ELECTRICIAN - POWER DISTRIBUTION

NSQF LEVEL- 4.5

SECTORS - POWER

COMPETENCY BASED CURRICULUM

CRAFT INSTRUCTOR TRAINING SCHEME (CITS)

GOVERNMENT OF INDIA
Ministry of Skill Development & Entrepreneurship
Directorate General of Training
CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE
EN-81, Sector-V, Salt Lake City, Kolkata – 700091

ELECTRICIAN – POWER DISTRIBUTION

(Engineering Trade)

SECTOR –POWER

(Revised in 2024)

Version 2.1

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Developed By
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1. COURSEOVERVIEW

The Craft Instructor Training Scheme is operational since inception of the Craftsmen Training Scheme. The first Craft Instructor Training Institute was established in 1948. Subsequently, 6 more institutes namely, Central Training Institute for Instructors (now called as National Skill Training Institute (NSTI)), NSTI at Ludhiana, Kanpur, Howrah, Mumbai, Chennai and Hyderabad were established in 1960's by DGT. Since then the CITS course is successfully running in all the NSTIs across India as well as in DGT affiliated institutes viz. Institutes for Training of Trainers (IToT). This is a competency based course for instructors of one year duration. "Electrician– Power Distribution" CITS trade is applicable for Instructors of "Electrician – Power Distribution" CTS Trade.

The main objective of Craft Instructor training programme is to enable Instructors explore different aspects of the techniques in pedagogy and transferring of hands-on skills so as to develop a pool of skilled manpower for industries, also leading to their career growth & benefiting society at large. Thus promoting a holistic learning experience where trainee acquires specialized knowledge, skills & develops attitude towards learning & contributing in vocational training ecosystem.

This course also enables the instructors to develop instructional skills for mentoring the trainees, engaging all trainees in learning process and managing effective utilization of resources. It emphasizes on the importance of collaborative learning & innovative ways of doing things. All trainees will be able to understand and interpret the course content in right perspective, so that they are engaged in & empowered by their learning experiences and above all, ensure quality delivery.

2. TRAINING SYSTEM

2.1 GENERAL

CITS courses are delivered in National Skill Training Institutes (NSTIs) & DGT affiliated institutes viz., Institutes for Training of Trainers (IToT). For detailed guidelines regarding admission on CITS, instructions issued by DGT from time to time are to be observed. Further complete admission details are made available on NIMI web portal http://www.nimionlineadmission.in. The course is of one-year duration. It consists of Trade Technology (Professional skills and Professional knowledge), Training Methodology and Engineering Technology/ Soft skills. After successful completion of the training programme, the trainees appear in All India Trade Test for Craft Instructor. The successful trainee is awarded NCIC certificate by DGT.

2.2 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements during a period of one year:

S No.	Course Element	Notional Training Hours
1.	**Trade Technology**	
	Professional Skill (Trade Practical)	480
	Professional Knowledge (Trade Theory)	270
2.	**Training Methodology**	
	TM Practical	270
	TM Theory	180
	Total	**1200**

Every year 150 hours of mandatory OJT (On the Job Training) at nearby industry, wherever not available then group project is mandatory.

3	On the Job Training (OJT)/ Group Project	150
4	Optional Course	240

Trainees can also opt for optional courses of 240 hours duration.

2.3 PROGRESSION PATHWAYS

- Can join as Instructor in Vocation Training Institute/ Technical Institute.
- Can join as a supervisor in Industries.

2.4 ASSESSMENT & CERTIFICATION

The CITS trainee will be assessed for his/her Instructional skills, knowledge and attitude towards learning throughout the course span and also at the end of the training program.

a) The Continuous Assessment(Internal) during the period of training will be done by **Formative Assessment Method** to test competency of instructor with respect to assessment criteria set against each learning outcomes. The training institute has to maintain an individual trainee portfolio in line with assessment guidelines. The marks of internal assessment will be as per the formative assessment template provided on www.bharatskills.gov.in.

b) The **Final Assessment** will be in the form of **Summative Assessment Method**. The All India Trade Test for awarding National Craft Instructor Certificate will be conducted by DGT at the end of the yearas per the guidelines of DGT. The learning outcome and assessment criteria will be the basis for setting question papers for final assessment**.** The external examiner during final examination will also check the individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

2.4.1 PASS CRITERIA

Allotment of Marks among the subjects for Examination:

The minimum pass percent for Trade Practical, TM practical Examinations and Formative assessment is 60% & for all other subjects is 40%.There will be no Grace marks.

2.4.2 ASSESSMENT GUIDELINE

Appropriate arrangements should be made to ensure that there will be no artificial barriers to assessment. The nature of special needs should be taken into account while undertaking the assessment. While assessing, the major factors to be considered are approaches to generate solutions to specific problems by involving standard/non-standard practices.

Due consideration should also be given while assessing for teamwork, avoidance/reduction of scrap/wastage and disposal of scrap/waste as per procedure, behavioral attitude, sensitivity to the environment and regularity in training. The sensitivity towards OSHE and self-learning attitude are to be considered while assessing competency.

Assessment will be evidence based comprising of the following:

- Demonstration of Instructional Skills (Lesson Plan, Demonstration Plan)
- Record book/daily diary
- Assessment Sheet
- Progress chart
- Video Recording
- Attendance and punctuality
- Viva-voce
- Practical work done/Models
- Assignments
- Project work

Evidences and records of internal (Formative) assessments are to be preserved until forthcoming yearly examination for audit and verification by examining body. The following

marking pattern to be adopted while assessing:

Performance Level	Evidence
(a) Weightage in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of an ***acceptable standard*** of crafts instructorship with ***occasional* guidance** and engage students by demonstrating good attributes of a trainer.	• Demonstration of ***fairly good*** skill to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field. • Average engagement of students for learning and achievement of goals while undertaking the training on specific topic. • A fairly good level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson. • Occasional support in imparting effective training.
(b) Weightage in the range of 75%-90% to be allotted during assessment	
For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of a ***reasonable standard*** of crafts instructorship with ***little* guidance** and engage students by demonstrating good attributes of a trainer.	• Demonstration of ***good*** skill to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field. • Above average engagement of students for learning and achievement of goals while undertaking the training on specific topic. • A ***good*** level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson. • Little support in imparting effective training.
(c) Weightage in the range of more than 90% to be allotted during assessment	
For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of a ***high standard*** of crafts instructorship with ***minimal or no support*** and engage students by demonstrating good attributes of a trainer.	• Demonstration of ***high*** skill level to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field. • Good engagement of students for learning and achievement of goals while undertaking the training on specific topic. • A ***high*** level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson. • Minimal or no support in imparting effective training.

3. GENERAL INFORMATION

Name of the Trade	**ELECTRICIAN – POWER DISTRIBUTION-CITS**
Trade Code	DGT/4053
NCO – 2015	2356.0100, 7411.0100, 7413.0100, 7413.9900, 7412.0200
NOS Covered	PSS/N9411, PSS/N9412, PSS/N9415, PSS/N9416, PSS/N9421, PSS/N9422, PSS/N9424, PSS/N9419, PSS/N9426, PSS/N9427, PSS/N9433, PSS/N9434, PSS/N9435, PSS/N9431, PSS/N9436
NSQF Level	Level-4.5
Duration of Craft Instructor Training	One Year
Unit Strength (No. Of Student)	25
Entry Qualification	Degree in Electrical/ Electrical and Electronics Engineering from AICTE/ UGC recognized Engineering College / University. OR 03 years Diploma in Electrical/ Electrical and Electronics Engineering after class 10th from AICTE/ recognized board of technical education. OR Ex-serviceman from Indian Armed Forces with 15 years of service in related field as per equivalency through DGR. OR 10th Class with 02-year NTC passed in the trade of "Electrician – Power Distribution".
Minimum Age	16 years as on first day of academic session.
Space Norms	98 Sq. m
Power Norms	5.2 KW (for two units in one shift)
Instructors Qualification for	
1. Electrician – Power Distribution-CITS Trade	B.Voc/Degree in Electrical/ Electrical and Electronics Engineering from AICTE/UGC recognized Engineering College/ university with two-year experience in the relevant field. OR 03 years Diploma in Electrical/ Electrical and Electronics Engineering from AICTE/recognized board of technical education with five years' experience in the relevant field. OR Ex-serviceman from Indian Armed Forces with 15 years of service in related field as per equivalency through DGR. Candidate should have undergone methods of Instruction of course or minimum 02 years of experience in technical training institute of Indian Armed Forces. OR NTC/NAC passed in the Trade of "Electrician – Power Distribution" With seven years' experience in the relevant field.

	Essential Qualification: Relevant National Craft Instructor Certificate (NCIC) in any of the variants under DGT.
2. Workshop Calculation & Science	B.Voc/Degree in any Engineering from AICTE/ UGC recognized Engineering College/ university with two years experience in relevant field. OR 03 years Diploma in Engineering from AICTE /recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with five years' experience in the relevant field. OR NTC/ NAC in any Engineering trade with seven years experience in relevant field. **Essential:** National Craft Instructor Certificate (NCIC) in relevant trade OR NCIC in RoDA or any of its variants under DGT.
3. Engineering Drawing	B.Voc/Degree in Engineering from AICTE/ UGC recognized Engineering College/ university with two years experience in relevant field. OR 03 years Diploma in Engineering from AICTE /recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with five years' experience in the relevant field. OR NTC/ NAC in any one of the 'Mechanical group (Gr-I) trades categorized under Engg. Drawing'/ D'man Mechanical / D'man Civil' with seven years experience. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in relevant trade OR NCIC in RoDA / D'man (Mech /civil) or any of its variants under DGT
4. Training Methodology	B.Voc/Degree in any discipline from AICTE/ UGC recognized College/ university with two years experience in training/ teaching field. OR Diploma in any discipline from recognized board / University with five years experience in training/teaching field. OR NTC/ NAC passed in any trade with seven years experience in training/ teaching field. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in any of the variants under DGT / B.Ed /ToT from NITTTR or equivalent.
5. Minimum Age for Instructor	21 Years

4. JOB ROLE

Brief description of job roles:

Manual Training Teacher/Craft Instructor; instructs students in ITIs/Vocational Training Institutes in respective trades as per defined job role. Imparts theoretical instructions for the use of tools & equipment of related trades and related subjects. Demonstrate process and operations related to the trade in the workshop; supervises, assesses and evaluates students in their practical work. Ensures availability & proper functioning of equipment and tools in stores.

Electrician General; installs, maintains and repairs electrical machinery equipment and fittings in factories, workshops power house, business and residential premises etc. Studies drawings and other specifications to determine electrical circuit, installation details etc. Positions and installs electrical motors, transformers, switchgears. Switch boards and other electrical equipment, fittings and lighting fixtures. Makes connections and solders terminals. Tests electrical installations and equipment and locates faults using megger, test lamps etc. Repairs or replaces defective wiring, burnt out fuses and defective parts and keeps fittings and fixtures in working order. May do armature winding, draw wires and cables and do simple cable jointing. May operate, attend and maintain electrical motors, pumps etc.

Lineman, Light and Power; erects and maintains overhead electric power lines to conduct electricity from power plant to place of use. Erects poles and small towers at specified distances with assistance of other workers. Climbs poles and towers and fixes insulators, lightning arresters, cross-brass etc. and other auxiliary equipment at proper heights. Strings and draws cables (wires) through insulators fixed on cross bars, exercising great care to leave proper sag in wires to avoid breakage under changing atmospheric conditions. Joins cable by various methods, fixes joint-boxes at specified places, replaces fuses and faulty components as necessary and tests for electrical continuity. Checks overhead lines in allotted section as necessary and maintains them in order for carrying electricity by effecting repairs of defective lines, poles, towers and auxiliary equipment as directed. May install and repair overhead power lines for electric trains, trams or trolley buses. May work on high tension or low-tension power lines.

Electrical Line Installers, Repairers and Cable Jointers, Other; perform number of routine and low skilled tasks in erecting and maintaining overhead lines, joining cables, etc., and are designated as Lineman's Mate; Cable Jointer Helper; etc., according to work performed.

Electrical Fitter; fits and assembles electrical machinery and equipment such as motors, transformers, generators, switchgears, fans etc., Studies drawings and wiring diagrams of fittings, wiring and assemblies to be made. Collects prefabricated electrical and mechanical components according to drawing and wiring diagrams and checks them with gauges, megger etc. to ensure proper function and accuracy. Fits mechanical components, resistance, insulators, etc., as per specifications, doing supplementary tooling where necessary. Follows wiring diagrams, makes electrical connections and solders points as specified. Checks for continuity, resistance, circuit shorting, leakage, earthing, etc. at each stage of assembly using megger, ammeter, voltmeter and other appliances and ensures stipulated performance of both mechanical and electrical components filled in assembly. Erects various equipment such as bus

bars, panel boards, electrical posts, fuse boxes switch gears, meters, relays etc. using non-conductors, insulation hoisting equipment as necessary for receipt and distribution of electrical current to feeder lines. Installs motors, generators, transformer etc. as per drawings using lifting and hoisting equipment as necessary, does prescribed electrical wiring, and connects to supply line. Locates faults in case of breakdown and replaces blown out fuse, burnt coils, switches, conductors etc. as required. Checks, dismantles, repairs and overhauls electrical units periodically or as required according to scheduled procedure. May test coils. May specialize in repairs of particular equipment manufacturing, installation or power house work and be designated accordingly.

Reference NCO 2015:

a) 2356.0100 – Manual Training Teacher/ Craft Instructor.
b) 7411.0100 - Electrician General
c) 7413.0100 - Lineman, Light and Power
d) 7413.9900 - Electrical Line Installers, Repairers and Cable Jointers, Other
e) 7412.0200 - Electrical Fitter

Reference NOS:

(i) PSS/N9411
(ii) PSS/N9412
(iii) PSS/N9415
(iv) PSS/N9416
(v) PSS/N9421
(vi) PSS/N9422
(vii) PSS/N9424
(viii) PSS/N9419
(ix) PSS/N9426
(x) PSS/N9427
(xi) PSS/N9433
(xii) PSS/N9434
(xiii) PSS/N9435
(xiv) PSS/N9431
(xv) PSS/N9436

5. LEARNING OUTCOME

Learning outcomes are a reflection of total competencies of a trainee and assessment will be carried out as per the assessment criteria.

5.1 TRADE TECHNOLOGY

1. Cultivate the discipline and safety compliance in working practices and environmental regulation. (NOS: PSS/N9415)
2. Illustrate the concept of electricity. Explain the verification and measurement of basic characteristics of electrical and magnetic circuits with their effects. (NOS: PSS/N9416)
3. Assess the construction of simple electronic circuits and test for functioning. (NOS: PSS/N9421)
4. Plan, execute, commissioning, maintenance and testing of electrical machines and their starters. (NOS: PSS/N9422)
5. Demonstrate on-site installation preventive maintenance, testing, repair/replacement of an electrical power distribution system. (NOS: PSS/N9424)
6. Exhibit testing, repair/replacement, maintenance and evaluate the performance of transformers and their types. (NOS: PSS/N9419)
7. Demonstrate to operate and maintain indoor and outdoor substations and determine estimation for HT/LT (on and underground cables) line. (NOS: PSS/N9426)
8. Exhibit the installation, testing and maintenance of batteries for battery room and electrical illumination system for power distribution substation. (NOS: PSS/N9427)
9. Illustrate the earthing installation, testing and maintenance. (NOS: PSS/N9433)
10. Demonstrate installation, repair/replacement and maintenance of tower/pole and safety accessories in power distribution substation. (NOS: PSS/N9434)
11. Assess the revenue, energy accounting (metering and billing) and energy losses in power distribution. (NOS: PSS/N9435)
12. Demonstrate the examination of faults and maintenance of substation equipment and panels. (NOS: PSS/N9436)
13. Explain the concepts of automation (SCADA and GIS mapping) in power distribution. (NOS: PSS/N9431)
14. Read and apply engineering drawing for different application in the field of work. (NOS: PSS/N9411)
15. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: PSS/N9412)

6. COURSE CONTENT

ELECTRICIAN – POWER DISTRIBUTION–CITS TRADE			
TRADE TECHNOLOGY			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Practical 10 hrs; Theory 05 hrs	Cultivate the discipline and safety compliance in working practices and environment regulation.	**Safety practices** 1. Demonstrate fires in electrical circuits & precautions. 2. Identify fire extinguishers & its types, general safety of tools & equipment. 3. Demonstrate how to free a person from electrocution and his treatment.	Safely handling tools & equipment. Use of proper tools & equipment & its maintenance. Shock treatment, first aid safety practice. Response to emergencies e.g. Power failure, system failure and fire etc. Firefighting. Standard distance for safe working zone, clearance from live HV electrical system. Introduction to National Electrical Code-2011 and BIS/ISI.
Practical 40 hrs; Theory20 hrs	Illustrate the concept of electricity. Explain the verification and measurement of basic characteristics of electrical and magnetic circuits with their effects.	**Basic electricity** 4. Verification of ohm's law. 5. Illustrate measurement of current & voltage in series and parallel circuits. 6. Compute resistance using wheat- stone bridge. 7. Verification of Kirchhoff's laws. 8. Check bare conductor joint and PVC wire joints 9. Check crimping of lugs. 10. Demonstrate soldering.	Fundamentals, ohm's law, Kirchhoff's laws. Laws of resistance, wheatstone bridge PVC wires, conductors &cables. Wire joints, soldering. Heating, lighting, magnetic & chemical effect of electric current. Joule's law.
		Magnetism 11. Check preparation of electromagnet. 12. Test different types of capacitor.	Magnetic circuits. Analogy of electrical and magnetic circuits. Permanent magnet Principle of electromagnet

			Faraday's laws of electromagnetic induction. Self and mutual induction. Fleming's rule, magnetisation curve. Hysteresis curve.
		Alternating current 13. Examine r, l, c, z of a circuit. 14. Demonstrate measurement of power, power factor, energy by different methods of single phase circuit.	Fundamental terms of alternating current. RLC circuit –series & parallel resonance. Impedance triangle, power triangle. Power factor. Need of highpower factor. Power factor improvement using capacitor banks and other methods. Automatic power factor correction (APFC)panels. Measuring instruments: PMMC,MI type,etc.
		Poly phase system 15. Demonstrate measurement of the line & phase values of voltage & current in star & delta connection. 16. Demonstrate measurement of power of three phase system.	Star & delta connections. Three phase power. Phasor diagram for connections. Three phase three wires & three phase four wires system. Wattmeter measurement system.
Practical 20 hrs; Theory10hrs	Assess construction of simple electronic circuits and test for functioning.	**Basic electronics** 17. Identify different colour coding of resistors. 18. Construct rectifier circuits. 19. Check the different wave shape using CRO. 20. Test the transistor single stage amplifier circuit. 21. Design simple circuit containing power diode & power transistor. 22. Construct UJT triggering circuit. 23. Use FET & MOSFET as an amplifier.	Diodes and its types, characteristics of semiconductor diodes and ZENER diode. Rectifiers & filter circuits. Working principle and use of CRO. Transistor, amplifier & types. Introduction to oscillator. basic concept of power diode, power transistor, introduction to- UJT, FET, SCR, DIAC, TRIAC, MOSFET, IGBT, Monostable, bistable and astablemultivibrators. Introduction to operational

		24. Assess construction of control circuits for – SCR, DIAC, TRIAC, IGBT. 25. Assemble different op-amp circuits using IC 741. 26. Verify truth tables of logic gates.	amplifiers (IC-741). Digital electronics –number system, logic gates. Combinational circuits. Sequential circuits. Convertors: DAC and ADC. Counters.
Practical 115 hrs; Theory 50 hrs	Plan, execute, commissioning, maintenance and testing of electrical machines and their starters.	**Dc generator** 27. Describe different parts of dc generator. 28. Demonstrate the building of the voltage on shunt generator. 29. Explain connection of compound generator & build up voltage. 30. Test and verify characteristics of series, shunt and compound generator. 31. Demonstrate dismantling & reassembling of dc generator.	Construction & working principle of dc generator. Types-series, shunt & compound generator. Emf equation, characteristics (OCC &LCC). Armature reactions, commutation. Efficiency, regulation& applications. Parallel operations care and maintenance & trouble shooting.
		DC Motor 32. Illustrate different parts of dc motor. 33. Demonstrate starting and Running of series, shunt & compound motors	Construction & principle of dc motor. Types- series, shunt & compound motors. Characteristics curve.
		Three phase induction motor 34. Design connection of various starters. 35. Start, run & load ac 3 phase squirrel cage & wound rotor induction motors for performance testing. 36. Check the change of direction of rotation. 37. Demonstrate measurement speed, torque, slip, current,	Squirrel cage & wound rotor: - construction, parts, working principle. Concept of rotating magnetic field applications. Types of starters-Dol, Star Delta, Auto Transformer starter etc. Rotor resistance type starter. Introduction to speed control of 3 phase induction motor. Torque-speed characteristics. Losses & efficiency.

		power, pf etc.	
		Single phase & special type of motors 38. Demonstrate starting and running of single phase motors & changing DOR (direction of rotation). 39. Check dismantling and reassembling of different types of 1-ø motors. 40. Draw on/off control circuit to run an electric induction motor (single phase)	Classification, construction, working principle & uses of singlephase induction motor. Methods of starting. Ac series and universal motor. Reluctance motor, hysteresis motor, stepper motor, servo motor, etc.
		Alternator 41. Illustrate installation of an alternator and identify various parts and terminals of the same. 42. Demonstrate build up voltage, excitation, loading characteristics. 43. Evaluate load regulation & performance efficiency. 44. Demonstrate synchronisation (by parallel operation) alternators by different methods. 45. Start and run, build up voltage and load mg set.	Types- hydro & turbo construction, working principle. Excitation methods, emf equation, phase sequence, loading and characteristics. Efficiency &voltage regulation. Parallel operations, conditions for synchronization. Brushless alternator. Single phase alternator. AVR (automatic voltage regulator). MG set –description, specifications & characteristics.
		Synchronous motor 46. Identify different parts of synchronous motor. 47. Connect, start and run the synchronous motor. 48. Demonstrate plotting of v-curve. 49. Demonstrate different applications of synchronous motor. 50. Check and correct power	Construction, working principle, starting method. Effect of change of excitation on load. V-curve and inverted v -curve. Power factor correction.

		factor.	
		Speed control of electrical machines using drives 51. Demonstrate speed control of dc motor using dc drive. 52. Explain verification of speed control of ac motor (induction motor) using ac drive.	Working principle, construction and parameterization of drives. DC and AC drive.
Practical 50 hrs; Theory25 hrs	Demonstrate on-site installation preventive maintenance, testing, repair/replacement of an electrical power distribution system.	**Power system: generation** 53. Visit and prepare layout plan/ single line diagram of the thermal /hydro /nuclear power plant. 54. Prepare layout plan and identify different elements of solar power system/wind power plant.	Power scenario in India. Single line diagram of power system.Power generation. Various ways of electrical power generation by conventional (thermal, hydro & nuclear power plant) and non-conventional methods (solar, wind, tidal, biomass power plant, etc).Load and load curves.base load and peak load power plant.Load forecasting. Optimal operation & control of power systems.
		Power system: transmission system 55. Draw and explain single line diagram of transmission system. 56. Video demonstration of laying OPGW along with earth wire at top of tower of HV line.	Transmission system. Layout of transmission system, selection of voltage for h.t and l.t lines, Advantages of high voltage for transmission both ac and dc Types of transmission line: short, medium, long and EHV transmission line. Two wire, three wire, four wire, six wire, seven wire transmission lines. Losses in transmission lines. Corona effect. Economic principle of power transmission: Kelvin's Law, Modified Kelvin's Law. Electrical safety guidelines and regulation for ht.Power Line

			Carrier Communication (PLCC) systemTechniques of hotline maintenance at HVS/S.Protection of transmission line via PLCC system.Line compensation. FACTS devices, The FACTS optimization problem. Transient and dynamic stability enhancement using FACTS components. Concepts of modern grid.
		Power distribution 57. Practice live-dead-live test in electrical panel (HV/LV). 58. Draw and explain single line diagram of types of distribution systems.	Distribution system. Layout of HT and LT distribution system, constructional feature of distribution. Lines and their erection. LT feeders and service mains.Ring mains and radial distribution system. Determination of size of conductor.General layout of substation. Single line diagram, general symbols for various equipment installed at substation.Single line diagram for various 33 KV, 132 KV, 220 KV, 400 KV substations. Basic parameters of all equipment and their name plate.
Practical 20 hrs; Theory10 hrs	Exhibit testing, repair/ replacement, maintenance and evaluate the performance of transformers and their types.	**Transformer** 59. Demonstrate parts and terminals of transformers. 60. Test and measure different transformation ratio. 61. Demonstrate open circuit (OC) test, short circuit (SC) test of a transformer. 62. Explain the measurement of efficiency & load regulation. 63. Demonstrate parallel	Principle, construction. Classification of transformers.Emf equation, rating loading, losses & efficiency regulation. Parallel operation.Cooling methods, transformer oil testing. Tap changer –on load and off load, OLTC.Auto transformer. Three phase transformer. Scott connections. Oil testing: DGA, metal particle analysis and furan

		operation. 64. Demonstrate connection of star and delta. 65. Assess different transformer oils. 66. Perform video demonstration of filtering of transformer oil. 67. Demonstrate IR and PI test.	test.Vectorgroup test. Connection phasor.Partial discharge and tan delta test.Protection of transformer using Buchholz relay.
		Instrument transformer 68. Measure high current and voltage using CT and PT. 69. Demonstrate ratio test, polarity test, insulation test on CT and PT. 70. Demonstrate testing of insulation resistance and winding resistance on CT and PT. 71. Illustrate installation and commissioning of CT and pt.	Instrument transformer- CT & PT. Welding transformer and their types. Location of CT and PT in the system. Testing and protection of instrument transformer. Basic concept of live tank and dead tank ct. Special protection of CT- PS class. 5p10 and 5p20 test.
Practical 40 hrs; Theory 20 hrs	Demonstrate to operate and maintain indoor and outdoor substations and determine estimation for HT/LT (onand underground cables) line.	**Distribution substation wiring** 72. Apply method of using wire gauge and micro-meter. 73. Demonstrate PVC casing-capping, conduit wiring, testing, maintenance and repairing of wiring. 74. Apply fuse, MCB, ELCB relays. 75. Demonstrate multi-storied building wiring.	National electrical code, SWG, Different types of wirings. Grading concept. Power cables: need of HT cables, advantage and disadvantages Installation, testing methods – wiring estimations & cost. Depreciation. load diversity. Off peak utilisation.
		Overhead line 76. Demonstrate various conductors viz., AAC, ACSR conductor, etc. 77. Illustrate mechanical and electrical testing of overhead conductors.	Objectives of distribution system. Classification of conductors and nomenclature. Current rating. Jointing of conductor. ABC system - prominent considerations for selection for ABC system; LT

		78. Demonstrate the identification of various sizes of copper wires and cable insulation FR/FRLS/FRLSH. 79. Explain joining of overhead line conductors. 80. Demonstrate the identification of aerial bunched cables used in distribution system. 81. Plan and commission overhead distribution line using bare conductors. 82. Plan and commission distribution line using ABC. 83. Demonstrate the identification of components and work with high voltage distribution system (HVDS).	ABC, HT ABC. Method of joining Aluminium 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.
		Underground line 84. Demonstrate the identification of different parts of various underground cables. 85. Illustrate preparation of cables for termination and joining. 86. Demonstrate termination kits and practice on terminations of LT/HT cables. 87. Demonstrate preparation of straight joint of different types of underground cable. 88. Perform high voltage (high potential) test. 89. Illustrate laying of HT/LT	Introduction, classification according to voltage, construction of paper insulated lead covered cables, types of 3 phase cables, viz., PVC, XLPE, halogen, optical fibre, etc. Cable type designation, installation of cable lines – general, laying cables in trenches: laying conduit built & tier by method, underground PVC cables- construction, range selection current rating of Aluminium, power cable, short circuit rating, bending, radius, load. Factor, cable jointing, Faults in the underground cable. Method of locating faults. Need for cable jointing

		cables in raceways and trenches. 90. Demonstrate and identify various cable glands. 91. Analyse passing of cables through cable entry plate for standard cables without connectors, up to IP 68 rated protection. 92. Demonstrate split cable entry for multiple pre-terminated cables, up to IP 65 rated protection and on a switch cabinet wall. 93. Demonstrate bonding and grounding of raceways, cable assembly and panels. 94. Check underground cables for faults and remove the fault.	(splicing). Need of termination kits. Joints and terminations; pre-moulded, heat shrinkable, extrusion moulded 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. 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. Locating faults, open circuit, short circuit and leakage in cables.
Practical 20 hrs; Theory10 hrs	Exhibit the installation, testing, and maintenance of batteries for battery room and electrical illumination system	**Battery system** 95. Demonstrate measurement of specific gravity and evaluate condition of battery based on its specific gravity using	Electrolysis Faraday's laws of electrolysis. Cells and batteries- primary & secondary cells, their construction & working. Lead acid battery and lithium ion

	for power distribution substation.	hydrometer. 96. Design battery by grouping of cells to get required current and voltage as needed. 97. Check the battery with high rate discharge tester 98. Evaluate the components of battery charger used in substation. 99. Interpret the V-I characteristics of solar cells and determine the fill factor. 100. Demonstrate maintenance of voltage stabiliser, UPS and inverter.	battery. Hybrid cell, alkaline cell. Charging methods. Grouping of cells for specified voltage and current. Various battery operations. boost charging. Two battery two charger system. End cell cutting. C5 and C10 charging methods. Factors affecting battery life correction factor, calculation of battery capacity. Principle and operation of solar cell. Awareness of maintenance free battery concept. Selection of site. Safety compliance of battery room. Voltage stabilization: stabilizer, ups, inverter.
		Illumination system 101. Demonstrate connection & installation all kinds of lamps. 102. Evaluate value of brightness using luxmeter. 103. Demonstrate maintenance of emergency lights.	Laws of illumination. Terminology and laws in illumination. Types of lamps-incandescent lamp and discharge lamp-fluorescent, HPMV, HPSV lamps. Drum switch, lighting calculations. Energy efficient lighting systems (CFL, LED etc.) Emergency lights. Various colour temperature-cool day 5700k/6500k, warm white-2700k/3000k, false recess type//surface type
Practical 20 hrs; Theory10 hrs	Illustrate the earthing installation, testing and maintenance.	**Earthing system** 104. Design and devise pipe, plate earthing and grid/mesh earthing. 105. Demonstrate earthing of delta connected system. 106. Demonstrate grounding of equipment and systems. 107. Perform measurement of	Earthing: I.E. Rules 1956, importance of earthing. Classification of earthing. Plate earthing and pipe earthing methods and IEE Regulations. Difference between grounding and earthing. Earth Resistance and Earth Leakage Circuit Breaker (ELCB).

		earth resistance using earth tester. 108. Employ the treatment to minimize earth resistance and maintenance of earth system. 109. Check earth leakage by ELCB and relay.	Balanced/ restricted earth protection. Methods of improving earth resistance, earth tester. Awareness of Circuit Main Earth (CME) and portable earth.
Practical 40 hrs; Theory 20 hrs	Demonstrate installation, repair/replacement and maintenance of tower/pole and safety accessories in power distribution substation.	**Supports and accessories** 110. Identify different supports, transmission towers, and various accessories. 111. Perform digging of pit, erection of supports and fitting various accessories on poles. 112. Perform stringing and sagging of line conductors. 113. Fasten jumper in pin, shackle and suspension type insulators. 114. Perform installation of overhead domestic service lines. 115. Measure current carrying capacity of conductors. 116. Practice installation and sealing of energy meters. 117. Install bus bar and bus coupler on LT line. 118. Demonstrate working with thermo vision camera.	CEA Safety regulation 2010 Supports and accessories: PCC pole, ST pole, cross arms, clamps, transmission towers. Different types of line insulators Foundations - Dry, Wet, PS, FS and Well type. 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. Thermo vision supervision at substation for hot point detection.
		Switchgear and protection in distribution system 119. Demonstrate identification of outdoor and indoor switchgears. 120. Demonstrate identification various substation equipment viz.,	Circuit breakers, isolators, fuses, relays, relaying schemes, installation, operation & maintenance. **Circuit breakers;** Types of circuit breakers, their applications and functioning. Production of arc and arc

		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. 121. Apprise operation of circuit breakers in maintenance (test) mode. 122. Illustrate use of grounding rod and make visible earthing. 123. Demonstrate timer test on circuit breakers. 124. Illustrate repair and maintenance of circuit breakers. 125. Identify lightening arrester in the yard and practice replacement. 126. Checking for wave trap and LMU and practice replacement and maintenance. 127. Explain isolation procedure and switching procedure preparation. 128. Demonstrate implementation of permit system and LOTO system. 129. Demonstrate the measurement and select size of fuse wire. 130. Examine faults in control room wiring and practice repairing. 131. Illustrate setting of pick up current and time setting multiplier for relay operation.	quenching methods (air blast, oil, sf-6 and vacuum) handling of sf6 gas (filling and evacuation procedure) inspection of contact resistance of breakers and alignment of contacts. Opening and closing time of breakers. Types of male and female contacts. Types of jaws & blades of various isolators. Maintenance of equipment Grounding rod Lightening arrester, surge counter Wave trap and LMU (line matching unit);6steps 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.

Practical 35hrs; Theory10 hrs	Assess the revenue, energy accounting (metering and billing) and energy losses in power distribution.	**Distribution metering & efficient energy management** 132. Illustrate collecting meter reading of various meters. 133. Examine study of MRI reports. 134. Check meter reading by using USB / Optical cable. 135. Evaluate log sheet at substation. 136. Illustrate generation of electricity bill using SBM. 137. Demonstrate shut down and work permit proforma.	Understanding electricity bill: transformers tariff structure, components of power (KW, KVA and KVAR) and power factor, concept of sanctioned load, maximum Demand, contract demand and Monthly Minimum Charges (MMC) Energy audit. **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. Detection of theft/tempering, unauthorized loads, IE rules & DERC norms regarding distribution system performance.
Practical 35hrs; Theory10 hrs	Demonstrate the examination of faults and maintenance of substation equipment and panels.	**Substation equipment and panels** 138. Demonstrate wiring of control cabinet as per wiring diagram, bunching of XLPE cables, channelling, tying and checking etc. 139. Demonstrate mounting of various control elements e.g. Circuit breakers, relays, contactors and timers etc. 140. Demonstrate installation of required measuring	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

		instruments and sensors in control panel. 141. Check the control panel for its performance. 142. Design layout of control cabinet, assemble control elements and wiring accessories.	elements and circuits.
Practical 35hrs; Theory10 hrs	Explain the concepts of automation (SCADA and GIS mapping) in power distribution.	**Technologies in power distribution** 143. Analyse the block diagram of SCADA. 144. Design the block diagram of modern distribution system	Introduction to distribution automation (da). Configuration and functions of da. State and trends of substation automation, intelligent affordable substation monitoring and control, advantages of an EEM (Enterprise Energy Management) substation automation solution. Distribution system monitoring and control using SCADA.Concept of modern distribution system and distribution planning.Role of computer in planning.GIS (Geographical Information System) mapping.

Engineering Drawing: 30 Hrs.		
Professional Knowledge ED-30 Hrs.	Read and apply engineering drawing for different application in the field of work.	**CIRCLES, TANGENTS AND ELLIPSE:** Practical applications procedure for constructing tangent to given circle-lines- loop pattern-- tangential circles- external tangents- internal tangents ellipse **PARABOLIC CURVES, HYPERBOLA:** Involutes - Properties and their application. Procedure for constructing parabolic curve-hyperbolic curve-in volute curve. epicycloids, hypocycloid, Involutes, spiral & Archimedes spiral **TECHNICAL DRAWING/ SKETCHING OF COMPONENTS' PARTS:** Views of object Importance of technical sketching-types of sketches-Isometric drawing sketching- Oblique drawing sketching. **PROJECTIONS:** Theory of projections (Elaborate theoretical instructions), Reference planes, orthographic projections concept

		1st Angle and 3rd Angle, Projections of points, Projections of Lines–determination of true lengths & inclinations. Projections of plane, determination of true shape. Exercises on missing surfaces and views. Orthographic drawing or interpretation of views. Introduction to first angle projections of solids. **ISOMETRIC VIEWS**: Fundamentals of isometric projections (Theoretical Projections) Isometric views from 2 to 3 given orthographic views. Preparation of simple working drawing of Furniture items like table, stool and any job prepared in the workshop. **FASTENERS:** Sketches of elements of screw threads, Sketches of studs, cap screws machine screws, set screws, Locking devices, bolts, Hexagonal & square nuts & nut bolt & washer assembly. Sketches of plain spring lock, toothed lock, washers, cap nut, check nut, slotted nut, cassel nut, sawn nut, wing nut, eye blot, tee bolt & foundation bolt. Sketches of various types of rivet heads (snap–pan–conical– countersunk) Sketches of keys (sunk, flat, saddle, gib head, woodruff) Sketches of hole & shaft assembly. Sign and Symbols of Electrical, Electronics and related trades Electrical and Electronics or trade related wiring diagram/ Layout diagram Electrical, Electronics/ trade related circuit diagram Block diagram of Instruments/ equipment of related trades Practice of blue print reading on Electrical / Electronics / Computer or IT related drawing etc., ISO Standards.
WORKSHOP CALCULATION & SCIENCE: 30 Hrs.		
Professional Knowledge WCS- 30 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	**WORKSHOP CALCULATION & SCIENCE:** **Fraction:** Concept of Fraction, Numbers, Variable, Constant, **Ratio & Proportion**: - Trade related problems **Percentage:** Definition, changing percentage to decimal and fraction and vice versa. Applied problems related to trade. Estimation and cost of product. **Algebra:** Fundamental Algebraic formulae for multiplication and factorization. Algebraic equations, simple & simultaneous equations, quadratic equations and their applications. **Mensuration 2D:** Concept on basic geometrical definitions, basic geometrical theorems. Determination of areas, perimeters of triangles, quadrilaterals, polygons, circle, sector etc. **Mensuration 3D:** Determination of volumes, surface areas of cube, cuboids cylinders, hollow cylinder, sphere prisms, pyramids cone spheres, frustums etc. Mass, Weight, Volume, Density, Viscosity, Specific gravity and related problems. **Trigonometry:** Concept of angles, measurement of angles in degrees, grades and radians and their conversions. Trigonometrical ratios and their relations. Review of ratios of some standard angles (0, 30,45,60,90

		degrees), Height & Distances, Simple problems. **Graphs:** basic concept, importance. Plotting of graphs of simple linear equation. Related problems on ohm's law, series-parallel combination. **Statistics:** Frequency tables, normal distribution, measure of central tendency – Mean, Median & Mode. Concept of probability. Charts like pie chart, bar chart, line diagram, Histogram and frequency polygon. **WORKSHOP SCIENCE:** **Units and Dimensions:** Conversions between British & Metric system of Units. Fundamental and derived units in SI System, Dimensions of Physical Quantities (MLT)-Fundamental & Derived. **Engineering Materials:** Classification properties and uses of ferrous metals, non-ferrous metals, alloys etc. Properties and uses of non-metals such as wood, plastic, rubber, ceramics industrial adhesives. **Heat & Temperature:** Concepts, differences, effects of heat, different units, relation, specific heat, thermal capacity, latent heat, water equivalent, mechanical equivalent of heat. Different Temperature measuring scales and their relation. Transference of heat, conduction, convection and radiation. Thermal Expansion related calculations. **Force and Motion**: Newton's laws of motion, displacement, velocity, acceleration, retardation, rest & motion such as linear, angular. Force – units, different laws for composition and resolution of forces. Concept on centre of gravity and equilibrium of forces in plane. Concept of moment of inertia and torque. **Work, power & energy**: Definitions, units, calculation & application. Concept of HP, IHP, BHP and FHP – related calculations with mechanical efficiency. S.I. unit of power and their relations. **Friction:** Concept of friction, laws of friction, limiting friction, coefficient of friction and angle of friction. Rolling friction & sliding friction with examples. Friction on inclined surfaces **Stress & Strain:** Concepts of stress, strain, modulus of elasticity. Stress- strain curve. Hook's law, different module of elasticity like Young's modulus, modulus of rigidity, bulk modulus and their relations.

		Poisson's ratio. **Simple machines:** Concept of Mechanical Advantage, Velocity Ratio, Efficiency and their relations. Working principles of inclined plane, lever, screw jack, wheel and axle, differential wheel and axle, worm and worm wheel, rack and pinion. Gear train. **Electricity:** Basic definitions like emf, current, resistance, potential difference, etc. Uses of electricity. Difference between ac and dc. Safety devices. Difference between conductors and semiconductors and resistors, Materials used for conductors, semiconductors and resistors. Ohm's Law. Series, parallel and series-parallel combination of resistances. Concept, definitions and units of electrical work, power and energy with related problems. **Fluid Mechanics:** Properties of fluid (density, viscosity, specific weight, specific volume, specific gravity) with their units. Concept of atmospheric pressure, gauge pressure, absolute pressure, vacuum and differential pressure.

SYLLABUS FORCORE SKILLS
1. Training Methodology (Common for all CITS trades) (270 Hrs + 180 Hrs)

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

7. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
TRADE TECHNOLOGY	
1. Cultivate the discipline and safety compliance in working practices and environmental regulation. (NOS: PSS/N9415)	Explain procedures to achieve a safe working environment in line with occupational health and safety regulations and requirements and according to site policy.
	Demonstrate necessary precautions on fire and safety hazards and report according to site policy and procedures.
	Evaluate and observe site policies and procedures in regard to illness or accident.
	Demonstrate basic first aid and use them under different circumstances.
	Explain different fire extinguisher and use the same as per requirement.
	Explain the BIS/ IE.
	Infer the national electrical code-2011.
2. Illustrate the concept of electricity. Explain the verification and measurement of basic characteristics of electrical and magnetic circuits with their effects. (NOS: PSS/N9416)	Explain verification of characteristics of series, parallel and its combination circuit using ohm's law and Kirchhoff's laws.
	Analyze the effect of the short and open in series and parallel circuits.
	Explain verification of relation of voltage components of RLC series circuit in AC.
	Identify the phase sequence of a 3 ø supply using a phase-sequence meter.
	Group the given capacitors to get the required capacity and voltage rating.
	Explain measurement of the power and energy in a single & three phase circuit using wattmeter and energy meter with CT and PT.
	Determine the power factor by direct and indirect methods in an ac single phase RLC parallel circuit.
	Explain construction of solenoid and determine its polarity for the given direction of current.
	Monitor a connection of lamp load in star and delta and determine relationship between line and phase values with precaution.
	Explain connection of balanced and unbalanced loads in 3 phase star system and to measure the power of 3 phase loads.
	Evaluate measurement of electrical parameters using tong tester in three phase circuits.
3. Assess the construction of simple electronic circuits and test for functioning. (NOS: PSS/N9421)	Monitor soldering on components, lug and board with safety.
	Identify the passive /active components by visual appearance, code number and check testing for their condition.
	Identify the control and functional switches in CRO and assess measurement of the DC&AC voltage, frequency and time period.

	Assess construction and review testing of half &full wave rectifiers with and without filter circuits.
	Monitor construction of circuit by using transistor as a switch.
	Evaluate construction and testing of a UJT as relaxation oscillator & electronic timer.
	Assess construction of amplifier circuit using transistor, FET and JFET and testing.
	Plan to construct and test lamp dimmer using TRIAC/DIAC.
	Test IGBT and use in circuit for suitable operation.
	Plan to construct and test the universal motor speed controller using SCR with safety.
	Appraise construction and testing of logic gate circuits.
4. Plan, execute, commissioning, maintenance and testing of electrical machines and their starters. (NOS: PSS/N9422)	Determine the load performance of different types of dc generator on load.
	Explain to connect, start, run and reverse direction of rotation of different types of dc motors.
	Review the load performance tests on different type of dc motor.
	Explain controlling the speed of a dc motor by different method.
	Plan to maintain, service and trouble shoot the dc motor starter.
	Assess circuit diagram drawing and connection of forward & reverse 3 phase squirrel cage induction motor.
	Plan to start, run and reverse an ac 3 phase squirrel cage induction motor by different type of starters.
	Evaluate measurement of the slip of 3 phase squirrel cage induction motor by tachometer for different output.
	Drawing of slip/load characteristics of the motor.
	Determine the efficiency of 3 phase squirrel cage induction motor by no load test/ blocked rotor test and brake test.
	Plot the speed torque (slip/torque) characteristics of slip ring induction motor.
	Monitor speed control of 3 phase induction motor.
	Demonstrate planning to connect, start and run a 3 phase synchronous motor.
	Demonstrate planning to connect start, run, control speed and reverse the DOR of different type of single phase motors.
	Assess installation of a single phase ac motor.
	Test continuity and insulation of various ac motors.
	Assess maintenance, service and troubleshooting of the ac motor & starter.
	Ensure planned work in compliance with standard safety norms related with alternator & mg set.
	Demonstrate planning to connect start and run an alternator and build up the voltage.
	Determine the load performance of a 3-phase alternator.
	Assess starting and loading of a mg set with 3 phase induction motor coupled to dc shunt generator and build up the voltage.

	Evaluate alignment of mg set.
	Appraise preventive and breakdown maintenance of alternator / mg set.
	Explain the effect of excitation current in terms of v-curves of synchronous motor.
	Explain the principle and working of drives.
5. Demonstrate on-site installation preventive maintenance, testing, repair/replacement of an electrical power distribution system. (NOS: PSS/N9424)	Explain present power generation, transmission, and distribution scenario of India.
	Illustrate various types of power generating stations.
	Discuss elements of power systems, transmission, distribution and generations.
	Discuss about power distribution from distribution substation to end consumers.
	Draw layout of transmission system.
	Explain criteria of selection of voltage for HT and LT line.
	Demonstrate types of wiring in power system.
	Analyse losses in transmission system.
	Describe economic principle of power transmission.
	Illustrate safety guidelines and regulation of HT.
	Infer hoe the PLCC helps in protection of transmission lines.
	Explain facts.
	Infer the need of distribution lines errection.
	Distinguish ring main and radial distribution system.
	Determine size of conductors to be used in distribution system.
	Design single line diagram for 33kv, 132kv,220kv and 400kv substation.
	Discuss parameters of equipment and their name plates.
6. Exhibit testing, repair/replacement, maintenance and evaluate the performance of transformers and their types. (NOS: PSS/N9419)	Plan work in compliance with standard safety norms related with transformer.
	Explain the types of transformers and their specifications.
	Verify the transformation ratio of a single phase transformer.
	Evaluate connection and testing of a single phase auto- transformer.
	Determine the losses (iron loss and copper loss) and the regulation of a single phase transformer at different loads.
	Assess measurement of the current and voltage using CT and PT.
	Plan to carry out winding for small transformer of 1KVA rating.
	Test the transformer oil with oil testing kit.
	Check connection of 3 single phase transformers for 3 phase operation of - a) delta-delta b) delta-star c) star-star d) star-delta.
	Plan to connect the given two single phase transformers a) parallel b) series (secondary only) and measure voltage.
	Assess connection& testing of3 phase transformer in parallel.
	Describe the instrument transformers with welding transformer.
	Evaluate testing and protection of instrument transformer.
	Illustrate the concept of live tank and dead tank CT.

	Plan to carry out 5p10 test.
7. Demonstrate to operate and maintain indoor and outdoor substations and determine estimation for HT/LT (on and underground cables) line. (NOS: PSS/N9426)	Explain National Electrical Code for wiring.
	Demonstrate the grading concept and its effect.
	Explain need, advantages and disadvantages of HT cables.
	Demonstrate testing method and estimate wiring cost.
	Describe the objectives of distribution system.
	Classify the different conductors and the underlying nomenclature.
	Explain the various current ratings.
	Describe the jointing of conductor.
	Demonstrate the ABC system and explain the prominent considerations for selection for ABC system.
	Illustrate the different method of joining Aluminium conductors.
	Elucidate the High voltage distribution system (HVDS).
	Describe the advantages of HVDS.
	Demonstrate the route survey for overhead and underground cable distribution system.
	Outline the various Safety procedures and permit to work.
	Illustrate the Operation and maintenance of distribution system.
	Demonstrate the construction of paper insulated lead covered cables
	Explain the types of 3 phase cables, viz., PVC, XLPE, halogen, optical fibre, etc.
	Elaborate the cable type designation.
	Illustrate the installation of cable lines – general, laying cables in trenches: laying conduit built.
	Describe the Faults in the underground cable. Method of locating faults.
	Elucidate the different types of connectors used in the cable, current path.
	Depict the methods of conductor connection and contact resistance.
	Explain the galvanic corrosion and use of bimetals.
	Outlie the connectivity for cable screen and armour, mechanical protection.
	Specify the basic concept of laying procedure and necessary step during emergency restoration and isolate faulty section of power cable in HV electrical system.
	Illustrate the various IP ratings (ingress protection) and IP codes format.
	Demonstrate the Importance of bonding and grounding.
	Construe the mechanism of locating faults.
8. Exhibit the installation, testing and maintenance of batteries for battery room and electrical illumination system for power distribution	Interpret the Faraday's laws of electrolysis.
	Elucidate the various types of Cells and batteries
	Explain the various charging methods.
	Illustrate the grouping of cells for specified voltage and current and the various battery operation.
	Elaborate the factors affecting battery life correction factor,

substation. (NOS:PSS/N9427)	calculation of battery capacity.
	Interpret the principle and operation of solar cell
	Clarify the Safety compliance of battery room.
	Explicate the Voltage stabilization
	Outline the Laws of illumination.
	Define the various types of lamps-incandescent lamp and discharge lamp-fluorescent, HPMV, HPSV lamps.
	Illustrate the various Energy efficient lighting systems (CFL, LED etc.)
	Depict the various colour temperatures.
9. Illustrate the earthing installation, testing and maintenance. (NOS:PSS/N9433)	Elaborate the principle of Earthing.
	Outline the importance of Earthing.
	Illustrate the classifications of Earthing.
	Elucidate plate earthing and pipe earthing methods and IEE Regulations.
	Clarify the difference between grounding and earthing.
	Explain the Earth Resistance and Earth Leakage Circuit Breaker (ELCB).
	Describe the methods of improving earth resistance.
	Depict the awareness of Circuit Main Earth (CME) and portable earth.
10. Demonstrate installation, repair/replacement and maintenance of tower/pole and safety accessories in power distribution substation. (NOS: PSS/N9434)	Outline the CEA Safety regulation 2010.
	Illustrate the Different types of line insulators.
	Elucidate the safety precautions and IE rules pertaining to domestic service connections.
	Explain the basic concept of mono pole, multi circuit tower and 90 degree crossing of two HV transmission line in same tower.
	Demonstrate the concept of transposition of towers.
	Depict the thermo vision supervision at substation for hot point detection.
	Clarify the working of Circuit breakers, isolators, fuses, relays, relaying schemes, installation, operation & maintenance.
	Define the various types of circuit breakers, their applications and functioning.
	Interpret the production of arc and arc quenching methods (air blast, oil, SF6 and vacuum) and handling of SF6 gas (filling and evacuation procedure).
	Elucidate the opening and closing time of breakers.
	Explain the maintenance of equipment.
	Demonstrate the working of Lightening arrester, surge counter.
	Illustrate the necessity, advantages and disadvantages of fuses.
	Explore the different types of LT & HT fuses drop out (DO) fuses sets
11. Assess the revenue, energy accounting (metering and billing) and	Explain revenue management system in electrical distribution.
	Explain the importance of processes for revenue collection.
	Describe flow chart of revenue collection.

energy losses in power distribution. (NOS: PSS/N9435)	Perform energy audit.
	Calculate aggregate technical and commercial loss.
	Explain the measures to reduce technical and commercial losses.
	Perform power purchase calculation and future demand.
	Explain long term and short-term agreement in power purchase.
	Manage supply demand gap.
	Interpret laws and regulation on withdrawal of power from grid network.
	Explain process and documents needed for change in category of supply.
	Demonstrate meter replacement and supply restoration.
12. Demonstrate the examination of faults and maintenance of substation equipment and panels. (NOS: PSS/N9436)	Design layout drawing of control cabinet.
	Design power and control circuits of various circuits used for controlling cabinets.
	Distinguish the control elements: isolators, pushbuttons, switches, indicators, MCB, fuses, relays, types of timers and limit switches etc.
	Demonstrate use of wiring accessories.
	Check various control elements and circuits.
13. Explain the concepts of automation (SCADA and GIS mapping) in power distribution. (NOS: PSS/N9431)	Describe the basic working of SCADA.
	Appraise the benefits of SCADA in a power distribution system.
	Analyse considerations for SCADA implementation
	Describe the key concepts of GIS mapping.
	Perform long term planning with GIS support.
	Discuss the concept and design of GIS and its applications in distribution system planning, analysis and asset management, etc.
14. Read and apply engineering drawing for different application in the field of work. (NOS: PSS/N9411)	Read & interpret the information on drawings and apply in executing practical work.
	Read &analyze the specification to ascertain the material requirement, tools and assembly/maintenance parameters.
	Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
15. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: PSS/N9412)	Solve different mathematical problems
	Explain concept of basic science related to the field of study

8. INFRASTRUCTURE

LIST OF TOOLS AND EQUIPMENT FOR ELECTRICIAN – POWER DISTRIBUTION - CITS			
For batch of 25 candidates			
S No.	**Name of the Tool & Equipment**	**Specification**	**Quantity**
A. TRAINEES TOOL KIT (For each additional unit trainees tool kit Sl. 1-17 is required additionally)			
1.	Measuring Steel Tape	15meter	20+1 Nos.
2.	Combination Plier Insulated	200 mm	20+1 Nos.
3.	Screw Driver Insulated	4mm X 150 mm, Diamond Head	20+1 Nos.
4.	Screw Driver Insulated	6mm X 150 mm	20+1 Nos.
5.	Electrician screw driver thin stem insulated handle	4mm X 100 mm	20+1 Nos.
6.	Heavy Duty Screw Driver insulated	5mm X 200 mm	20+1 Nos.
7.	Electrician Screw Driver thin stem insulated handle	4mm X 250 mm	20+1 Nos.
8.	Punch Centre	9mm X 150 mm	20+1 Nos.
9.	Knife Double Bladed Electrician	100 mm	20+1 Nos.
10.	Neon Tester	500 V	20+1 Nos.
11.	Steel Rule Graduated both in Metric and English Unit	300 mm with precision of 1/4th mm	20+1 Nos.
12.	Hammer, cross peen with handle	250 grams	20+1 Nos.
13.	Plier side cuttting	150 mm	20+1 Nos.
14.	Electrician Helmet	Yellow Colour	20+1 Nos.
15.	Hand gloves	Standard quality	20+1 Nos.
16.	Gum Boot	Standard quality	20+1 Nos.
17.	Safety Belt	Standard quality	5 Nos.
B. SHOP TOOLS, EQUIPMENT & ACCESSORIES– For 2 (1+1) units no additional items are required			
(i) List of Tools			
18.	Hammer Ball peen with handle	500 grams	4 Nos.
19.	Pincer	150 mm	4 Nos.
20.	C- Clamp	200 mm and 100 mm,	2 Nos. each
21.	Spanner Adjustable drop forged, SS	150 mm & 300mm	2 Nos. each
22.	Blow lamp brass	0.5 ltr.	1 No.
23.	Chisel Cold	25 mm X 200 mm	2 Nos.
24.	Chisel firmer with wooden Handle	6 mm X 200 mm	2 Nos.
25.	Allen Key alloy steel	1.5-10 mm (set of 9)	1 Set

26.	Grease Gun	0.5 ltr. Capacity	1 No
27.	Bradawl		2 Nos.
28.	Pipe vice Cast Iron with hardened jaw open type	100 mm	2 Nos.
29.	Hand Vice	50 mm jaw	4 Nos.
30.	Table Vice	100 mm jaw	8 Nos.
31.	Scissors blade, SS	200mm	4 Nos.
32.	Scissors blade, SS	150 mm	2 Nos.
33.	Crimping Tool	1.5 sq. mm to 16 sq. mm	2 Nos.
		16 sq. mm to 95 sq. mm	2 Nos.
34.	Wire Cutter and Stripper	150 mm	4 Nos.
35.	Out Side Micrometer	0 - 25 mm least count 0.01mm	2 Nos.
36.	Thermometer Digital	0° C - 150° C	1 No.
37.	Series Test Lamp	230V, 60W	4 Nos.
38.			
39.	Mallet hard wood	0.50 kg	4 Nos.
40.	Hammer Extractor type	0.40 kg	4 Nos.
41.	Hacksaw frame	Adjustable 300 mm Fixed 150 mm	2 Nos. each
42.	Try Square	150 mm blade	4 Nos.
43.	Pliers flat nose insulated	200 mm	4 Nos.
44.	Pliers round nose insulated	100 mm	4 Nos.
45.	Tweezers	150 mm	4 Nos.
46.	Snip Straight and Bent heavy duty	250 mm	2 Nos. each
47.	D.E. metric Spanner Double Ended	6 - 32 mm	2 Set
48.	Drill hand brace	0-100mm	4 Nos.
49.	Drill S.S. Twist block	2 mm, 5 mm and 6 mm set of 3	4 Set
50.	Plane cutters	50 mm X 200mm	2 Nos.
51.	Smoothing cutters	50 mm X 200mm	2 Nos.
52.	Gauge, wire imperial stainless steel marked in SWG & mm	Wire Gauge - Metric	4 Nos.
53.	File flat	200 mm 2nd cut with handle	8 Nos.
54.	File half round	200 mm 2nd cut with handle	4 Nos.
55.	File round	200 mm 2nd cut with handle	4 Nos.
56.	File flat rough	150 mm with handle	4 Nos.
57.	File flat bastard	250 mm with handle	4 Nos.
58.	File flat smooth	250 mm with handle	4 Nos.
59.	File Rasp, half round	200 mm bastard with handle	4 Nos.
60.	Copper bit soldering iron.	0.25 kg	2 Nos.

61.	De soldering Gun	Heat proof nozzle, PVC type, 250mm	4 Nos.
(ii) List of Equipment			
62.	Ohm Meter; Series Type & Shunt Type, portable box type	50/2000-ohm analog	2 Nos. each
63.	Digital Multi Meter	DC 200mv -1000v,0 – 10A & AC 200mv- 750v , 0-10A, resistance 0-20 MΩ and 3 1/2 digit	12 Nos.
64.	A.C. Voltmeter M.I. analog, portable box type housed in Bakelite case	Multi range 75 V - 150V - 300V - 600V	3 Nos.
65.	Milli Voltmeter center zero analog, portable box type housed in Bakelite case	100 – 0 – 100 mV	2 Nos.
66.	Ammeter MC analog, portable box type housed in Bakelite case	0 - 500 mA, 0-5 A, 0-25 A	2 Nos. each
67.	AC Ammeter MI, analog, portable box type housed in Bakelite case	0 - 1 A, 0-5 A, 0-25 A	2 Nos. each
68.	Kilo Wattmeter Analog	0-1.5-3KW, pressure coil rating-240v/440v, current rating-5A/10A Analog, portable type Housed in Bakelite case	2 Nos.
69.	Digital Wattmeter	230 V, 1 KW, 50 Hz	2 Nos.
70.	A.C. Energy Meter	Single Phase, 10 A, 240 V induction type (as per IEC 61850)	2 Nos.
71.	A.C. Energy Meter	Three Phase, 15 A , 440 V induction type (as per IEC 61850)	2 Nos.
72.	Digital Energy Meter	Single Phase, three phase (as per IEC 61850)	2 Nos. each
73.	MRI Equipment		1 No.
74.	Power Factor Meter Digital	440 V, 20 A, Three Phase portable box type	2 Nos.
75.	Frequency Meter	45 to 55 Hz	2 Nos.
76.	Magnetic Flux Meter	0-500 Tesla	2 Nos.
77.	Lux meter	Lux meter LCD read out 0.05 to 7000 lumens with battery.	2 Nos.
78.	Tachometer	Analog Type - 10000 RPM	1 No.
79.	Tachometer	Digital Photo Sensor Type - 10000 RPM	1 No.
80.	Hydrometer		2 Nos.

81.	Hand Drill Machine	0-6 mm capacity	2 Nos.
82.	Portable Electric Drill Machine	0-12 mm capacity 750w, 240v with chuck and key	1 No.
83.	Load Bank (Lamp / heater Type)	6 KW, 3Ph	1 No.
84.	Brake Test arrangement with two spring balance rating	0 to 25 kg	1 No.
85.	Tong Tester / Clamp Meter	0 - 100 A (Digital Type)	2 Nos.
86.	Megger	Analog - 500 V	2 Nos.
87.	Earth Resistivity tester		1 set
88.	Wheat Stone Bridge with galvanometer and battery		2 Nos.
89.	Single Phase Variable Auto Transformer	0 - 270 V, 10Amp (Air cooled)	2 Nos.
90.	Phase Sequence Indicator	3 Phase, 415 V	2 Nos.
91.	AC Starters: - a. Resistance type starter b. Direct on line Starter c. Star Delta Starter- Manual d. Star Delta Starter – Semi automatic e. Star Delta Starter – Fully automatic f. Star Delta Starter - Soft starter	For A.C Motors of 2 to 5 H.P.	1 No. each
92.	Oscilloscope Dual Trace	20 MHz	1 No.
93.	Synchroscope	440V, 50 Hz	1 No.
94.	Function Generator	2 to 200 KHz, Sine, Square, Triangular 220 V, 50 Hz, Single Phase	1 No.
95.	Digital multi-function meter	3 Phase	1 No.
96.	Soldering Iron	25-Watt, 65 Watt and 120-Watt, 230 Volt	2 Nos. each
97.	Temperature controlled Soldering Iron	50-Watt, 230 Volt	2 Nos.
98.	Discrete Component Trainer	Discrete Component (for diode and transistor circuit) with regulated power supply +5,0- 5 V,+12 ,0-12 V	2 Nos.
99.	Linear I.C. Trainer	Linear I.C. Trainer with regulated power supply 1.2V to 15V PIC socket 16pin and 20 pin with bread board	1 No.

100.	Digital I.C. Trainer	Digital I.C. Trainer 7 segment display and bread board	1 No.
101.	Oil Testing Kit	Oil Testing Kit 230 V, single phase 50 Hz 60 VA output 0-60 KV Variable	1 No.
102.	Inverter with Battery	1 KVA with 12 V Battery Input- 12-volt DC Output- 220 volt AC	1 No.
103.	Ni-Cd Battery	1.2 Amps	3 Nos.
104.	Voltage Stabilizer	AC Input - 150 - 250 V, 600 VA AC Output - 240 V, 10 A	1 No.
105.	DC Power Supply	0 - 30 V, 5 A	2 Nos.
106.	24 V battery set		1 set
107.	110 V battery charger		1 No.
108.	Battery Charger	0 - 6 - 9 - 12 - 24 - 48 V, 30amp	1 No.
109.	Current Transformer	415 V, 50Hz, CT Ratio 25 / 5 A, 5VA	2 Nos.
110.	Potential Transformer	415 V, 50Hz, PT Ratio, 440V/110V, 10VA	2 Nos.
111.	Solar panel with Battery	18 Watt	1 Set
112.	D.C. milli ammeter	0-500m A	1 No.
113.	Hygrometer		1 No.
114.	Potential Transformer	415 volt, 50 Hz, PT ratio 11KV/ 110 V, 10VA	1 No.
115.	Laptop	Latest Version	2 Nos.
116.	Ink jet/ laser printer		1 No.
(iii) List of Accessories			
117.	Oil Can	250 ml	2 Nos.
118.	Contactor & auxiliary contacts	3 phase, 415 Volt, 25 Amp with 2 NO and 2 NC	2 Nos. each
119.	Contactor & auxiliary contacts.	3 phase, 415 volt, 32 Amp with 2 NO and 2 NC	2 Nos. each
120.	Limit Switch	Limit Switch, Liver operated 2A 500V, 2-contacts	2 Nos.
121.	Rotary Switch	16 A/440V	2 Nos.
122.	Relay- a. Cut out Relays b. Reverse current c. Over current d. Under voltage	 a. 16A, 440V b. 16A, 440V c. 16A, 440V d. 360V-440V	2 No. each
123.	Static relay - distance protection		1 No.

124.	Laboratory Type Induction Coil	1000 W	2 Nos.
125.	Knife Switch DPDT fitted with fuse terminals	16 Amp	4 Nos.
126.	Knife Switch TPDT fitted with fuse terminals	16 Amp/ 440 V	4 Nos.
127.	Miniature Breaker	16 amp	2 Nos.
128.	Earth Plate	60cm X 60cm X 3.15mm Copper Plate 60cm X 60cm X 6mm GI Plate	1 Each
129.	Earth Electrode	Primary Electrode 2100x28x3.25mm Secondary Cu Strip 20x5mm	1 No.
130.	MCCB	100Amps, Triple pole	1 No.
131.	ELCB	2 Pole, 32 Amps, 240V	1 No.
132.	Earth Discharge Rod	33KV	2 Nos.
133.	Rheostat (Sliding type)	0 - 25 Ohm, 2 Amp 0 - 300 Ohm, 2 Amp 0 -1 Ohm, 10Amp 0 -10 Ohm, 5 Amp	1 No. each
134.	Capacitors	Electrolytic, Ceramic, Polyester film,Variable, Dual run	2 Each
135.	Various Electronic components	Resistors, Diode, Transistor, UJT, FET, SCR, DIAC, TRAIC, IGBT, Small transformer etc.	As required
136.	Various Lamps	**Halogen Incandescent Lamp** Fluorescent tube High-pressure sodium Lamp	1 Each
137.	LED	**Tube, Lamp**	4 Each
138.	Plug socket, Piano Switch, Lamp Holder	230 V, 5 A	2 Each
139.	Bus bar with brackets	1 mtr. each	3 Nos.
140.	LT fuse set (Henley Unit)		1 set
141.	11 KV DO fuse set		1 set
142.	Fuse Wire	18, 20, 22 SWG	1 Roll each
143.	LT Shackle Insulator		2 Nos.
144.	Bucholtz Relay		1 No.
145.	Breather with Silica Gel & Oil		1 No.
146.	Standard Wire Gauge		4 Nos.
147.	ACSR Conductor - Weasel, Rabbit, Raccoon, Dog, Panther, Zebra, Moose	1 Meter piece	1 set

148.	HT XLPE Cable (1 meter piece)	3x70, 3x120, 3x185, 3x240, 3x300 sq. mm	1 set each
149.	LT PVC insulated cable (1 meter piece)	3½x 120, 3½x150, 3½x 240, 3½x 400, 3½x 600 sq mm	1 set
150.	Twisted pair cable, non-metallic sheathed cable, underground feeder cable, ribbon cable, metallic sheathed cable, Multi conductor cable, direct buried cable.	1 Mtr.	1 No. each
151.	Aerial Bunched Cable (ABC)	70, 120, 185 sq mm	1 mtr each
152.	11KV pin insulator		1 No.
153.	11 KV pin with nut		1 No.
154.	11 KV disk insulator		1 No.
155.	11 KV suspension fitting		1 No.
156.	33 KV tension fitting		1 No.
157.	ST pole clamp		1 No.
158.	PCC pole clamp		1 No.
159.	PG clamp - panther to panther, panther to dog & dog to dog		1 set
160.	RCC Pole with accessories (MS angle iron, 'C' clamp, stay insulator etc.) and materials	6 Mtr.	2 No.
161.	Stone pad		1 No.
162.	Cross arm	V Type	1 No.
C. Shop Machinery - For 4 (2+2) units no additional items are required			
163.	Motor Generator (DC to AC) set consisting of - Shunt Motor with starting compensator and switch directly coupled to AC generator with exciter and switch board mounted with regulator, breaker, ammeter, voltmeter frequency meter, knife blade switch and fuses etc. Set complete with cast iron bed plate, fixing bolts, foundation bolts and flexible coupling.	Shunt Motor rating: 5 HP, 440V AC Generator rating: 3-Phase, 4 wire, 3.5 KVA, 400/230 Volts, 0.8 pf, 50 cycles	1 No.
164.	AC Squirrel Cage Motor with star delta starter and triple pole iron clad switch fuse with Mechanical Load.	5 HP, 3-Phase, 415 V, 50 Hz	1 No.

165.	AC phase-wound slip ring Motor with starter switch	5 HP, 440 V, 3 Phase, 50 Hz	1 No.
166.	Universal Motor with starter/switch	240 V, 50 Hz, 1 HP	1 No.
167.	Synchronous motor with accessories like starter, excitation arrangements.	3 Phase, 3 HP, 440V, 50Hz, 4 Pole	1 No.
168.	Thyristor/IGBT controlled A.C. motor drive with	VVVF control 3 Phase, 2 HP	1 No.
169.	Single phase Transformer, core type, air cooled	1 KVA, 240/415 V, 50 Hz	3 Nos.
170.	Three phase transformer, shell type oil cooled with Delta/ Star	3 KVA, 415/240 V, 50 Hz	2 Nos.
171.	Secondary injection set		1 No.
D. Shop Floor Furniture and Materials - For 2 (1+1) units no additional items are required			
172.	Working Bench	2.5 m x 1.20 m x 0.75 m	4 Nos.
173.	Wiring Board	3-meter x1 meter with 0.5-meter projection on the top	1 No.
174.	Instructor's table		1 No.
175.	Instructor's chair		2 Nos.
176.	Metal Rack	100cm x 150cm x 45cm	4 Nos.
177.	Lockers with drawers		1 for Each Trainee
178.	Almirah	2.5 m x 1.20 m x 0.5 m	1 No.
179.	Black board/white board	(minimum 4X6 feet)	1 No.
180.	Fire Extinguisher	Foam type, CO_2 type & dry power type	3 Nos. each
181.	Fire Buckets	Standard size	2 Nos.
182.	Rubber mat	2' x 4' x 1"	2 Nos.
Note: software of MATLAB is also required.			


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