical circuit (04 hrs) 30. Measure current & voltage and analyse the effects of shorts and opens in series and parallel circuits. (04 Hrs) 31. Measure resistance using voltage drop method. (04 Hrs) 32. Measure resistance using Wheatstone bridge. (03 Hrs) 33. Determine the change in resistance due to temperature. (03 Hrs) 34. Verify the characteristics of series parallel combination of resistors. (03 Hrs) 35. Determine the poles and plot the field of a magnet bar. (03 Hrs) 36. Wind a solenoid and determine the magnetic effect of electric current. (04 Hrs) 37. Measure induced emf due to change in magnetic field. (04hrs) 38. Determine direction of induced emf and current. 1(04hrs) 39. Practice on generation of mutually induced emf. (04	Open and short circuits in series and parallel networks. Laws of Resistance and various types of resistors. Wheatstone bridge; principle and its applications. Effect of variation of temperature on resistance. Different methods of measuring the values of resistance. Series and parallel combinations of resistors. Magnetic terms, magnetic materials and properties of magnet. Principles and laws of electro-magnetism. Self and mutually induced EMFs. **Electrostatics:** Capacitor- Different types, functions, grouping and uses. Inductive and capacitive reactance, their effect on AC circuit and related vector concepts. Handling of charging and discharging of static capacitors and other static charged equipment. (10 hrs.)

		hrs) 40. Measure the resistance, impedance and determine inductance of choke coils in different combinations. (04 Hrs) 41. Identify various types of capacitors, charging / discharging and testing. (03Hrs) 42. Group the given capacitors to get the required capacity and voltage rating. (03Hrs)	
Professional Skill 60Hrs; Professional Knowledge 10Hrs	Verify basic characteristics of electrical and magnetic circuits and perform measurements using analog / digital instruments. (Mapped NOS: PSS/N1707)	43. Measure current, voltage and PF and determine the characteristics of RL, RC and RLC in AC series circuits. (08Hrs) 44. Measure the resonance frequency in AC series circuit and determine its effect on the circuit. (06hrs) 45. Measure current, voltage and PF and determine the characteristics of RL, RC and RLC in AC parallel circuits. (08Hrs) 46. Measure the resonance frequency in AC parallel circuit and determine its effects on the circuit. (06hrs) 47. Measure power, energy for lagging and leading power factors in single phase circuits and compare characteristic graphically. (08Hrs) 48. Measure Current, voltage, power, energy and power factor in three phase circuits. (06hrs) 49. Practice improvement of PF by use of capacitor in three	Comparison and Advantages of DC and AC systems. Related terms frequency, Instantaneous value, R.M.S. value Average value, Peak factor, form factor, power factor and Impedance etc. Sine wave, phase and phase difference. Active and Reactive power. Single Phase and three-phase system. Problems on A.C. circuits. Classification of electrical instruments and essential forces required in indicating instruments. PMMC and Moving iron instruments. Measurement of various electrical parameters using different analog and digital instruments. Measurement of energy in three phase circuit. (10 hrs.)

		phase circuit. (06Hrs) 50. Measure power factor in three phase circuit by using power factor meter and verify the same with voltmeter, ammeter and wattmeter readings. (10Hrs)	
Professional Skill 60Hrs; Professional Knowledge 08Hrs	Verify basic characteristics of electrical and magnetic circuits and perform measurements using analog / digital instruments. (Mapped NOS: PSS/N1707)	51. Ascertain use of neutral by identifying wires of a 3-phase 4 wire system and find the phase sequence using phase sequence meter. (08Hrs) 52. Determine effect of broken neutral wire in three phase four wire system. (06hrs) 53. Determine the relationship between Line and Phase values for star and delta connections. (08Hrs) 54. Measure the Power of three phase circuit for balanced and unbalanced loads. (08Hrs) 55. Measure current and voltage of two phases in case of one phase is short-circuited in three phase four wire system and compare with healthy system.(10 hrs) 56. Measure electrical parameters using tong tester in three phase circuits. (10 Hrs) 57. Measure various electrical parameters using digital multifunction meter.(10hrs)	Advantages of AC poly-phase system. Concept of three-phase Star and Delta connection. Line and phase voltage, current and power in a 3 phase circuits with balanced and unbalanced load. Phase sequence meter. Basic concept of Digital Multi-Function Meter. Basic concept of Accuracy class of meters. Communication from MFM to SCADA system. Improvement of power factor using Capacitor Bank. (08 hrs.)
Professional Skill 50Hrs; Professional Knowledge 10Hrs	Assemble simple electronic circuits and test for functioning. (Mapped NOS: PSS/N2504)	58. Determine the value of resistance by colour code and identify types. (06Hrs) 59. Test active and passive electronic components and its applications. (10Hrs) 60. Determine V-I	Resistors – colour code, types and characteristics. Active and passive components. Atomic structure and semiconductor theory.

		characteristics of semiconductor diode. (06Hrs) 61. Construct half wave, full wave and bridge rectifiers using semiconductor diode. (14Hrs) 62. Check transistors for their functioning by identifying its type and terminals. (06Hrs) 63. Use transistor as an electronic switch and series voltage regulator. (08Hrs)	P-N junction, classification, specifications, biasing and characteristics of diodes. Rectifier circuit - half wave, full wave, bridge rectifiers and filters. Transistors; Principle of operation, types, characteristics various configuration and biasing of transistor. Application of transistor as a switch, voltage regulator and amplifier. (10 hrs.)
Professional Skill 50Hrs; Professional Knowledge 10Hrs	Assemble simple electronic circuits and test for functioning. (Mapped NOS: PSS/N2504)	64. Operate and set the required frequency using function generator. (05Hrs) 65. Make a printed circuit board for power supply. (05Hrs) 66. Construct simple circuits containing UJT for triggering and FET as an amplifier. (05Hrs) 67. Troubleshoot defects in simple power supplies. (05Hrs) 68. Construct power control circuit by SCR, Diac, Triac and IGBT. (05Hrs) 69. Construct variable DC stabilized power supply using IC. (05Hrs) 70. Practice on various logics by use of logic gates and circuits. (06Hrs) 71. Generate and demonstrate wave shapes for voltage/ current of rectifier and single stage amplifier using CRO. (08Hrs) 72. Construct 1ϕ or 3ϕ bridge rectifier/ inverter/ logic	Basic concept of power electronics devices. IC voltage regulators Digital Electronics - Binary numbers, logic gates and combinational circuits. Functions & settings of oscilloscope and waveform analysis. Construction and working of SCR, DIAC, TRIAC and IGBT. Types and applications of various multivibrators. (10 hrs.)

			gate, measure input and output voltage and analyze waveforms by using oscilloscope.(06Hrs)	
Professional Skill 50Hrs; Professional Knowledge 10Hrs	Carry out installation, testing and maintenance of batteries and battery room in distribution substation. (Mapped NOS: PSS/N2504)	73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85.	Identify and use of various types of cells. (02Hrs) Measure voltage of different cells and Batteries. (03Hrs) Practice on grouping of cells for specified voltage and current under different conditions with due care. (02Hrs) Measure specific gravity of electrolyte and determine correction factor. (03Hrs) Identify various components of battery charger used in sub-station. (02Hrs) Perform proper setting of voltage according to mode of charging and practice on Battery charging. (03Hrs) Perform setting and carry out Trickle charging of Battery. (05Hrs) Practice charging and discharging of Ni-Cd battery. (05Hrs) Charge batteries by using float and boost charger. (05Hrs) Check DC leakage and practice for its protection. (05Hrs) Carry out testing of batteries. (05Hrs) Practice on routine, care/ maintenance of batteries. (05Hrs) Determine the number of solar cells in series / parallel for given power	Chemical effect of electric current and Laws of electrolysis. Explanation of Anodes and cathodes. Types of cells, advantages/ disadvantages and their applications. Lead acid cell; Principle of operation and components. Types of battery charging, Load test of Ni-Cd and Lead Acid batteries, Safety precautions, test equipment and maintenance. Grouping of cells for specified voltage and current. Alkaline batteries Types of Battery operation: - Floating operation - Change over operation Boost charging Two Battery two charger system End cell cutting. C5 and C10 charging methods Factors affecting Battery life: - Over charging - Under charging - Leakage Correction factor, Calculation of Battery capacity Inspection of Battery Principle and operation of solar cell. Awareness of maintenance free battery concept. Safety compliance of battery room. (10 hrs.)

		requirement. (05Hrs)	
Professional Skill 60Hrs; Professional Knowledge 12Hrs	Estimate, Assemble, install and test wiring system. (Mapped NOS: PSS/N1707)	86. Identify various conduits and different electrical accessories. (03Hrs) 87. Practice cutting, threading of different sizes & laying Installations. (03Hrs) 88. Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, RCCB, RCBO, MPCB, MCCB etc. (06Hrs) 89. Draw layouts and practice in PVC Casing-capping, Conduit wiring with minimum to a greater number of points of minimum 15 metres. length. (06Hrs) 90. Wire up PVC conduit wiring to control one lamp from two or three different places. (06 Hrs) 91. Wire up PVC conduit wiring and practice control of sockets and lamps in different combinations using switching concepts. (06Hrs) 92. Wire up the consumer's main board with ICDP switch MCB and distribution fuse box. (05Hrs) 93. Prepare and mount the energy meter board. (03Hrs) 94. Estimate the cost/bill of material for wiring of hostel/ residential building and workshop. (04Hrs) 95. Practice wiring of hostel and residential building as per IE rules. (06Hrs) 96. Practice wiring of institute	I.E. rules on electrical wiring. Types of domestic and industrial wirings. Study of wiring accessories e.g. switches, fuses, relays, MCB, RCCB, RCBO, MCCB etc. MPCB and its accessories. Under voltage, over voltage, shunt modules. Grading of cables and current ratings. Principle of laying out of domestic wiring. Voltage drop concept. PVC conduit and Casing-capping wiring system. Different types of wiring - Power, control, Communication and entertainment wiring. Wiring circuits planning, permissible load in sub-circuit and main circuit. Estimation of load, cable size, bill of material and cost. Inspection and testing of wiring installations. Special wiring circuit e.g. godown, tunnel and workshop etc. (12 hrs.)

		and workshop as per IE rules. (06Hrs) 97. Practice testing / fault detection of domestic and industrial wiring installation and repair. (06Hrs)	
Professional Skill 40Hrs; Professional Knowledge 12Hrs	Plan and install electrical illumination system and test. (Mapped NOS: PSS/N1707)	98. Group different wattage of lamps in series for specified voltage. (04 Hrs) 99. Practice installation of various lamps e.g. fluorescent tube, HP sodium vapour, metal halide etc. (14Hrs) 100. Prepare decorative lamp circuit. (05 Hrs) 101. Prepare decorative lamp circuit to produce rotating light effect/running light effect. (05 Hrs) 102. Install light fitting for show case lighting. (06Hrs) 103. Install light fittings with various types of LEDs and fixture. (06Hrs)	Laws of Illuminations. Types of illumination system. Illumination factors, intensity of light. Type of lamps, advantages/ disadvantages and their applications. Calculations of lumens and efficiency. Different types of LEDs and fixtures. Luminous efficiency of LED Various color temperatures – Cool Day light - 5700K/ 6500K, Warm white - 2700K/ 300K False Recess type / Surface type. (08 hrs.)
Professional Skill 90Hrs; Professional Knowledge 16 Hrs	Plan, Execute commissioning, testing of AC motors& Starters and carry out their maintenance. (Mapped NOS: PSS/N1709)	104. Identify parts and terminals of three phase AC motors. (05 Hrs) 105. Practice reading of power and control schematic drawings of motors. (05 Hrs) 106. Connect, start and run three phase induction motors by using DOL, star-delta starters. (05 Hrs) 107. Connect, start, run and reverse the direction of rotation of slip-ring motor through rotor resistance starter. (08 Hrs) 108. Practice on connection and settings of Soft starters. (06 Hrs) 109. Determine the efficiency of	Introduction of DC motors and their applications. Working principle of three phase induction motor. Squirrel Cage Induction motor, Slip-ring induction motor; construction, characteristics, Slip and Torque. Different types of starters for three phase induction motors, its necessity, basic contactor circuit, parts and their functions. Basic knowledge of soft starter Single phasing prevention. No load test and blocked rotor test of induction motor. Losses & efficiency.

		three phase squirrel cage induction motor by no load test and blocked rotor test. (06 Hrs) 110. Test for continuity and insulation resistance of three phase induction motor. (06 Hrs) 111. Perform speed control of three phase induction motor by various methods like rheostatic control, autotransformer etc. (12 Hrs) 112. Identify parts and terminals of different types of single-phase AC motors. (05 Hrs) 113. Install, connect and determine performance of single-phase AC motors. (08Hrs) 114. Start, run and reverse the direction of rotation of single-phase AC motors. (08 Hrs) 115. Practice on speed control of single phase AC motors. (08 Hrs) 116. Practice repair and maintenance of AC motors. (08 Hrs)	Various methods of speed control. Braking system of motor. Maintenance and repair. Working principle, different method of starting and running of various single-phase AC motors. Domestic and industrial applications of different AC motors. Characteristics, losses and efficiency. (16 hrs.)
Professional Skill 65Hrs; Professional Knowledge 15Hrs	Perform testing and carry out maintenance of Alternator and Synchronous motor. (Mapped NOS: PSS/N1711)	117. Identify parts and terminals of alternator. (07 Hrs) 118. Test for continuity and insulation resistance of alternator. (08 Hrs) 119. Connect, start and run an alternator and build up the voltage. (08 Hrs) 120. Determine the load performance and voltage regulation of three phase alternator. (08 Hrs) 121. Parallel operation and	Principle of alternator, e.m.f. equation, relation between poles, speed and frequency. Types and construction. Efficiency, characteristics, regulation, phase sequence and parallel operation. Effect of changing the field excitation and power factor correction. Working principle of synchronous motor.

		synchronization of three phase alternators. (08 Hrs) 122. Identify parts and terminals of a synchronous motor. (06 Hrs) 123. Connect, start and plot V-curves for synchronous motor under different excitation and load conditions. (10 Hrs) 124. Carry out maintenance of Alternator and synchronous motor. (10 Hrs)	Effect of change of excitation and load. V and anti V curve. Power factor improvement. Rotary Converter, MG Set description and Maintenance. (15 hrs.)
Professional Skill 20Hrs; Professional Knowledge 05Hrs	Perform speed control of AC motors by using solid state devices/ AC drives. (Mapped NOS: PSS/N1709)	125. Enter motor data and perform auto tuning on thyristors/ AC drive. (06 Hrs) 126. Perform reversing the direction of rotation of AC motors by using thyristors / AC drive. (08 Hrs) 127. Perform connections and identify parameters of AC drives. (06 Hrs)	Working, parameters and applications of AC drive. Speed control of 3 phase induction motor by using VVVF/AC Drive. (05 hrs.)
Professional Skill 44Hrs; Professional Knowledge 08 Hrs	Detect the faults and troubleshoot inverter, stabilizer, battery charger and UPS etc. (Mapped NOS: PSS/N6002)	128. Identify and assemble circuits of voltage stabilizer and UPS. (08 Hrs) 129. Assemble circuits of battery charger and inverter. (08 Hrs) 130. Test, analyze defects and repair voltage stabilizer, emergency light and UPS. (09 Hrs) 131. Maintain, service and troubleshoot battery charger and inverter. (09 Hrs) 132. Install an Inverter with battery and connect it in domestic wiring for operation. (09 Hrs)	Basic concept, block diagram and working of voltage stabilizer, battery charger, emergency light, inverter and UPS. Preventive and breakdown maintenance. (08 hrs.)
ENGINEERING DRAWING: (40 Hrs.)			
Professional	Read and apply	**ENGINEERING DRAWING:**	

Knowledge ED: 40 Hrs.	engineering drawing for different application in the field of work.	Introduction to Engineering Drawing and Drawing Instruments • Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instrument Freehand drawing of– • Geometrical figures and blocks with dimension • Transferring measurement from the given object to the free hand sketches. • Free hand drawing of hand tools. Drawing of Geometrical figures: • Angle, Triangle, Circle, Rectangle, Square, Parallelogram. • Lettering & Numbering – Single Stroke Dimensioning Practice • Types of arrowhead Symbolic representation– • Different electrical symbols used in the related trades Reading of Electrical Circuit Diagram Reading of Electrical Layout drawing
WORKSHOP CALCULATION & SCIENCE: (40Hrs.)		
Professional Knowledge WCS: 40 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	**WORKSHOP CALCULATION & SCIENCE:** **Unit, Fractions** Classification of unit system Fundamental and Derived units F.P.S, C.G.S, M.K.S and SI units Measurement units and conversion Factors, HCF, LCM and problems Fractions - Addition, substraction, multiplication & division Decimal fractions - Addition, subtraction, multilipication & division Solving problems by using calculator **Square root, Ratio and Proportions, Percentage** Square and suare root Simple problems using calculator Applications of pythagoras theorem and related problems Ratio and proportion Ratio and proportion - Direct and indirect proportions Percentage Precentage - Changing percentage to decimal and fraction **Material Science** Types metals, types of ferrous and non ferrous metals Introduction of iron and cast iron **Mass, Weight, Volume and Density** Mass, volume, density, weight

		Related problems for mass, volume, density, weight and specific gravity **Speed and Velocity, Work, Power and Energy** Work, power, energy, HP, IHP, BHP and efficiency Potential energy, kinetic energy and related problems with assignment **Heat & Temperature and Pressure** Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and non-metals Scales of temperature, celsius, fahrenheit, kelvin and conversion between scales oftemperature Heat &Temperature - Temperature measuring instruments, types of thermometer, pyrometer and transmission of heat - Conduction, convection and radiation **Basic Electricity** Introduction and uses of electricity, molecule, atom, how electricity is produced, electric current AC,DC their comparison, voltage, resistance and their units Conductor, insulator, types of connections - series and parallel Ohm's law, relation between V.I.R & related problems Electrical power, energy and their units, calculation with assignments. **Mensuration** Area and perimeter of square, rectangle and parallelogram Area and perimeter of Triangles Area and perimeter of circle, semi-circle, circular ring, sector of circle, hexagon and ellipse Surface area and volume of solids - cube, cuboid, cylinder, sphere and hollow cylinder

Project work / Industrial visit

Broad Areas:

a) Prepare and assemble a test board with switches, plug socket, lamp holder etc.
b) Temperature controlled system for switching 'ON' and 'OFF' of any circuit using bi-metallic strip.
c) Series/ parallel combinational circuits.
d) Circuits using Electronic components.
e) Waveform analysis of circuits.
f) Protection of electrical equipment.
g) Automatic control using relays.
h) Fuse and power failure indicator using relays.
i) Door alarm/indicator.
j) Decorative light.
k) Motor circuits, speed control and testing.
l) Inverter/ UPS/ Battery charger/ Stabilizer

SYLLABUS FOR ELECTRICIAN – POWER DISTRIBUTION TRADE			
SECOND YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 55 Hrs; Professional Knowledge 15Hrs	Assemble accessories and carry out wiring of control cabinets and equipment. (Mapped NOS: PSS/N1707)	133. Carry out wiring of control cabinet as per wiring diagram, bunching of XLPE cables, channelling, tying and checking etc. (15Hrs) 134. Mount various control elements e.g. circuit breakers, relays, contactors and timers etc. (12Hrs) 135. Identify and install required measuring instruments and sensors in control panel. (08Hrs) 136. Test the control panel for its performance. (08Hrs) 137. Design layout of control cabinet, assemble control elements and wiring accessories for: (i) Forward and reverse operation of induction motor. (06Hrs) (ii) Automatic star-delta starter with change of direction of rotation. (06Hrs)	Study and understand Layout drawing of control cabinet, power and control circuits. Various control elements: Isolators, pushbuttons, switches, indicators, MCB, fuses, relays, types of timers and limit switches etc. Wiring accessories: Race ways/ cable channel, DIN rail, terminal connectors, thimbles, lugs, ferrules, cable binding strap, buttons, cable ties, sleeves, gromats and clips etc. Testing of various control elements and circuits. (15 hrs.)
Professional Skill 58Hrs; Professional Knowledge 18Hrs	Perform on-site installation, preventive maintenance, testing, repair/ replacement of electrical power distribution	138. Identify outdoor and indoor switchgears. (04 Hrs) 139. Identify power and distribution transformers.(04 Hrs) 140. Visit to power and motor control centre and	Various ways of electrical power generation by conventional and non-conventional methods. Transmission and distribution networks. General layout of substation Single line diagram, general

	equipment viz., circuit breakers, isolators, lightening arresters, reactor, capacitor bank etc. (Mapped NOS: PSS/N1708, PSS/N0106)	identify various equipment. (04 Hrs) 141. Practice Live-dead-Live test in electrical panel (HV/LV). (04 Hrs) 142. Draw layout of thermal power plant and identify function of different elements. (08 Hrs) 143. Draw layout of hydel power plant and identify functions of different elements. (08 Hrs) 144. Draw single line diagram of transmission and distribution system. (08 Hrs) 145. Identify various substation equipment viz., isolators, over current relays, earth fault relay, differential relay, REF relay, lightening arresters, Surge counter, wave trap, Reactor, Capacitor bank, Circuit breakers – ACB, SF-6 and VCB etc. (14 Hrs) 146. Video demonstration of laying OPGW along with earth wire at the top of tower of HV Line. (04 Hrs)	symbols for various equipment installed at substation. Single line diagram for various 33 KV, 132 KV, 220 KV, 400 KV substations. Basic idea about distribution system Electrical Safety guidelines and regulations for HT. Direct and indirect Risks of electricity. Voltage detector and its application Basic Parameters of all equipments and their name plate. Techniques of Hotline maintenance at HVS/s. Protection of transmission line via PLCC system. (18 hrs.)
Professional Skill 42Hrs; Professional Knowledge 15Hrs	Perform on-site installation, preventive maintenance, testing, repair/ replacement of electrical power distribution equipment viz., circuit breakers, isolators, lightening arresters, reactor, capacitor bank etc.	147. Practice operation of isolators. (02 Hrs) 148. Identify different components of Circuit Breakers. (02hrs) 149. Perform operation of circuit breakers in maintenance (test) mode. (03hrs) 150. Practice use of grounding rod and make visible earthing. (02 hrs) 151. Practice operation of	Types of isolators like Horizontal centre break, Double break, Pantograph type. **Circuit Breakers;** Types of circuit breakers, their applications and functioning. Production of arc and arc quenching methods (Air blast, oil, SF-6 and vacuum) Types of male and female contacts. Types of jaws & blades of various isolators

	(Mapped NOS: PSS/N1708, PSS/N0106)	Circuit Breakers; ACB, SF-6 and VCB etc. (06 hrs) 152. Practice filling and evacuation of gas in SF-6 Circuit breaker. (03hrs) 153. Carry out timer test on circuit breakers. (02 hrs) 154. Carry out repair and maintenance of circuit breakers. (08 hrs) 155. Identify lightening arrester in the yard and practice replacement. (04 hrs) 156. Practice reading of surge counter. (02 hrs) 157. Identify Wave Trap and LMU and practice replacement. (04 hrs) 158. Carry out maintenance on wave trap and LMU. (04 hrs)	Maintenance of equipment Grounding Rod Lightening arrester, surge counter Wave Trap and LMU (Line Matching Unit); power line carrier communication (PLCC) system Corona losses in transmission lines in power system. General routine maintenance. Handling of SF6 gas (filling and evacuation procedure) Inspection of contact resistance of breakers and alignment of contacts. Opening and closing time of breakers. (15 hrs.)
Professional Skill 120Hrs; Professional Knowledge 25Hrs	Carry out testing, maintenance and evaluate performance of transformers. (Mapped NOS: PSS/N2407)	159. Verify terminals, identify components and calculate transformation ratio of single-phase transformers. (07Hrs) 160. Determine voltage regulation of single-phase transformer at different loads and power factors. (07Hrs) 161. Perform series and parallel operation of two single phase transformers. (07 Hrs) 162. Verify the terminals and accessories of three phase transformer HT and LT side. (05Hrs) 163. Perform 3 phase operation (i) delta-delta (ii) delta-star (iii) star-star (iv) star-delta, by use of	Working principle, construction and classification of transformer. Single phase and three phase transformers. Turn ratio and e.m.f. equation. Series and parallel operation of transformers. Voltage Regulation and efficiency. Auto Transformer and instrument transformers (CT & PT). Method of connecting three single phase transformers for three phase operation. Types of Cooling, protective devices, bushings and termination etc. Testing of transformer oil. Routine tests and Pre-commissioning tests of transformers. On load tap changer, driving mechanism and operation of tap.

		three single phase transformers. (07Hrs) 164. Perform BDV (Dielectric strength) and water particle content test of transformer oil. (07 Hrs) 165. Video demonstration of filtering of transformer oil. (05Hrs) 166. Carry out routine tests of transformer to check operational performance. (07Hrs) 167. Carry out IR & PI test of distribution transformer used in substations using analog& digital megger. (07Hrs) 168. Measure Transformer winding resistance. (02Hrs) 169. Carry out IR test of individual bushings of distribution transformer. (03Hrs) 170. Identify phase and neutral bushings of HV & LV side of the distribution transformer. (05Hrs) 171. Identify various components of cooler control system of the transformer. (04Hrs) 172. Carry out manual and auto operation of fan from transformer marshalling kiosk. (04 Hrs) 173. Perform transformation ratio test. (04 Hrs) 174. Carry out Short circuit test and measure impedance voltage/ short circuit impedance (principal tap) and load loss. (05 Hrs)	Oil test include DGA (Dissolved gas analysis) and its interpretation Metal particle analysis and FURAN test Partial discharge (PD) and tan delta test. Alarm and Trip settings for winding temperature Indicator, oil temperature Indicator and Buchholz etc. On load tap changer (OLTC), Driving mechanism and operation of tap locally as well as remotely from control room. Vector group test for parallel operation of transformers. (25 hrs.)

		175. Carry out Open circuit test for measurement of no-load loss and current. (10Hrs) 176. Carry out induced Voltage Test of Transformer. (08Hrs) 177. Carry out tests on components / accessories viz., buchholz relay, Temperature indicators, Pressure relief devices, Oil preservation system etc. (08Hrs) 178. Carry out maintenance of transformer. (08Hrs)	
Professional Skill 80Hrs; Professional Knowledge 20Hrs	Plan and prepare LT/HT cable and Underground cable joints. (Mapped NOS: PSS/N0108)	179. Identify different types of HT/LT cables. (04hrs) 180. Identify different parts of various underground cables. (04hrs) 181. Practice preparation of cables for termination and joining. (08hrs) 182. Demonstrate termination kits and practice on terminations of LT/HT cables. (08hrs) 183. Make straight joint of different types of underground cable. (10hrs) 184. Carry out high voltage (high pot) test. (06 hrs) 185. Practice laying of HT/LT cables in raceways and trenches. (06 hrs) 186. Demonstrate and identify various cable glands. (05 hrs) 187. Practice passing of cables through cable entry plate for standard cables without connectors, up to	Power cables: Need of HT cables, advantages and disadvantages, various types viz., PVC, XLPE, Halogen, Optical fiber, etc. Awareness of HT/LV cable Cable insulation & voltage grades. Classification of cable on the basis of construction, voltage and current. Need for cable jointing (splicing). Need of termination kits. Joints and terminations; pre-moulded, heat shrinkable, extrusion molded joints Slip on, cold shrink terminations. Types of connectors used in the cable, current path. Methods of conductor connection, contact resistance. Precautions in using various types of cables. Galvanic corrosion and use of bimetals. Connectivity for cable screen and armour, mechanical protection Kits for joints and terminations (cold and heat shrink). HV and LV cable joint procedure.

		IP 68 rated protection. (05 hrs) 188. Practice split cable entry for multiple pre-terminated cables, up to IP 65 rated protection. (05 hrs) 189. Practice cable entry on a switch cabinet wall. (05 hrs) 190. Demonstrate bonding and grounding of raceways, cable assembly and panels. (05 hrs) 191. Test underground cables for faults and remove the fault. (09 hrs)	Cable termination to equipment Standards and testing; type, routine, field test Stress control Basic concept of Laying procedure and necessary step during emergency restoration and isolate faulty section of power cable in HV Electrical system. Introduction to IP ratings (Ingress protection) and IP Codes format. Importance of Bonding and grounding, various types. Testing of cables, locating faults, open circuit, short circuit and leakage in cables. (20 hrs.)
Professional Skill 55 Hrs; Professional Knowledge 15Hrs	Perform testing, repair/ replacement and maintenance of control elements viz., CT, PT, etc., used for protection and measurement in power distribution. (Mapped NOS: PSS/N1707)	192. Identify Current transformers, its specifications and carry out visual inspection. (03hrs) 193. Carry out ratio test on CT. (03 hrs) 194. Carry out Polarity test on CT. (03 hrs) 195. Check insulation resistance of CT. (03 hrs) 196. Carry out winding resistance test on CT. (03 hrs) 197. Carry out Excitation (Saturation) test on CT. (04 hrs) 198. Carry out Burden test on CT. (04 hrs) 199. Carry out knee point voltage test of protection core. (03 hrs) 200. Carry out ratio change of CT by changing taps in primary and secondary side. (04 hrs) 201. Perform installation and	Instrument Transformer: Necessity/ Advantages • Difference between Power Transformer & Instrument Transformer. • Location of CT and PT in the System. • Difference between Instrument Transformers used for Protection/ Measurement Testing of CT and PT Isolation transformer Basic concept of Live tank and Dead tank CT Basic concept of CVT Various types of CT categories and burden-Cl-1/0.5/0.2, Protection CT – 5P10 etc Special Protection CT – PS class Various substations; outdoor, indoor, pole mounted, Gas insulated substation (GIS), etc. Various terms like – maximum demand, average demand, load factor, diversity factor, plant utility factor etc. (15 hrs.)

		commissioning of current transformer. (06 hrs) 202. Identify potential transformers, its specifications and carry out visual inspection. (02 hrs) 203. Perform insulation resistance tests on PT; winding to winding and each winding to ground. (03hrs) 204. Carry out Polarity test on PT. (02hrs) 205. Perform turn's ratio test on PT. (03hrs) 206. Perform installation and commissioning of potential transformer. (04hrs) 207. Identify isolation transformers and its specifications. (03hrs) 208. Carry out repair/ replacement and maintenance of CT and PT. (02 hrs)	
Professional Skill 55 Hrs.; Professional Knowledge 15Hrs.	Plan and prepare Earthing installation, carryout testing and maintenance. (Mapped NOS: PSS/N6002)	209. Identify various earthing components and their specifications. (05Hrs) 210. Plan and prepare pipe earthing. (09Hrs) 211. Plan and prepare plate earthing. (09Hrs) 212. Plan and prepare grid/mesh earthing. (09Hrs) 213. Practice earthing of delta connected system. (03Hrs) 214. Practice grounding of equipment and systems. (03Hrs) 215. Perform measurement of	Introduction Importance of Earthing Classification of Earthing: - • Depending upon use; Equipment, System, Discharge, Support and Line Earthing. • Depending upon type; Well type, Pipe, Plate, Mesh, Delta and Chemical earthing Plate earthing and pipe earthing methods and IEE regulations. Difference between grounding and earthing. Earth resistance and earth leakage circuit breaker. Balanced/ Restricted earth protection.

		earth resistance using earth tester. (05Hrs) 216. Carry out treatment to minimize earth resistance. (04Hrs) 217. Carry out maintenance of earth system. (04Hrs) 218. Test earth leakage by ELCB and relay. (04Hrs)	Awareness of circuit main earth (CME) and portable earth. (12 hrs.)
Professional Skill 100Hrs; Professional Knowledge 20 Hrs	Plan and commission overhead distribution line including ABC and HVDS. (Mapped NOS: PSS/N0108)	219. Identify various conductors viz., All aluminium conductor (AAC), ACSR conductor, etc. (08Hrs) 220. Perform mechanical and electrical testing of overhead conductors. (12 Hrs) 221. Identify various sizes of copper wires and cable insulation FR/FRLS/FRLSH. (08Hrs) 222. Practice joining of overhead line conductors. (12 Hrs) 223. Identify Aerial Bunched Cables used in distribution system. (08Hrs) 224. Plan and commission overhead distribution line using bare conductors. (20 Hrs) 225. Plan and commission distribution line using ABC. (20 Hrs) 226. Identify components and work with High Voltage Distribution System (HVDS). (12 Hrs)	Objectives of Distribution System. Classification of Conductors and Nomenclature Current rating Jointing of conductor ABC System - Prominent Considerations for Selection for ABC System; LT ABC, HT ABC Method of joining aluminum conductors. High Voltage Distribution System (HVDS) Advantages of HVDS Route survey for overhead and underground cable distribution system. Safety Procedures and Permit to Work Operation and Maintenance of Distribution System. (20 hrs.)
Professional Skill 75 Hrs; Professional Knowledge	Carry out installation, repair/ replacement and maintenance of tower/pole and	227. Identify different Supports, Transmission Towers, and various accessories.(08 Hrs) 228. Perform digging of pit,	CEA safety regulation 2010 Supports and Accessories: PCC Pole, ST Pole, Cross Arms, Clamps, Transmission Towers Different types of Line insulators

23Hrs	accessories in Power Distribution System. (Mapped NOS: PSS/N0108)	erection of supports and fitting various accessories on poles.(12 Hrs) 229. Perform stringing and sagging of line conductors.(10 Hrs) 230. Fasten jumper in pin, shackle and suspension type insulators. (10 Hrs) 231. Perform installation of overhead domestic service lines.(15 Hrs) 232. Measure current carrying capacity of conductors. (05 hrs) 233. Practice installation and sealing of energy meters.(05 Hrs) 234. Install bus bar and bus coupler on LT line. (05 Hrs) 235. Practice working with thermo vision camera. (05 Hrs)	Foundations - Dry, Wet, PS, FS and Well type Construction of Distribution and Transmission Network. Erection & Commissioning of Equipments. Safety precautions and IE rules pertaining to domestic service connections. Basic concept of MONO Pole, Multi circuit Tower and 90 degree crossing of two HV Transmission line in same tower. Basic concept of transposition of towers. Types of Faults in electrical system. Thermo vision supervision at substation for hot point detection. (23 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 15Hrs.	Monitor meter readings, generate bill, maintain & upkeep various log sheets and energy accounting. (Mapped NOS: PSS/N3001)	236. Practice on collecting meter reading of various meters. (08hrs) 237. Practice study of MRI reports. (12 hrs) 238. Take meter reading by using USB / Optical cable. (12 hrs) 239. Observe/ Study log sheet at substation. (08 hrs) 240. Practice generation of electricity bill using SBM. (05 hrs) 241. Demonstrate shut down and work permit proforma. (05 hrs)	**Energy meters;** Types, Meter Reading**,** Description of MRI**,** General layout of Meter Test Lab. Testing of Meters, Operation of SBM (Spot billing machine) Knowledge about TOD metering **Log Sheet;** Maintenance and up keeping of daily Log Sheet at various Substation and energy accounting along with Recording of Complaints and follow-up action Shut down and work Permit. (15hrs.)
Professional Skill 75 Hrs.; Professional	Examine the faults and carry out repairing of substation	242. Practice isolation procedure and switching procedure preparation. (12hrs)	Isolator, circuit breaker, Earth switch; Working principal and mechanism

Knowledge 24Hrs.	equipment and panels. (Mapped NOS: PSS/N2503, PSS/N2505)	243. Practice implementation of permit system and LOTO system. (12hrs) 244. Identify various fuse sets viz., HRC, DO, 33KV fuse set, etc. (05 hrs) 245. Measure and select size of fuse wire. (06 hrs) 246. Practice reading of energy flow diagram. (06 hrs) 247. Examine faults in Control Room Wiring and practice repairing. (14 hrs) 248. Identify various parts of relay and ascertain the operation. (10Hrs) 249. Practice setting of pick up current and time setting multiplier for relay operation. (10 hrs)	Emergency lighting system 6 Steps of Lockout/ Tagout (LOTO), colour coding of tags and locks, different types of locks. Energy flow diagram. Necessity, Advantages / Disadvantages of fuses. Types of IT & HT fuses Drop out (DO) Fuses sets Rupturing Capacity & recommended sizes of fuse elements. Installation and maintenance. Types of relays and its operation. High power rectifier system and its application at various industries. Introduction to SCADA and GIS mapping. (24 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 15Hrs.	Read and understand electrical Schematic drawings of power and control circuits of outdoor substation. (Mapped NOS: PSS/N2503)	250. Interpret Single line/ Layout drawings with Equipment and Protection codes as per ANSI. (15 hrs) 251. Interpret Layout drawings of 400kV/220kV/132kV/66kV/33kV/11kV outdoor substations. (15 hrs) 252. Interpret various panel wiring drawings of substation equipment. (20 hrs)	Power and control schematic drawings with interlocks. Isolator and Earth switch wiring, PT terminal box wiring CT terminal box wiring Circuit breaker closing and tripping circuits, Marshalling box wiring, Relay and control panel wiring. RTCC panel wiring. OLTC panel wiring. Mimic panel wiring. (15 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 06Hrs.	Operate firefighting equipment and systems used in substation. (Mapped NOS: PSS/N2001)	253. Identify various fire fighting equipment used in substations.(05 hrs) 254. Practice on different fire fighting extinguishers. (20 hrs)	**Fire Fighting;** Categories of Fire-A, B, C, D & E - General description Description Fire Fighting Equipments Suitable for various categories of fire. Electrical Fire; Origin and Preventive Measures Do's and Don'ts for Electrical Safety.

			Fire protection system: Various type of system used in the Electrical distribution system. (06 hrs.)
ENGINEERING DRAWING: (40 Hrs.)			
Professional Knowledge ED: 40 Hrs.	Read and apply engineering drawing for different application in the field of work.	**ENGINEERING DRAWING:** Reading of Electrical Sign and Symbols. Sketches of Electrical components. Reading of Electrical wiring diagram and Layout diagram. Reading of Electrical earthing diagram. Drawing the schematic diagram of plate and pipe earthing. Drawing of Electrical circuit diagram. Drawing of Block diagram of Instruments & equipment of trades.	
WORKSHOP CALCULATION & SCIENCE: (34Hrs)			
Professional Knowledge WCS: 34 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	**WORKSHOP CALCULATION & SCIENCE:** **Friction** Friction - Lubrication **Algebra** Algebra - Addition, subtraction, multiplication & division Algebra - Theory of indices, algebraic formula, related problems **Elasticity** Elasticity - Elastic, plastic materials, stress, strain and their units and young's modulus **Profit and Loss** Profit and loss - Simple problems on profit & loss Profit and loss - Simple and compound interest **Estimation and Costing** Estimation and costing - Simple estimation of the requirement of material etc., as applicable to the trade. Estimation and costing - Problems on estimation and costing	
Project work / Industrial visit **Broad Areas:** Visit to Substation Control Panel Room (Components, Power distribution, Grid management, Quality of Electrical Supply, etc.) a) Patrolling of Line b) Installation of pole mounted substation c) Maintenance of substation d) Testing of substation equipment			

SYLLABUS FOR CORE SKILLS
1. Employability Skills (Common for all CTS trades) (120Hrs + 60 Hrs.)

Learning outcomes, assessment criteria, syllabus and Tool List of Core Skills subjects which is common for a group of trades, provided separately inwww.bharatskills.gov.in/ dgt.gov.in