GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

COMPETENCY BASED CURRICULUM

SOLAR TECHNICIAN (ELECTRICAL)

(Duration: One Year)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL –3.5

SECTOR – POWER

Directorate General of Training

SOLAR TECHNICIAN (ELECTRICAL)

(Engineering Trade)

(Revised in March 2023)

Version: 2.0

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL –3.5

Developed By

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1. COURSE INFORMATION

During the one-year duration of Solar Technician (Electrical) trade a candidate is trained on professionalSkill, professional Knowledge and Employability Skillrelated to job role. In addition to this a candidate is entrusted to undertake project work and extracurricular activities to build up confidence. The broad components covered under Professional Skill subject are as below: -

During the coursethe trainee learns about safety and environment, use of fire extinguishers, artificial respiratory resuscitation to begin with. He gets the idea of trade tools & its standardization, identifies different types of conductors, cables & their skinning & joint making. Basic electrical laws and their application in different combinations of electrical circuit are practiced along with laws of magnetism. Performs testing by various Electrical Instruments like Wattmeter, Energy meter, etc.Performs basic Electric energy calculations and understand transmission and distribution of electrical power. The Trainee understands natural planetary movements and sunlight's path. Measures intensity of solar radiation, analyzes shadow effect on incident solar radiation, plots curve of radiation measured and draws a solar map with respect to time for a location.The Trainee learns about characteristics of Photovoltaic cells and modules, Batteries, Charge Controllers and constructs small Solar DC appliances. The Trainee learns to arrange and test solar batteries and their correct disposal. Learns connections and testing of Solar Panel, Charge Controller,Battery Bank and Inverter.Learns types of Inverters used in the Solar system and their application according to the requirements of the project. Preparesbill of material for small, medium and mega solar projects.Plan and prepares reports on building integrated solar mount.Installation and commissioning of Solar PV plant and hybrid plants.The Trainee learns various tests pertaining to PV Modules and their installation as per IEC standards.Understands manufacturing process of solar panels, prepare and commission marketable solar productsviz., solar water pump, solar street light, solar fertilizer sprayer etc. The Trainee learns about electrical maintenance of Inverters/Cables/Junction boxes, inspectionof mounting structure of solar modules and replacement of defective fixtures.

2. TRAINING SYSTEM

2.1 GENERAL

The Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of economy/ Labour market. The vocational training programmes are delivered under the aegis of Directorate General of Training (DGT). Craftsman Training Scheme (CTS) with variantsand Apprenticeship Training Scheme (ATS) are two pioneer schemes of DGT for strengthening vocational training.

CTS courses are delivered nationwide through network of ITIs. The course 'Solar Technician (Electrical)' is of one-year duration. It mainly consists of Domain area and Core area. The Domain area (Trade Theory and Trade Practical) imparts professional skills and knowledge, while Core area (Employability Skills) imparts requisite core skill, knowledge and life skills.After passing out of the training program, the trainee is awarded National Trade Certificate (NTC) by DGT which is recognized worldwide.

Trainee broadly needs to demonstrate that they are able to:

- Read and interpret technical parameters/ documentation, plan and organize work processes, identify necessary materials and tools.
- Perform tasks with due consideration to safety rules, accident prevention regulations and environmental protection stipulations.
- Apply professional knowledge & employability skills while performing the job and modification & maintenance work.
- Check the circuit/ equipment/ panel as per drawing for functioning, identify and rectify faults/ defects.
- Document the technical parameters related to the task undertaken.

2.2 PROGRESSION PATHWAYS

- Can join industry as Technician and will progress further as Senior Technician, Supervisor and can rise up to the level of Manager.
- Can become Entrepreneur in the related field.
- Can join Apprenticeship Programmes in different types of industries leading to a National Apprenticeship Certificate (NAC).
- Can join Crafts Instructor Training Scheme (CITS) in the trade for becoming an instructor in ITIs.
- Can join Advanced Diploma (Vocational) courses under DGT as applicable.

2.3 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.	Professional Skill (Trade Practical)	840
2.	Professional Knowledge (Trade Theory)	240
3.	Employability Skills	120
	Total	**1200**

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

On the Job Training (OJT) / Group Project	150
Optional Courses (10th/ 12th class certificate along with ITI certification or add on short term courses)	240

Trainees of one-year or two-year trade can also opt for optional courses of up to 240 hours in each year for 10th/ 12th class certificate along with ITI certification or add on short term courses.

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course through formative assessment and at the end of the training programme through summative assessment as notified by the DGT from time to time.

a) The **Continuous Assessment** (Internal) during the period of training will be done by **Formative Assessment Method** by testing for assessment criteria listed against learning outcomes.The training institute has to maintain an individual trainee portfolio as detailed in assessment guideline. 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. The All India Trade Test for awarding NTCwill be conducted by Controller of examinations, DGT as per the guidelines. The pattern and marking structure is being notified by DGTfrom time to time. **The learning outcome and assessment criteria will be the basis for setting question papers for final**

assessment. The 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 REGULATION

For the purposes of determining the overall result, weightage of 100% is applied for six months and one year duration courses and 50% weightage is applied to each examination for two years courses. The minimum pass percent for Trade Practical and Formative assessment is 60% for all other subjects is 33%. 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. Due consideration should be given while assessing for teamwork, avoidance/reductionofscrap/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 some of the following:

- Job carried out in labs/workshop
- Record book/ daily diary
- Answer sheet of assessment
- Viva-voce
- Progress chart
- Attendance and punctuality
- Assignment
- Project work
- Computer based multiple choice question examination
- Practical Examination

Evidences and records of internal (Formative) assessments are to be preserved until forthcoming examination for audit and verification by examining body. The following marking pattern to be adopted for formative assessment:

Performance Level	Evidence
(a) Mark in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate	• Demonstration of good skill in the use of

should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices.	hand tools, machine tools and workshop equipment. • 60-70% accuracy achieved while undertaking different work with those demanded by the component/job. • A fairly good level of neatness and consistency in the finish. • Occasional support in completing the project/job.
(b) Mark in the range of 75%-90% to be allotted during assessment	
For this grade, a candidate should produce work which demonstrates attainment of a reasonable standard of craftsmanship, with little guidance, and regard for safety procedures and practices.	• Good skill levels in the use of hand tools, machine tools and workshop equipment. • 70-80% accuracy achieved while undertaking different work with those demanded by the component/job. • A good level of neatness and consistency in the finish. • Little support in completing the project/job.
(c) Mark in the range of more than 90% to be allotted during assessment	
For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.	• High skill levels in the use of hand tools, machine tools and workshop equipment. • Above 80% accuracy achieved while undertaking different work with those demanded by the component/job. • A high level of neatness and consistency in the finish. • Minimal or no support in completing the project.

3. JOB ROLE

Solar Panel Installation Technician; is also known as 'Panel Installer', the Solar Panel Installation Technician is responsible for installing solar panels at the customers' premises. The individual at work checks the installation site, understands the layout requirement as per design, assesses precautionary measures to be taken, installs the solar panel as per customer's requirement and ensures effective functioning of the system post installation.

Solar PV System Installation Engineer; is responsible for designing and installing the solar photovoltaic system at the customer's premises to meeting their power requirement. The individual at work evaluates the installation site, designs the installation, plans and arranges for materials, and ensures smooth installation process. The individual also supervises the installation technicians' work.

Solar PV System Maintenance Technician; is responsible for maintenance and effective functioning of the installed solar panels. The individual at work cleans the installed solar modules, checks the photovoltaic system for uninterrupted power output and identifies faults in the PV system.

Module Assembly Technician; is responsible for fixing frames and junction box in the solar module. The individual at work prepares the solar module for final assembly, frames the module and fixes the junction box with cables on the rear side of the module. The individual is also responsible for connecting the tabbing wire from the module to the junction boxand soldering them.

Reference NCO-2015:

a) 7421.1401 – Solar Panel Installation Technician
b) 7421.1402 – Solar Photo Voltaic System Installation Technician
c) 7421.1403 – PV System Installation Engineer
d) 8212.2301 – Module Assembly Technician

Reference NOS:

(i) PSS/N2001
(ii) SGJ/N0104
(iii) ELE/N6001
(iv) SGJ/N0105
(v) SGJ/N0106
(vi) SGJ/N0101
(vii) SGJ/N0102
(viii) SGJ/N0103
(ix) ELE/N5903
(x) SGJ/N0107
(xi) PSS/N9401
(xii) PSS/N9402

4. GENERAL INFORMATION

Name of the Trade	**SOLAR TECHNICIAN (ELECTRICAL)**
Trade Code	DGT/2003
NCO - 2015	7421.1401, 7421.1402, 7421.1403, 8212.2301
NSQF Level	Level 3.5
NOS Covered	PSS/N2001, SGJ/N0104, ELE/N6001, SGJ/N0105, SGJ/N0106, SGJ/N0101, SGJ/N0102, SGJ/N0103, ELE/N5903, SGJ/N0107, PSS/N9401, PSS/N9402
Duration of Craftsmen Training	One Year (1200 hours + 150 hours OJT/Group Project)
Entry Qualification	Passed 10th class examination
Minimum Age	14 years as on first day of academic session.
Eligibility for PwD	LD, LC, DW, AA, DEAF, LV, HH
Unit Strength (No. Of Student)	20 (There is no separate provision of supernumerary seats)
Space Norms	50 Sq. m
Power Norms	3 KW
Instructors Qualification for	
(i) Solar Technician (Electrical) Trade	B.Voc/Degree in Electrical/ Electrical and Electronics Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Electrical/ Electrical and Electronics Engineering from AICTE/recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. **OR** NTC/NAC passed in the Trade of "Solar Technician (Electrical)" With three years experience in the relevant field. **<u>Essential Qualification</u>:** Relevant Regular / RPL variants of National Craft Instructor Certificate (NCIC) under DGT. ***NOTE: Out of two Instructors required for the unit of 2(1+1), one***

	must have Degree/Diploma and other must have NTC/NAC qualifications. **However both of them must possess NCIC in any of its variants.**
(i) Workshop Calculation & Science	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. OR 03 years Diploma in Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. OR NTC/ NAC in any one of the engineering trades with three years' experience. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in relevant trade. OR NCIC in RoDA or any of its variants under DGT.
(ii) Engineering Drawing	B.Voc/Degree in Engineering from AICTE /UGC recognized Engineering College/ university with one-year experience in the relevant field. OR 03 years Diploma in Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. OR NTC/ NAC in any one of the engineering/ Draughtsman group of trades with three years' experience. **Essential Qualification:** Regular / RPL variants of National Craft Instructor Certificate (NCIC) in relevant trade OR Regular/RPL variants NCIC in RoDA or any of its variants under DGT
(iii) Employability Skill	MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years' experience with short term ToT Course in Employability Skills. (Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above) OR Existing Social Studies Instructors in ITIs with short term ToT

	Course in Employability Skills.
(iv) Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

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 LEARNING OUTCOME:

1. Prepare profile with an appropriate accuracy as per drawing following safety precautions. (NOS: PSS/N2001)
2. Prepare electrical wire joints, carry out soldering and crimping. (NOS: SGJ/N0104)

3. Construct and test various characteristics of electrical and magnetic circuits. (NOS: SGJ/N0104, ELE/N6001)
4. Assemble, install and test wiring system. (NOS: SGJ/N0104)
5. Use instruments for measurement of various electrical parameters. (NOS: SGJ/N0104, SGJ/N0105, SGJ/N0106)
6. Perform basic Electric energy calculations and understand transmission and distribution of electrical power. (NOS: SGJ/N0101)
7. Verify natural planetary movements and sunlight's path. (NOS: SGJ/N0101)
8. Demonstrate characteristics of Photovoltaic cells, Modules, Batteries and Charge controllers. (NOS: SGJ/N0102, SGJ/N0103, SGJ/N0104)
9. Construct and demonstrate Solar DC appliances. (NOS: SGJ/N0104, ELE/N5903)
10. Connect, test, undertakemaintenance and disposal of solar batteries. (NOS: SGJ/N0103)
11. Connect and test solar panel, Charge controller, Battery bank and Inverter. (NOS: SGJ/N0103, SGJ/N0104)
12. Prepare bill of materials for small, medium and mega solar PV projects. (NOS: SGJ/N0102)
13. Perform various tests and measurement pertaining to PV Modules and their installation as per IEC standards. (NOS: SGJ/N0104, SGJ/N0105)
14. Assist in Installation and commissioning of Solar PV plant and Hybrid plant. (NOS: SGJ/N0105)
15. Perform Operation & Maintenance of PV system with best practices. (NOS: SGJ/N0107, ELE/N6001)
16. Perform manufacturing of solar panel, prepare and commission marketable solar products. (NOS: SGJ/N0102, SGJ/N0101, ELE/N5903)
17. Read and apply engineering drawing for different application in the field of work. (NOS: PSS/N9401)
18. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: PSS/N9402)

6. ASSESSMENT CRITERIA

LEARNING OUTCOMES	ASSESSMENT CRITERIA
1. Prepare profile with an appropriate accuracy as per drawing following safety precautions. (NOS: PSS/N2001)	Identify the trade tools; practice their uses with safety, care & maintenance.
	Identification of danger, warning, caution & safety signs.
	Preventive measures for electrical accidents and use of fire extinguishers.
	Connection of electrical accessories.
2. Prepare electrical wire joints, carry out soldering and crimping. (NOS: SGJ/N0104)	Skinning, twisting and crimping.
	Identify various types of cables and measure conductor size using SWG and micrometer.
	Make joints on single strand conductors.
	Crimping and soldering of joints / lugs.
3. Construct and test various characteristics of electrical and magnetic circuits. (NOS: SGJ/N0104, ELE/N6001)	Measure parameters in combinational DC circuits by applying Ohm's Law for different resistor values and voltage sources.
	Measure current and voltage in DC circuits to verify Kirchhoff's Law.
	Verify laws of series and parallel circuits with voltage source in different combinations.
	Measure current and voltage and analyse the effects of shorts and opens in series and parallel circuits.
	Measure power, energy for lagging and leading power factors in single phase circuits.
	Determine the relationship between Line and Phase values for star and delta connections.
	Measure the Power of three phase circuit for balanced and unbalanced loads.
4. Assemble, install and test wiring system. (NOS: SGJ/N0104)	Identification various conduits and different electrical accessories.
	Cutting, threading of different sizes & laying Installations.
	Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, ELCB.
	Wire up PVC conduit wiring to control one lamp from two different places using two way switches.
	Control panel wiring using wiring accessories and mounting of

	control elements, e.g. meters, fuses, relays, switches, push buttons, MCB, ELCB etc.
	Prepare different types of earthing and measure earth resistance by earth tester / Megger.
5. Use instruments for measurement of various electrical parameters. (NOS: SGJ/N0104, SGJ/N0105, SGJ/N0106	Use of various analog and digital measuring Instruments.
	Measuring instruments in single and three phase circuits e.g. multi-meter, Wattmeter, Energy meter, Phase sequence meter and Frequency meter etc.
	Test single phase energy meter for its errors.
6. Perform basic Electric energy calculations and understand transmission and distribution of electrical power. (NOS: SGJ/N0101)	Measure power consumption for different loads with various times of use and calculate watt-hour.
	Find out power ratings from product label and prepare a load calculation chart.
	Perform OC and SC test to determine and efficiency of single phase transformer.
	Draw circuit diagram of substation and indicate various components.
7. Verify natural planetary movements and sunlight's path. (NOS: SGJ/N0101)	Plot sun chart and locate the sun at your location for a given time of the day.
	Measure intensity of solar radiation using Pyranometer and radiometers.
	Analyse shadow effect on incident solar radiation and find out contributors.
	Plot curve of radiation measured with respect to time for a location.
8. Demonstrate characteristics of Photovoltaic cells, Modules, Batteries and Charge controllers. (NOS: SGJ/N0102, SGJ/N0103, SGJ/N0104)	Connect solar panels in series & parallel and measure voltage and current.
	Charge & discharge a solar battery rated 12V, 100 Ah using Battery charger by CV and CC method and Tabulate the observations during charging & discharging cycle.
	Connect the charge controller (12V, 10A) with Solar battery (12V, 100Ah), Solar panel (75W) and DC load.
	Test the charge controller working with the above circuit.
9. Construct and demonstrate Solar DC appliances.	Construct a solar lantern using Solar PV panel (15W), Charge controller (6V, 5A), output control circuit for variable illumination, Rechargeable battery (6V, 7Ah) and DC LED lamp (5W).

(NOS: SGJ/N0104, ELE/N5903)	Construct a Solar water pump using a DC pump (24 V), Solar Panel (250 W), Charge controller (24 V, 10 A).
10. Connect, test, undertake maintenance and disposal of solar batteries. (NOS: SGJ/N0103)	Prepare connecting wires for grouping of solar batteries.
	Check the condition of electrolyte in a solar battery using hydrometer and add distilled water to the required level in the solar battery.
	Connect two solar batteries (12V, 100Ah each) in series to a 24Volt DC pump and Test the Voltage and current in the circuit.
	Connect two solar batteries (12V, 100Ah each) in series to a 24 DC pump and Test the Voltage and current in the circuit.
11. Connect and test solar panel, Charge controller, Battery bank and Inverter. (NOS: SGJ/N0103, SGJ/N0104)	Connect MC 4 connectors to a solar panel using crimping tool.
	Connect the PWM controller with solar panel & solar battery and note input /output current and battery voltage at different time intervals.
	Connect the MPPT controller with solar panel & solar battery and note input and output current and battery voltage, at different time intervals.
	Connect a Solar panel (10W), Solar charge controller (12V, 10A), Solar battery (12V, 100 Ah) and a normal inverter and convert to a solar inverter.
	Connect a 1 KW Solar PCU to 1 KW Solar panel installation using a suitable battery bank and test the performance.
12. Prepare Bill of materials for small, medium and mega solar PV projects. (NOS: SGJ/N0102)	Prepare bill of material for a 1/5/10/20/100 KW solar PV installation
	Estimate cost of a 1 KW solar PV installation and prepare a quotation.
13. Perform various tests and measurement pertaining to PV Modules and their installation as per IEC standards. (NOS: SGJ/N0104, SGJ/N0105)	Measure Insulation resistance and Wet Leakage Current of PV Modules.
	Perform Bypass Diode test - Pmax at STC and Pmax at low irradiance.
	Measure Ground Continuity, Impulse Voltage, Reverse current and Partial Discharge.

14. Assist in Installation and commissioning of Solar PV plant and Hybrid plant. (NOS: SGJ/N0105)	Create a rough layout of the rooms showing existing Grid meter line, MCB, nearest shaded & dry place for a solar PCU and place for panels.
	Connect the array junction box to the above installation and draw wires up to PCU.
	Wire the above installation panels, battery etc. to a 1 KW Solar PCU
	Prepare a First inspection report on the solar plant installation.
	Prepare a list of Do's and Don'ts in the installation.
	Evaluate windiness of a place using an anemometer.
	Test with a blower and model windmill & record the observations.
15. Perform Operation & Maintenance of PV system with best practices. (NOS: SGJ/N0107, ELE/N6001	Demonstrate Standard Operating Procedures of PV system.
	Demonstration of Solar Panel Maintenance: - Cleaning, DC Array Inspection, Precautions While Cleaning.
	Demonstration of Battery Maintenance- Checking of Electrolyte Level, Specific Gravity Using Hydrometer, Physical Damage, Terminal Voltage, Cleaning of Battery Terminals.
16. Perform manufacturing of solar panel, prepare and commission marketable solar products. (NOS: SGJ/N0102, SGJ/N0101, ELE/N5903)	Assemble a solar panel using the cell string.
	Determine the I-V curve of finished solar PV panel and prepare a model certificate.
	Assemble, install and commission a solar water pump/street light/solar fertilizer spray.
17. Read and apply engineering drawing for different application in the field of work. (NOS: PSS/N9401)	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.
18. Demonstrate basic mathematical concept and principles to	Solve different mathematical problems.
	Explain concept of basic science related to the field of study.

perform practical operations. Understand and explain basic science in the field of study. (NOS: PSS/N9402)	

7. TRADE SYLLABUS

SYLLABUS FOR SOLAR TECHNICIAN (ELECTRICAL) TRADE			
DURATION: ONE YEAR			
Duration	**Reference Learning outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Professional Skill 60Hrs; Professional Knowledge 15Hrs	Prepare profile with an appropriate accuracy as per drawing following safety precautions	1. Visit of various sections of the institutes and identification of danger, warning, caution & safety signs. 2. Preventive measures for electrical accidents and use of fire extinguishers. 3. Practice elementary first aid and artificial respiration. 4. Disposal procedure of waste materials. 5. Use of personal protective equipment. 6. Familiarization with signs and symbols of electrical Accessories.	Scope of the trade. Safety rules and safety signs. Types and working of fire extinguishers. First aid safety practice. Hazard identification and prevention. Response to emergencies, e.g. power failure, system failure and fire etc.
		7. Workshop practice on filing and hacksawing. 8. Practice sawing, planing, drilling and assembling for making a wooden switchboard. 9. Workshop practice on drilling, chipping, internal and external threading of different sizes. 10. Prepare an open box from metal sheet.	Concept of Standards and advantages of BIS/ISI. Trade tools specifications. Electrical symbols. Introduction to National Electrical Code-2011.
Professional	Prepare electrical	11. Practice on skinning,	Fundamentals of electricity.

Skill 25 Hrs; Professional Knowledge 05Hrs	wire joints, carry out soldering and crimping.	twisting and crimping. 12. Identify various types of cables and measure conductor size using SWG and micrometre. 13. Make joints on single strand conductors. 14. Practice in crimping and soldering of joints / lugs.	Concept of current, voltage, power, resistors and capacitors. Generation of DC electricity. Electrical conductors and insulators. Differentiate between AC and DC current. Types of joints and techniques of soldering.
Professional Skill 60 Hrs; Professional Knowledge 12Hrs	Construct and test variouscharacteristics of electrical and magnetic circuits.	15. Measure parameters in combinational DC circuits by applying Ohm's Law for different resistor values and voltage sources. 16. Measure current and voltage in DC circuits to verify Kirchhoff's Law. 17. Verify laws of series and parallel circuits with voltage source in different combinations. 18. Measure current and voltage and analyse the effects of shorts and opens in series and parallel circuits. 19. Verify the characteristics of series parallel combination of resistors. 20. Determine the poles and plot the field of a magnet bar. 21. Identify various types of capacitors, charging / discharging and testing. 22. Test AC circuit with resistive load like lamp, heater, etc.	Ohm's Law; Simple electrical circuits and problems. Kirchoff's Laws and applications. Series and parallel circuits. Open and short circuits in series and parallel networks. Series and parallel combinations of resistors. Magnetic terms, magnetic materials and properties of magnet. Electrostatics: Capacitor-Different types, functions, grouping and uses. Inductive and capacitive reactance and their effect on AC circuit. Comparison and Advantages of DC and AC systems. Sine wave, phase and phase difference. Related terms frequency, Instantaneous value, R.M.S. value Average value, Peak factor, form factor, power factor and Impedance etc. Active and Reactive power. Single Phase and three-

		23. Test AC circuit with inductive load like fan, pump, etc. 24. Measure power, energy for lagging and leading power factors in single phase circuits. 25. Measure Current, voltage, power, energy and power factor in three phase circuits. 26. Ascertain use of neutral by identifying wires of a 3-phase 4 wire system and find the phase sequence. 27. Determine the relationship between Line and Phase values for star and delta connections. 28. Measure the Power of three phase circuit for balanced and unbalanced loads.	phase system. 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.
Professional Skill 45 Hrs; Professional Knowledge 07 Hrs	Assemble, install and test wiring system.	29. Identify various conduits and different electrical accessories. 30. Practice cutting, threading of different sizes & laying Installations. 31. Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, ELCB, MCCB etc. 32. Drawing layouts and practice in PVC Casing-capping, Conduit wiring	I.E. rules on electrical wiring. Types of domestic and industrial wirings. Study of wiring accessories e.g. switches, fuses, relays, MCB, ELCB, MCCB, switchgears etc. 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,

		with minimum to number of points as per IE rules. 33. Wire up PVC conduit wiring to control one lamp from two different places using two way switch. 34. Practice testing / fault detection of domestic and industrial wiring installation and repair. 35. Practice control panel wiring using wiring accessories and mounting of control elements, e.g. meters, fuses, relays, switches, push buttons, MCB, ELCB etc. 36. Prepare different types of earthing and measure earth resistance by earth tester / megger. 37. Practice Installation of lightening arrestor.	Communication and entertainment wiring. Wiring circuits planning, permissible load in sub-circuit and main circuit. Importance of Earthing. Plate earthing and pipe earthing methods and IEE regulations. Earth resistance and earth leakage circuit breaker. Lightening arrestor.
Professional Skill 25 Hrs; Professional Knowledge 05Hrs	Use instruments for measurement of various electrical parameters.	38. Identify and practice of various analog and digital measuring Instruments. 39. Practice on measuring instruments in single and three phase circuits e.g. multi-meter, Wattmeter, Energy meter, Phase sequence meter and Frequency meter etc. 40. Test single phase energy meter for its errors.	Classification of electrical instruments and essential forces required in indicating instruments. PMMC and Moving iron instruments. Range extension. Wattmeter, PF meter, Energy meter, Megger, Earth tester, Frequency meter, Phase sequence meter, Multimeter, Tong tester etc. Instrument transformers – CT and PT.
Professional Skill 45 Hrs;	Perform basic electric energy	41. Measure power consumption for different	Calculation of total watt hour of all loads per day and

Professional Knowledge 10Hrs	calculations and understand transmission and distribution of electrical power.	loads with various times of use and calculate watt-hour. 42. Find out power ratings from product label and prepare a load calculation chart. 43. Verify terminals, identify components and calculate the transformation ratio of single phase transformers. 44. Perform OC and SC test to determine and efficiency of single phase transformer. 45. Visit to transmission / distribution substation. 46. Draw actual circuit diagram of substation visited and indicate various components.	daily average watt hour from twelve months electricity bill. Working principle of transformer. Electric power demand, supply and gap in city, state and national level. Conventional energy Generation by thermal (coal, gas diesel) and hydel power plant. (small and large) Advantages of high voltage transmission. Transmission network of India. Study of distribution of power and substation. Overhead v/s underground distribution system.
Professional Skill 60Hrs; Professional Knowledge 12Hrs	Verify natural planetary movements and sunlight's path.	47. Plot sunchart and locate the sun at your location for a given time of the day. 48. Find out relations between sunlight and earth motion by globe model. 49. Observe and compare sunlight and angle of inclination during 12 hours of a day on different days. 50. Locate magnetic poles (North and South) with the help of magnetic compass. 51. Observe on Globe, which countries are in the Northern hemisphere and which on the Southern hemisphere.	Non-renewable and Renewable energy concept. Advantages over non renewable energy; brief discussion main renewable energy resources viz. solar (PV and thermal), wind, Biofuel, Biomass, small hydro, Tidal power, Wave power, Geo thermal energy etc. Solar energy fundamentals. Study of Sun path(east to west, North to south and south to north movement). Study of daily and seasonal changesof sunlight. Angle of inclination of

		52. Prepare a list of places around India, their latitude and longitude. 53. Measure intensity of solar radiation using Pyranometer and radiometers. 54. Analyse shadow effect on incident solar radiation and find out contributors. 55. Plot curve of radiation measured with respect to time for a location. 56. Draw a solar map by collecting data of solar radiation in a location for one year. 57. Compare the effects of direct radiation, diffused radiation and reflected radiation and prepare reports.	radiant light and its relation with latitude and longitude of different locations on Earth. Definition of key earth-sun angles. Equation of time, solar constant etc. Definition of GHI & DNI Definition of tracking (single axis and double axis) Solar radiation over India (measurements, satellite data and maps) (10-12 years historical data) Application of sunchart on shadow identification. Sunlight spectrum.
Professional Skill 100Hrs; Professional Knowledge 19Hrs	Demonstrate characteristics of Photovoltaic cells, Modules, Batteries and Charge controllers.	58. Test an LED and a Photodiode to verify the photo emitting effect and light sensitivity. 59. Test a Photo voltaic cell for different illumination levels and verify photovoltaic property. 60. Plot I-V curve for photovoltaic cell based on the illumination at constant temperature. 61. Plot I-V curve for photovoltaic cell based on temperature at constant illumination. 62. Test photovoltaic cell in	Semiconductor properties and types. P-type and N-type semiconductors, PN junction, etc. Conversion of solar radiation to electricity. Main materials used to develop solar cells (Silicon, Cadmium tellurides, etc.) Light sensitive properties of PN junction. Difference of photo electric and photo voltaic effects of a PN junction. PV cell characteristics, I–V curve, effects of temperature.

		sunlight at various angles of inclination and direction. 63. Test different rated Photovoltaic modules (Panels) and plot I-V curve. 64. Record specification of different solar panels and compare specifications to select a panel. 65. Test different types of PV panels such as, mono crystalline, poly crystalline, amorphous silicon and thin film modules. Prepare a report on panels. 66. Determine the relation between number of cells and maximum voltage per module. 67. Connect suitably rated wires in the terminal box of a solar panel and connect end terminals using MC 4 connectors.	Photovoltaic effect. Photo voltaic module: minimal functional specification, cells per module, max watts per module, maximum voltage at max power, maximum current at max power. Standard test conditions (STC) of a PV module. Terminal box and connectors of a Solar PV module. Identification of various test standards of PV module. Measurement of area of the cells and compare with the module area in data sheet. Identification of faulty PV module.
		68. Connect solar panels in series and measure voltage and current. Repeat with different rated panels. 69. Connect solar panels in parallel and measure voltage and current. Repeat with different rated panels. 70. Shift the panels to rooftop or the place of installation using safe handling practices.	Solar PV array; series and parallel calculation. Handling of PV modules. Module mounting; structures requirement. Photovoltaic cell and PV modules: types - mono crystalline, poly crystalline, amorphous silicon and thin film PV cells and their comparison. Recent thin film technologies (CdTe, GIGS, CIS etc.)

		71. Check the structural and area requirement for installation of 1 KW solar panel. 72. Identify different solar panels as per specification. 73. Compare different types of solar panels and prepare a report. 74. Charge a solar battery rated 12V, 100 Ah using Battery charger by CV and CC method and Tabulate the observations during charging cycle. 75. Discharge a solar battery rated 12V, 100 Ah using DC load under Constant Current and tabulate the observations during discharging cycle. 76. Verify Voltage, ampere hour (Ah), state of charge (SOC), depth of discharge (DOD), Efficiency, C-rating of battery from 5 different manufacturers. Compare and select suitable solar battery. 77. Connect the charge controller (12V, 10A) with Solar battery (12V, 100Ah), Solar panel (75W) and DC load (12V such as LED light 3W & 5W, DC Fan & FM radio). 78. Test the charge controller working with the above circuit and study the	Safe handling of panels. **Battery fundamentals;** Storage batteries: Various types of Batteries- Lead acid battery, nickel cadmium battery, lithium ion battery. Battery construction, working, charge/discharge and applications. Safe working with battery. Solar Rechargeable SMF Battery; energy, storage capacity specifications, voltage, ampere hour (Ah), state of charge (SOC), depth of discharge (DOD), Efficiency, C-rating, cycle life, self-discharge etc. Deep discharge and shallow cycle. Block diagram of a charge controller. Tools required for working with battery. Charge controllers, fuses, blocking diodes, bypass diode, LED indicators, low voltage disconnect, high voltage disconnect. Solar DC home lighting, Solar mobile Handset charger, Solar FM radio, Solar DC fan and other solar DC devices. Power packs for decentralized energy supply. Troubleshooting of batteries and charge controllers.

		performance. 79. Construct home lighting system using solar panel. 80. Construct and test a solar powered mobile handset charger. 81. Construct a dusk to dawn charge controller (12V, 10A) with Solar battery (12V, 100Ah), Solar panel (75W) and LED light (12V DC, 5W). 82. Construct a home lighting system with manual control.	
Professional Skill 45Hrs; Professional Knowledge 07Hrs	Construct and demonstrate Solar DC appliances.	83. Construct a solar lantern using Solar PV panel (15W), Charge controller (6V, 5A), Output control circuit for variable illumination, Rechargeable battery (6V, 7Ah) and DC LED lamp (5W). (08hrs) 84. Construct a Solar Day lighting using manual charge controller (12V, 10A), Solar battery (12V, 100Ah), Solar panel (75 W) and 4X LED light (12V DC, 5W). (08hrs) 85. Construct a Solar Garden light using dusk to dawn charge controller (12V, 10 A), Solar battery (12V, 100 Ah), Solar panel (75 W) and 4X LED light (12V DC, 5W). 86. Construct a Solar Street light using dusk to dawn	Solar DC domestic application: Making of solar lantern. Solar Day lighting. Solar Garden Lights. Safety in DC system. Quality standards List out the inventory list of equipments and tools for construction of a DC system. Solar DC industrial application: Solar street light. Solar home lighting system. Solar Securitysystem. Solar DC water pump. Differentiate AC and DC solar pumps and their PV requirements for various HP capacity.

		charge controller (12V, 10 A), Solar battery (12V, 100 Ah), Solar panel (75 W) and 4X LED light (12V DC, 5W). 87. Construct a Solar Security system using a Manual charge controller rated (12V, 10 A), Solar battery (12V, 100 Ah), Solar panel (75 W) and Security camera & CCTV/Intruder alarm (12 V DC). (08hrs) 88. Construct a Solar water pump using a DC pump (24 V), Solar Panel (250 W), Charge controller (24 V, 10 A).	
Professional Skill 45 Hrs; Professional Knowledge 07 Hrs	Connect, test, undertake maintenance and disposal of solar batteries.	89. Prepare connecting wires for grouping of solar batteries. 90. Connect two solar batteries (12V, 100Ah each) in series to a 24 V DC pump and Test the Voltage and current in the circuit. 91. Connect two solar batteries (12V, 100 Aheach) in parallel to a parallel group of 12 Volts DC LED lights and Test the Voltage and current in the circuit. 92. Check the condition of electrolyte in a solar battery using hydrometer and add distilled water to the required level in the	Battery bank: Series and parallel connections. Specific gravity. Use of hydrometer. Safety aspects in handling batteries. Charging/ Discharging of batteries. Maintenance of battery. Risk of batteries. Ventilation requirements. Requirement of connecting only similar batteries. Disposal procedure of batteries. Common defects in batteries. Procedure for capacity testing.

		solar battery. 93. Remove complete electrolyte from a lead acid battery and refill. 94. Shift 12V 100Ah battery on a trolley to different location following safe handling practices. 95. Plan for rack system of battery bank storage. 96. Prepare a report on maintenance and disposal of solar batteries.	
Professional Skill 60Hrs; Professional Knowledge 12 Hrs	Connect and test solar panel, Charge controller, Battery bank and Inverter.	97. Connect MC 4 connectors to a solar panel using crimping tool. 98. Connect the PWM controller with solar panel & solar battery and note input /output current and battery voltage at different time intervals. 99. Connect the MPPT controller with solar panel & solar battery and note input and output current and battery voltage, at different time intervals. 100. Compare the results of the above. 101. Open PWM and MPPT Charge controllers and identify components wired to understand mechanism. 102. Connect solar panels to	Solar panel terminal wires and MC-4 connectors. Choice of wires (DC cables) used in the solar PV Electrical system. Array junction box (AJB) or combiner box. Protection devices in AJB. PWM charge controller. MPPT charge controller. Block diagram of charge controller. Overview of Sequence of connection (step wise) in an off grid system. **Inverter**: working, front panel controls and back panel controls. Normal and solar inverter. Solar charge controller for a normal inverter. Selection of solar inverter or Power Conditioning Unit (PCU). Switching ON and shut

		an Array Junction box. 103. Connect and test a 12V DC/230V AC normal inverter. 104. Connect a Solar panel (10W), Solar charge controller (12V, 10A), Solar battery (12V, 100 Ah) and a normal inverter and convert to a solar inverter. 105. Prepare a comparative chart by collecting data sheets of different solar PCU and normal inverters. 106. Practice procedural switching 'ON' and Shutdown of solar PCU. 107. Connect a 1 KW Solar PCU to 1 KW Solar panel installation using a suitable battery bank and test the performance. 108. Check of front panel features of a Solar PCU. 109. Check of back panel features of a Solar PCU. 110. Demonstrate Solar PV e-learning software.	down procedure of a solar inverter Types of Inverter: - Standalone, Grid Tied (MPPT/Central/String), Micro inverter. IEC Std followed for Inverter in solar projects. Block diagram of Solar Photo voltaic electrical system. Classification of inverters- Stand alone or off-grid inverter, Hybrid inverter, Grid-tie inverter. Wall mount or array mount inverter. Inverter room planning for mega projects. Integration of inverters in large PV projects. Overview of PV System Software.
Professional Skill 45 Hrs; Professional Knowledge 07 Hrs	Prepare Bill of materials for small, medium and mega solar PV projects.	111. Prepare bill of material for a 1 KW solar PV installation. (08hrs) 112. Prepare bill of material for a 5 KW solar PV installation. 113. Prepare a Bill of materials for a 10 KW solar PV installation.	Single Line Diagram (SLD) and identifying different component symbols in SLD. System sizing: Selection of components of the Solar Photovoltaic Electrical system. Load calculation and system sizing.

		114. Prepare a Bill of materials for a 20 KW solar PV installation. 115. Prepare a Bill of materials for a 100 KW solar PV installation. (08hrs) 116. Estimate cost of a 1 KW solar PV installation and prepare a quotation.	Battery sizing. Solar panel sizing. Sizing small and medium solar PV projects and their SLDs. System types based on: Backup requirements, Grid availability, Budget and space. Various skill requirements during solar PV plant installation. Guidance for Solar Installation by MNRE
Professional Skill 20Hrs; Professional Knowledge 05Hrs	Perform various tests and measurement pertaining to PV Modules and their installation as per IEC standards.	117. Carry out visual inspection of PV modules. 118. Measure Insulation resistance and Wet Leakage Current of PV Modules. 119. Perform Bypass Diode test -Pmax at STC and Pmax at low irradiance. 120. Measure Ground Continuity, Impulse Voltage, Reverse current and Partial Discharge. 121. Practice to undertake precautions against Module breakage. 122. Demonstrate hot spot on modules through audio visual aids.	Performance standards IEC 62125/61646 (Diagnostic, Electrical, Performance, Thermal, Irradiance, Environmental, Mechanical) Safety Standards IEC 61730-1,2 (Electrical Hazards, Mechanical Hazards, Thermal Hazards, Fire Hazards) Hot spot on modules and method to detect them at site.
Professional Skill 145Hrs; Professional Knowledge	Assist in Installation and commissioning of Solar PV plant and Hybrid plant.	123. Create a rough layout of the rooms showing existing Grid meter line, MCB, nearest shaded & dry place for a solar PCU	**Site survey**: Inspection of field, Selection of site, Shadow analysis. Types of roofs, Weather monitoring.

28 Hrs		and place for panels. 124. Prepare a layout of roof showing open areas and occupied areas and mark obstructions that can cause shadows. Take site photographs. 125. Mark locations for components of solar PV electrical system on site. 126. Perform shadow analysis in the rooftop of a 1 KW Solar PV plant. Use sun path diagram for the latitude and solar pathfinder. 127. Install a roof top Solar panel mounting structure for 1 KW installation that uses Solar panels 250 W x 4 Nos. 128. Mount Solar panels 250 W x 4 Nos. on the Mounting structure. 129. Wire Solar panels 250 W x 4 Nos. 130. Connect the array junction box to the above installation and draw wires up to PCU. 131. Perform different angle of inclination of Solar panel mounting for various cities considering their latitude. 132. Perform Cable laying in the field. 133. Perform finishing work on mounting structure.	Solar path finder and sun path diagram. Wind Load conditions on Solar PV Panels like Wind Speed, Height of Panel above roof and Relative Location of Panels on roof. Identifying challenges' in the placement of modules/PCU in the site. (Portrait/landscape placement, number of tables etc.). Roof area, shadow free area, structure, type& age of the building, usable area, O&M challenges, and integration issues Wire (cable) requirement/ estimation. Special tools and material handling equipment required during installation. Solar panel mounting structures. Solar plant foundation planning. Installation of solar panels. Solar panel facing direction. Changing the angle of inclination as per location and seasonal setting. MMS systems or using trackers. Solar plant, civil works: drilling, digging, finishing,

		Perform concrete foundation making over mounting pole base. 134. Perform setting of seasonal angles on mounting structure.	Mixing concrete.
		135. Wire a battery bank for 1 KW installation, using 4X 12V, 100 Ah Solar batteries. 136. Wire the above installation panels, battery etc. to a 1 KW Solar PCU. 137. Group and distribute the loads as per economical planning. 138. Wire the AC mains connection to the Solar PCU (Do not switch 'ON'). 139. Prepare a Checklist for finding out errors during above installation. 140. Check as per the checklist and prepare a clearance certificate before commissioning. 141. Perform Procedural first switch ON, observe No load test results and record. 142. Perform 'ON Load' test, progressively add load till full load and record observation. 143. Perform Overload test and record observation. 144. Prepare a First inspection report onthe solar plant	Battery Bank wiring, load wiring and distribution panel. Switching loads, economical planning of load distribution. Inverter wiring, Interface with the existing electrical system. Commissioning skills: Preparation of check off list. Safety precautions before initial starting. Observation of parameters pre and post operation. Operational test before connecting to Load. Progressive load connecting and on load testing. Overload testing. First inspection report generation. Customer orientation. Documentation and record. Do's and Don'ts in the installation. Types of installation for solar array mounts based roof types: Manual Mount: Raft/rack mounts

		installation. 145. Prepare a list of Do's and Don'ts in the installation. 146. Prepare a report on Customer orientation. 147. Prepare a report on visible and audio annunciations, alarms or alerts in a solar PCU. 148. Perform shutting down procedure of the above solar plant.	Pillar or Pole mount Building integrated mount Ballast roof mounts RCC rooftop mount Tracking mounts: Manual track Automatic track Single axis and dual axis Safety at heights Condition monitoring and report generation.
		149. Prepare a ballast foundation for tiled roof. 150. Prepare a rack mount for a tilted roof. 151. Plan and prepare a report on building integrated solar mount. 152. Prepare a foundation for a single Pillar mount. 153. Visit a Mega project and prepare a report including strings, array, inverter room, output transformers, plant layout and SCADA room. 154. Prepare a report on site suitable for windmill. 155. Observe the presence of obstacles in a site suitable for windmill. 156. Evaluate windiness of a place using an anemometer. 157. Prepare a report on wind mill energy conversion system through sufficient audio visual sessions.	Maintenance of a solar plant. Alarms & security. Data logger and SCADA room. Introduction to wind power Components of wind turbine generator (WTG). Windmill; principle of operation and types. Elements of a wind mill. Minimum threshold, nominal speed during operation and out of service, high speeds of wind energy. Speed governor and control of transmission of energy. Electrical generator and Charge controller for windmill. Small (mini) hydro electricity generation and charge controller. Basics of other renewable energy resources for power generation, such as bio gas plant. Windmill suitable for

		158. Test with a blower and model windmill & record the observations.	integration with solar PV plant and its integration.
Professional Skill 20Hrs; Professional Knowledge 05Hrs	Perform Operation & Maintenance of PV system with best practices.	159. Demonstrate Standard Operating Procedures of PV system. 160. Demonstrate Electrical Maintenance of Inverters/Cables/Junction Boxes, Fault Indications of Inverters/PCU. 161. Demonstration of Solar Panel Maintenance: - Cleaning, DC Array Inspection, Precautions While Cleaning. 162. Demonstration of Battery Maintenance- Checking of Electrolyte Level, Specific Gravity Using Hydrometer, Physical Damage, Terminal Voltage, Cleaning of Battery Terminals. 163. Inspection of Mounting Structure of Solar Modules, Procedure of replacement of defective Fixtures.	SOP (Standard Operation Procedures) of PV system. Types of Maintenance (Preventive/Corrective/Condition Based). Electrical maintenance /Solar Panel maintenance/ Battery maintenance/ Charge Controller maintenance / Solar Panel maintenance.
Professional Skill 40 Hrs; Professional Knowledge 08 Hrs	Perform manufacturing of solar panel, prepare and commission marketable solar products.	164. Verify the I-V curve of solar cells. 165. Perform the incoming inspection of Solar PV cells and categorise according to the quality. 166. Construct a cell string. 167. Assemble a solar panel using the above cell string.	**Solar panel manufacturing:** Skills for incoming inspection of PV cells. Making of cell string. Parts of solar panel. Assembly of panel parts. Framework and sealing of panel. Testing and certification. Quality standards. Manual

		168. Perform the framework and seal the Solar panel. 169. Determine the I-V curve of finished solar PV panel and prepare a model certificate. 170. Visit a solar panel manufacturing industry and prepare a report. (or through an audio visual session) 171. Prepare a report on automatic manufacturing of solar panels through audio visual sessions. 172. Assemble, install and commission a solar street light. 173. Assemble, install and commission a model of solar fertilizer sprayer. 174. Prepare a report on possible innovative solar products for marketing. 175. Assemble, install and commission a solar water pump. 176. Assemble, install and commission a solar traffic light.	and automatic manufacturing Solar water treatment plant Solar air conditioning Solar refrigeration. Solar agricultural products – sowing, digging, fertilizer or pesticide spraying. Introduction to solar energy technologies for decentralized (thermal) energy supply; Solar cookers for domestic and community cooking Solar Sprinklers for drip irrigation, Solar water pumping, Solar dryer, Solar air Heater. Solar Traffic Light, Solar distillation, Solar pond. National and international energy policies. National Solar Mission, Renewable Purchase Obligation Implementation at state level. Loan and promotional schemes. Incentives, subsidies & concessions. Solar rooftop business models. Administrative processes. Details of various websites and mobile apps where policies can be accessed.
ENGINEERING DRAWING: (40 Hrs.)			
Professional Knowledge	Read and apply engineering	Introduction to Engineering Drawing and Drawing Instruments–	

ED-40 Hrs.	drawing for different application in the field of work.	• Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instrument Free hand 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 trade. Reading of Electrical Circuit Diagram Reading of Electrical Layout drawing
WORKSHOP CALCULATION & SCIENCE: (36 Hrs)		
Professional Knowledge WCS-36 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	**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, multiplication & division Solving problems by using calculator **Square root, Ratio and Proportions, Percentage** Square and square root Simple problems using calculator Applications of Pythagoras theorem and related problems Ratio and proportion Ratio and proportion - Direct and indirect proportions Percentage Percentage - Changing percentage to decimal and fraction **Material Science** Types metals, types of ferrous and non ferrous metals

		Introduction of iron and cast iron **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 of temperature 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 Magnetic induction, self and mutual inductance and EMF generation Electrical power, energy and units of electrical energy **Mensuration** Area and perimeter of square, rectangle and parallelogram Area and perimeter of Triangles **Trigonometry** Measurement of angles Trigonometrical ratios Trigonometrical tables
Project work / Industrial visit: - • Solar applications viz. Solar traffic light, solar water pump etc. • Hybrid plant • Report on skills required in the Solar PV installation. • Report on existing National and state level energy policy. • Report for setting up a small business in the solar industry.		

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

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

ANNEXURE-I

List of Tools & Equipment			
SOLAR TECHNICIAN (ELECTRICAL) (For batch of 20 candidates)			
S No.	**Name of the Tools and Equipment**	**Specification**	**Quantity**
A. TRAINEES TOOL KIT			
1.	Measuring Steel Tape	5 meter	21 (20+1) Nos.
2.	Combination Plier Insulated	200 mm	21 (20+1) Nos.
3.	Screw Driver Insulated	4mm X 150 mm, Diamond Head	21 (20+1) Nos.
4.	Screw Driver Insulated	6mm X 150 mm	21 (20+1) Nos.
5.	Electrician screw driver thin stem insulated handle	4mm X 100 mm	21 (20+1) Nos.
6.	Heavy Duty Screw Driver insulated	5mm X 200 mm	21 (20+1) Nos.
7.	Electrician Screw Driver thin stem insulated handle	4mm X 250 mm	21 (20+1) Nos.
8.	Punch Centre	9mm X 150 mm	21 (20+1) Nos.
9.	Knife Double Bladed Electrician	100 mm	21 (20+1) Nos.
10.	Neon Tester	500 V	21 (20+1) Nos.
11.	Steel Rule Graduated both in Metric and English Unit	300 mm with precision of 1/4th mm	21 (20+1) Nos.
12.	Hammer, cross peen with handle	250 grams	21 (20+1) Nos.
B. SHOP TOOLS & EQUIPMENT			
(i) List of Tools & Accessories			
13.	Electrical Symbol and Accessories Charts		04 nos.
14.	Pipe vice Cast Iron with hardened jaw open type	100 mm	2 Nos.
15.	Hand Vice	50 mm jaw	2 Nos.
16.	Table Vice	100 mm jaw	2 Nos.
17.	Hacksaw frame (with blade)	Adjustable 300 mm Fixed 150 mm	2 Nos. Each
18.	File flat	200 mm 2nd cut with handle	2 Nos.
19.	File half round	200 mm 2nd cut with handle	2 Nos.
20.	File round	200 mm 2nd cut with handle	2 Nos.
21.	Pliers long nose insulated	150 mm	4 Nos.
22.	Pliers flat nose insulated	200 mm	4 Nos.
23.	Pliers, round nose insulated	100 mm	4 Nos.

24.	D.E. metric Spanner Double Ended	6 - 32 mm	2 Set
25.	Gauge, wire imperial stainlees steel marked in SWG & mm	Wire Gauge - Metric	2 Nos.
26.	Portable Electric Drill Machine	0-12 mm capacity 750W, 240V with chuck and key	1 No.
27.	Crimping Tool	1.5 sq mm to 16 sq mm 16 sq mm to 95 sq mm	1 No. Each
28.	Pliers Side Cutting	150 mm	2 No.
29.	Wire stripper adjustable length		2 No.
30.	Hammer, ball peen With handle		2 No.
31.	Scriber (Knurled centreposition)		2 No.
32.	Tool kit Box/bag portable		5 No.
33.	Allen Key		1 Set
34.	Scissors blade	150 mm	2 No.
35.	Electrical loads: set of Incandescent lamp, Tube light, CFL, LED light, Heater and Geyser	Electrical loads: set of Incandescent lamp, Tube light, CFL, LED light, Heater and Geyser	2 Set
36.	Torque wrench	8N-m to 15N-m	1 No.
37.	Pipe Cutter to cut pipes	upto 5 cm. dia	1 No.
38.	Pipe Cutter to cut pipes	above 5 cm dia	1 No.
39.	Try Square	150 mm blade	2 No.
40.	Multi Meter (analog)	0 to 1000 M Ohms, 2V to 500 V,100 microA to 10A DC and AC	1 No
41.	Load Bank (variable)	Up to 1.2 KW (Lamp / heater Type)	1 No.
42.	Wire Cutter and Stripper	150 mm	4 Nos.
43.	Earth Plate	60cm X 60cm X 3.15mm Copper Plate 60cm X 60cm X 6mm GI Plate	1 Each
44.	Earth Electrode	Primary Electrode 2100x28x3.25mm Secondary Cu Strip 20x5mm	1 No.
45.	Out Side Micrometer	0 - 25 mm least count 0.01mm	2 Nos.
46.	Tap set	Different size	02 Set Each
47.	Trolley for Transportation of Batteries		02 Nos.
48.	Die for Threading	Different sizes	02 Set
49.	Rooftop Mounting Structure	For 4 x 250 W solar panels mounting practice, with tilt adjustment	2 Set
50.	Electrical wiring and switch gear rack	Electrical control elements suitable for practice of control circuits using banana plugs and sockets	1 No.
51.	Protective relays and contactors rack	suitable for practice of control circuits using banana plugs and	1 No.

		sockets	
52.	MCCB	100Amps, Triple pole	1 No.
53.	ELCB and RCCB	25Amps, double pole and 25Amps, double pole, IΔn 30 mA	1 Each
54.	Fuses	HRC, Glass, Rewire Type	4 Each
55.	**Cables:** Twisted Pair Nonmetallic Sheathed Cable Underground Feeder Cable Ribbon Cable Metallic Sheathed Cable Multi-Conductor Cable Coaxial Cable Direct-Buried Cable	1 mtr each	1 Each
56.	Solar cable (Red)	5 square mm	As required
57.	Solar cable (Black)	5 square mm	As required
58.	Three core wire	(230 V, 15 A)	As required
59.	Battery cable	7.5 sqmm	As required
60.	Resin cored Solder		As required
61.	Solder wax		As required
62.	MC – 4 connector		As required
63.	pins	5 mm	As required
64.	lugs	7.5 mm	As required
65.	Hacksaw blades	200 mm, 300 mm	As required
66.	Bolts, nuts, anchor bolts, washers, screws, other pins, lugs etc		As required
67.	Civil work utensils	spade, mixing spoon, leveling plates	1 Set
68.	Plumbing tools		1 Set
69.	Plumbing raw materials		As required
70.	Civil work raw materials		As required
(ii)	**List of Equipment**		
71.	Multimeter	Digital 0 to 1000 M Ohms, 2V to 700 V,100 micro A to 10A DC and AC	02 Nos.
72.	Megger	Analog - 500 V	01 Nos.
73.	Hydrometer		04 Nos.

74.	Solar Insulation meter		02 Nos.
75.	Pyranometer		01 No.
76.	Pyrheliometer		01 No.
77.	Lux meter	Lux meter LCD read out 0.05 to 7000 Lumens with battery.	02 Nos.
78.	Magnetic Flux Meter	0-500 tesla	02 Nos.
79.	Tong Tester / Clamp Meter	0 - 100 A (Digital Type)	01 Nos.
80.	Soldering Iron	25 Watt, 65 Watt and 120 Watt, 230 Volt	02 Nos. Each
81.	Temperature controlled Soldering Iron	50 Watt, 230 Volt	02 Nos.
82.	Thermometer Digital	0° C - 150° C	01 No.
83.	Sun Shine recorder		02 No.
84.	Weather monitoring station	To monitor and record Sunshine, wind velocity, temperature, rainfall etc with software.	01 No.
85.	Solar cell based sunlight radiation meter	For Solar power measurement up to 2000 w/square meter	02 No.
86.	Magnetic compass		04 No.
87.	Cut models of photo voltaic cell assembly		02 Nos.
88.	Cut model of Lead acid battery		01 No.
89.	Lead Acid battery	12V, 40Ah, 75Ah	01 Each
90.	Lead Acid battery	12V, 100 Ah	04 Nos.
91.	Solar simulator for solar cell characteristic study	To study IV curve of a solar cell of minimum 2 watt under variable illumination, temperature and suitable load	01 No.
92.	IV Curve tester		01 No.
93.	Sun path finder		01 No.
94.	Solar energy trainer with grouping of solar cells	To group (series or parallel) at least six solar cells each with minimum 2 W with suitable loads	01 No.
95.	Solar tracker demonstrator kit	To study manual and automatic control of 10 W solar panel in East-west and North-south &back	01 No.
96.	Solar PV e-learning software using animations for training		01 License

97.	Halogen lamp with stand for illumination of solar panels in lab	AC mains operated to provide 0 to 1000 watts per meter square	02 Set
98.	Motorized Bench Grinder	AC mains operated	01 No.
99.	Battery Charger	0 - 6 - 9 - 12 - 24 - 48 V, 30amp	01 No.
100.	Solar photovoltaic module	75 W mono crystalline module 75 W amorphous silicon module 250 W thin film module 5W, 10W, 40W poly crystalline module	01 Each
101.	Solar panels	250 Wp	04 Nos.
102.	Solar Charge controller with Dusk to Dawn automatic switching	12V, 10A	05 Nos.
103.	Solar charge controller with manual switch (Day lighting)	12 V 10 A	05 Nos.
104.	Array junction box	for connecting 250W x 4 Nos. solar panel with DC fuse, DC MCB, and surge suppressor protection	02 Nos.
105.	Solar lantern	LED type	01 No.
106.	Solar lantern	CFL type	01 No.
107.	Solar lantern assembly sets		01 No.
108.	Home light system	12 V DC with FM receiver, LED bulb and mobile charger as loads	01 No.
109.	Solar cell kit		01 No.
110.	Clinometer	for Angle measurement	01 No.
111.	Spirit level	For floor level check	01 No.
112.	Anemometer	for wind speed measurement	01 No.
113.	DC table fan	12 V	01 No.
114.	A.C. Voltmeter M.I	0 –500V AC	02 Nos.
115.	Volt meter	0 - 30V	02 Nos.
116.	Volt meter	0 - 100V	02 Nos.
117.	Ammeter MC	0 - 1A	02 Nos.
118.	Ammeter MC	0 - 5A	02 Nos.
119.	Ammeter MC centre zero	0 - 20A	02 Nos.
120.	Ammeter MC centre zero	0-50A	02 Nos.
121.	Power Factor Meter		01 No.

122.	Rheostat	0 -1 Ohm, 5 Amp 0 -10 Ohm, 5 Amp 0- 25 Ohm, 1 Amp 0- 300 Ohm, 1 Amp	01 No. each
123.	A.C. Energy Meter	Single Phase, 10 A, 240 V induction type	01 No.
124.	A.C. Energy Meter	Three Phase, 15 A, 440 V induction type	01 No.
125.	Kilo Wattmeter Analog	0-1.5-3KW, pressure coil rating-240v/440v, current rating-5A/10A Analog, portable type Housed in bakelite case	02 Nos.
126.	Digital Wattmeter	230 V, 1 KW, 50 Hz	02 Nos.
127.	Phase Sequence Indicator	3 Phase, 415 V	02 Nos.
128.	Frequency Meter	45 to 55 Hz	02 Nos.
129.	DC LED Lamp	3W, 5W, 10W	50 Each
130.	DC Pump	24 V	02 Nos.
131.	PWM Controller		04 Nos.
132.	MPPT Charge Controller		04 Nos.
133.	Inverter with Battery	1 KVA with 12 V Battery Input- 12 volt DC, Output- 220 volt AC	01 No.
134.	Solar PCU	Off grid 1 KW MPPT Sine wave Solar Power Conditioning Unit	04 Nos.
135.	Solar Grid tied inverter Demonstrator kit	300W KW	01 No.
136.	Solar Street Light	12V, 75Ah battery, 75 Wp solar panel, 12V, 10A dusk to dawn charge controller, 60 W LED lights and 9 m height pole all dismountable	01 Nos.
137.	Solar, wind and hybrid power plant	1 KW cumulative	01 No.
138.	Solar Traffic Light	12V, 75Ah battery, 75 Wp solar panel, 12V, 10A dusk to dawn charge controller, 15 W LED lights with suitable colors and 9 m height pole all dismountable	01 No.
139.	Used water treatment solar plant demonstrator kit	1 liter capacity	01 No.
140.	solar DC pump	1 HP	01 No.
141.	Demonstration kit for wind	300 W	01 No.

	generation (Wind turbine with blower)		
142.	Rechargeable battery	12 V 100 Ah	As required
143.	Rechargeable battery	12 V 7 Ah	As required
144.	Rechargeable battery	6 V 5 Ah	As required
145.	LED lights	12 V DC	As required
146.	LED lights	6 V DC	As required
C. SAFETY AND PROTECTIVE EQUIPMENT			
147.	Rubber gloves		10 Pair
148.	Cotton gloves		05 Pair
149.	Gum boots		02 Pair
150.	Safety Goggles		04 Nos.
151.	Safety Helmet		04 Nos.
152.	First Aid kit		02 Nos.
153.	Fire Extinguisher CO_2	Arrange all proper NOCs and equipments from Municipal/Competent authorities.	
D. SHOP FLOOR FURNITURE AND MATERIALS			
154.	Working Bench	2.5 m x 1.20 m x 0.75 m	04 Nos.
155.	Wiring Board	3 meters x 1 meter with 0.5 meter projection on the top	01 No.
156.	Instructor's table		01 No.
157.	Instructor's chair		02 Nos.
158.	Trainee Chair		01 for Each Trainee
159.	Trainee table for two trainee		10 Nos.
160.	Metal Rack	100cm x 150cm x 45cm	04 Nos.
161.	Lockers with drawers		01 for Each Trainee
162.	Almirah	2.5 m x 1.20 m x 0.5 m	01 No.
163.	Black board/white board	(Minimum 4X6 feet)	01 No.

Note: -

1. *All the tools and equipment are to be procured as per BIS specification.*
2. *Internet facility is desired to be provided in the class room.*

ANNEXURE - II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts, trainers of ITIs, NSTIs, faculties from universities and all others who contributed in revising the curriculum.

Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

List of Expert members contributed/ participated for finalizing the course curriculum of Solar Technician (Electrical) trade held on 27.10.2017 at Appex Hi-Tech Institute, Bangalore.

S No.	Name & Designation Sh/Mr/Ms	Organization	Remarks
1.	B. S. Arun Kumar, Head Renewable	Tata Projects Ltd., Bangalore	Chairman
2.	Dr. Chandan Banerjee, DDG (Scientist F)	National Institute of Solar Energy, Gurgaon	Expert
3.	Dr. A.K. Saxena, AGM	Bharat Heavy Electricals Ltd. Gurgaon	Expert
4.	Rajinder Kaura CMD	Bergen Group of Companies, Gurgaon	Expert
5.	Gp. Capt. Yogesh Sharma (Retd), Director	Bergen Institute on Research for development of skills, Gurgaon	Expert
6.	DrIshan Purohit , Energy Specialist	International Finance Corporation World Bank Group, New Delhi	Expert
7.	Anurag Mishra, Head Solar	Emergent Ventures India, Gurgaon	Expert
8.	Sandeep Mittal, Vice President Operations & New Projects	JBM group, Gurgaon	Expert
9.	A. K. Chaubey, Head HR (NR & WMC)	L & T Constructions, New Delhi	Expert
10.	Vibhor	Bergen Institute on Research for development of skills, Gurgaon	Expert
11.	S. James, Managing Director	Solax Energy LLP, Bangalore	Member
12.	S. Dhananjay, Director	Renergy Power Systems Pvt. Ltd., Bangalore	Member
13.	Geetha, CEO	Temco Renewable Energy Solutions, Bangalore	Member
14.	Rama Siva, Founder	Anthro Power, Bangalore	Member
15.	Priyank R. Harsurkar, Deputy Manager	BEL, Bangalore	Member
16.	Ramesh Bandiwaddar, Deputy Manager	BEL, Bangalore	Member
17.	Dr. C. S. Mala, HOD	TCE BMS Institute of Technology,	Member

		Bangalore	
18.	Shanthi G., Deputy Director	MGIRED, Bangalore	Member
19.	S. R. C. Sathyanarayan, CEO	Sri Ranga Consultants	Member
20.	N. Sridhar	KASSIA	Member
DGT & Training Institute			
21.	Satya Shankar BP, Director (AT)	DGT HQ, New Delhi	Member
22.	B Ashfaq Ahmed, Director	Apex Hi-Tech Institute, Bangalore	Member
23.	Sanjay Kumar, Director (C&P)	DGT HQ, New Delhi	Coordinator/ Member
24.	B.V.S. Sesha Chari, Director	CSTARI, Kolkata	Member
25.	B. N. Sridhar, DDT	FTI, Bangalore	Member
26.	C. Ramasubramanian, DDT	Apex Hi-Tech Institute, Bangalore	Member
27.	L.K. Mukherjee, DDT	CSTARI, Kolkata	Member
28.	N. Nath, ADT	CSTARI, Kolkata	Member
29.	B. K. Nigam, Training Officer	CSTARI, Kolkata	Coordinator
30.	Anurag Vats, Training Officer	CSTARI, Kolkata	Coordinator
31.	Malathi R., Training Officer	RVTI, Bangalore	Member
32.	Palani, Training Officer	ATI, Hyderabad	Member
33.	M.P. Rajan, VI	ATI, Calicut	Member
34.	Anupama, JTO	ITI, Peenya	Member
35.	Uma Shankar Bhargava, JTO	ITI, Hosur Road	Member
36.	LingarajGowda, JTO	ITI, Hosur Road	Member
37.	Venkatesh Reddy, JTO	BTC, Bangalore	Member

ABBREVIATIONS

CTS	Craftsmen Training Scheme
ATS	Apprenticeship Training Scheme
CITS	Craft Instructor Training Scheme
DGT	Directorate General of Training
MSDE	Ministry of Skill Development and Entrepreneurship
NTC	National Trade Certificate
NAC	National Apprenticeship Certificate
NCIC	National Craft Instructor Certificate
LD	Locomotor Disability
CP	Cerebral Palsy
MD	Multiple Disabilities
LV	Low Vision
HH	Hard of Hearing
ID	Intellectual Disabilities
LC	Leprosy Cured
SLD	Specific Learning Disabilities
DW	Dwarfism
MI	Mental Illness
AA	Acid Attack
PwD	Person with disabilities


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