



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 – 4



SECTOR – RENEWABLE ENERGY

SOLAR TECHNICIAN (ELECTRICAL)

(Engineering Trade)

(Designed in 2018)

Version: 1.0

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL – 4

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

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Solar Technician (Electrical)

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1. COURSE INFORMATION

During the two-year duration of Solar Technician (Electrical) trade a candidate is trained on professional Skill, professional Knowledge and Employability Skill. In addition to this a candidate is entrusted to undertake project work and extracurricular activities to build up confidence. The broad components covered related to the trade are categorized in four semesters each of six months duration. The semester wise course coverage is categorized as below:-

1st Semester – In this semester the 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.

2nd Semester – In this semester 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. Prepares bill 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 products viz., solar water pump, solar street light, solar fertilizer sprayer etc. The Trainee learns about electrical maintenance of Inverters/Cables/Junction boxes, inspection of mounting structure of solar modules and replacement of defective fixtures.

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 the economy / labor market. The vocational training Programmes are delivered under the aegis of the National Council of Vocational Training (NCVT). Craftsman Training Scheme (CTS) and Apprenticeship Training Scheme (ATS) are two pioneer Programmes of NCVT for propagating vocational training.

CTS courses are delivered nationwide through network of ITIs. The course '**Solar Technician (Electrical)**' is of one-year (02 semester) 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 (Workshop calculation & science, Engineering Drawing and 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 NCVT 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 CAREER PROGRESSION PATHWAYS

- 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.

2.3 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements during a period of one-year (02 semesters):

S No.	Course Element	Notional Training Hours
1.	Professional Skill (Trade Practical)	1050
2.	Professional Knowledge (Trade Theory)	252
3.	Employability Skills	110
4.	Engg Drawing & Workshop Calculation science	210
5.	Library & Extracurricular Activities	58
6.	Project Work	160
7.	Revision & Examination	240
	Total	2080

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of the course and at the end of the training program as notified by the Government of India (GoI) from time to time. The employability skills will be tested in the first two semesters itself.

a) The **Internal Assessment** 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 template (Annexure – II).

b) The final assessment will be in the form of summative assessment method. The All India Trade Test for awarding NTC will be conducted by NCVT at the end of each semester as per the guideline of Government of India. The pattern and marking structure is being notified by Govt. of India from 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

The minimum pass percentage for practical is 60% & minimum pass percentage of theory subjects is 40%. For the purposes of determining the overall result, 50% weightage is applied to the result of each semester examination.

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/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 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

Evidences of internal assessments are to be preserved until forthcoming semester 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 produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices	<ul style="list-style-type: none"> • Demonstration of good skill in the use of hand tools, machine tools and workshop equipment. • Below 70% tolerance dimension 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) Weightage 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	<ul style="list-style-type: none"> • Good skill levels in the use of hand tools, machine tools and workshop equipment. • 70-80% tolerance dimension achieved while undertaking different work with those demanded by the component/job.

practices	<ul style="list-style-type: none"> • A good level of neatness and consistency in the finish. • Little support in completing the project/job.
(c) Weightage in the range of more than 90% to be allotted during assessment	
<p>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.</p>	<ul style="list-style-type: none"> • High skill levels in the use of hand tools, machine tools and workshop equipment. • Above 80% tolerance dimension 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 box and 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

4. GENERAL INFORMATION

Name of the Trade	Solar Technician (Electrical)
NCO - 2015	7421.1401, 7421.1402, 7421.1403, 8212.2301
NSQF Level	Level 4
Duration of Craftsmen Training	1 Year (2 Semesters each of six month duration)
Entry Qualification	Passed 10 th class examination under 10+2 System of education with Science and Mathematics or its equivalent.
Unit Strength (No. Of Student)	16 (Max. Supernumeraries seats: 5)
Space Norms	50 Sq. m
Power Norms	3 KW
Instructors Qualification for	
(i) Solar Technician (Electrical) Trade	<p>Degree in Electrical/ Electrical and Electronics Engineering from recognized Engineering College/ university with one year experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>Diploma in Electrical / Electrical and Electronics Engineering from recognized board of technical education with two years experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>NTC/NAC passed in the Trade of "Solar Technician (Electrical)" With 3 years post qualification experience in the relevant field.</p> <p><i>Desirable:</i> Preference will be given to a candidate with CITS (Craft Instructor Training Scheme) in relevant Trade.</p> <p><i>Out of two Instructors required for the unit of 2 (1+1), one must have Degree/Diploma and other must have NTC/NAC qualifications.</i></p>
(ii) Workshop Calculation & Science	<p>Degree in Engineering with one year experience.</p> <p style="text-align: center;">OR</p> <p>Diploma in Engineering with two years experience.</p> <p>Desirable: Craft Instructor Certificate in RoD & A course under NCVT.</p>
(iii) Engineering Drawing	Degree in Engineering with one year experience.

	<p style="text-align: center;">OR</p> <p>Diploma in Engineering with two years experience.</p> <p style="text-align: center;">OR</p> <p>NTC / NAC in the Draughtsman (Mechanical / Civil) with three years experience.</p> <p>Desirable:</p> <p>Craft Instructor Certificate in RoD & A course under NCVT.</p>					
(iv) Employability Skill	<p>MBA OR BBA with two years experience OR Graduate in Sociology/ Social Welfare/ Economics with Two years experience OR Graduate/ Diploma with Two years experience and trained in Employability Skills from DGET institutes.</p> <p style="text-align: center;">AND</p> <p>Must have studied English/ Communication Skills and Basic Computer at 12th/ Diploma level and above.</p> <p style="text-align: center;">OR</p> <p>Existing Social Studies Instructors duly trained in Employability Skills from DGT institutes</p>					
List of Tools and Equipment	As per Annexure – I					
Distribution of training on Hourly basis: (Indicative only)						
Total Hrs /week	Trade Practical	Trade Theory	Engg. Drawing	Workshop Calc. & Science	Employability Skills	Extra-Curricular Activity
40 Hours	25 Hours	6 Hours	3 Hours	2 Hours	2 Hours	2 Hours

5. NSQF LEVEL COMPLIANCE

NSQF level for Solar Technician (Electrical) Trade under CTS: **Level 4**

As per notification issued by Govt. of India dated- 27.12.2013 on National Skill Qualification Framework total 10 (Ten) Levels are defined.

Each level of the NSQF is associated with a set of descriptors made up of five outcome statements, which describe in general terms, the minimum knowledge, skills and attributes that a learner needs to acquire in order to be certified for that level.

Each level of the NSQF is described by a statement of learning outcomes in five domains, known as level descriptors. These five domains are:

- a. Process
- b. Professional Knowledge
- c. Professional Skill
- d. Core Skill
- e. Responsibility

The broad learning outcome of **Solar Technician (Electrical)** trade under CTS mostly matches with the Level descriptor at Level - 4.

The NSQF level – 4 descriptor is given below:

Level	Process Required	Professional Knowledge	Professional Skill	Core Skill	Responsibility
Level 4	Work in familiar, predictable, routine, situation of clear choice	Factual knowledge of field of knowledge or study	Recall and demonstrate practical skill, routine and repetitive in narrow range of application, using appropriate rule and tool, using quality concepts	Language to communicate written or oral, with required clarity, skill to basic Arithmetic and algebraic principles, basic understanding of social political and natural environment	Responsibility for own work and learning.

6. LEARNING/ ASSESSABLE OUTCOME

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

6.1 GENERIC LEARNING OUTCOME

1. Apply safe working practices
2. Comply with environment regulation and housekeeping.
3. Interpret & use company and technical communication.
4. Demonstrate basic mathematical concept and principles to perform practical operations.
5. Understand and explain basic science in the field of study including simple machine.
6. Read and apply engineering drawing for different application in the field of work.
7. Understand and apply the concept in productivity, quality tools, and labour welfare legislation in day to day work to improve productivity & quality.
8. Explain energy conservation, global warming and pollution and contribute in day to day work by optimally using available resources.
9. Explain personal finance, entrepreneurship and manage/organize related task in day to day work for personal & societal growth.
10. Utilize basic computer applications and internet to take benefit of IT developments in the industry.

6.2 SPECIFIC LEARNING OUTCOME

Semester-I

11. Prepare profile with an appropriate accuracy as per drawing.
12. Prepare electrical wire joints, carry out soldering and crimping.
13. Understand characteristics of electrical and magnetic circuits.
14. Assemble, install and test wiring system.
15. Use instruments for measurement of various electrical parameters.
16. Perform basic Electric energy calculations and understand transmission and distribution of electrical power.

17. Understand and verify natural planetary movements and sunlight's path.
18. Demonstrate characteristics of Photovoltaic cells, Modules, Batteries and Charge controllers.
19. Construct and demonstrate Solar DC appliances.

Semester-II

20. Connect, test, undertake maintenance and disposal of solar batteries.
21. Connect and test solar panel, Charge controller, Battery bank and Inverter.
22. Prepare bill of materials for small, medium and mega solar PV projects.
23. Perform various tests and measurement pertaining to PV Modules and their installation as per IEC standards.
24. Assist in Installation and commissioning of Solar PV plant and Hybrid plant.
25. Perform Operation & Maintenance of PV system with best practices.
26. Understand manufacturing of solar panel, prepare and commission marketable solar products.

7. LEARNING OUTCOME WITH ASSESSMENT CRITERIA

GENERIC LEARNING/ ASSESSABLE OUTCOME	
LEARNING / ASSESSABLE OUTCOME	ASSESSMENT CRITERIA
1. Apply safe working practices	1.1 Follow and maintain procedures to achieve a safe working environment in line with occupational health and safety regulations and requirements and according to site policy.
	1.2 Recognize and report all unsafe situations according to site policy.
	1.3 Identify and take necessary precautions on fire and safety hazards and report according to site policy and procedures.
	1.4 Identify, handle and store / dispose off dangerous goods and substances according to site policy and procedures following safety regulations and requirements.
	1.5 Identify and observe site policies and procedures in regard to illness or accident.
	1.6 Identify safety alarms accurately.
	1.7 Report supervisor/ Competent of authority in the event of accident or sickness of any staff and record accident details correctly according to site accident/injury procedures.
	1.8 Identify and observe site evacuation procedures according to site policy.
	1.9 Identify Personal Protective Equipment (PPE) and use the same as per related working environment.
	1.10 Identify basic first aid and use them under different circumstances.
	1.11 Identify different fire extinguisher and use the same as per requirement.
2. Comply environment regulation and housekeeping	2.1 Identify environmental pollution & contribute to the avoidance of instances of environmental pollution.
	2.2 Deploy environmental protection legislation & regulations
	2.3 Take opportunities to use energy and materials in an environmentally friendly manner
	2.4 Avoid waste and dispose waste as per procedure
	2.5 Recognize different components of 5S and apply the same in the working environment.
3. Interpret & use company and technical communication	3.1 Obtain sources of information and recognize information.
	3.2 Use and draw up technical drawings and documents.
	3.3 Use documents and technical regulations and occupationally related provisions.

	3.4 Conduct appropriate and target oriented discussions with higher authority and within the team.
	3.5 Present facts and circumstances, possible solutions & use English special terminology.
	3.6 Resolve disputes within the team
	3.7 Conduct written communication.
4. Demonstrate basic mathematical concept and principles to perform practical operations.	4.1 Semester examination to test basic skills on arithmetic, algebra, trigonometry and statistics.
	4.2 Applications will be assessed during execution of assessable outcome and will also be tested during theory and practical examination.
5. Understand and explain basic science in the field of study including simple machine.	5.1 Semester examination to test basic skills on science in the field of study including friction, heat, temperature and simple machine.
	5.2 Applications will be assessed during execution of assessable outcome and will also be tested during theory and practical examination.
6. Read and apply engineering drawing for different application in the field of work.	6.1 Semester examination to test basic skills on engineering drawing.
	6.2 Applications will be assessed during execution of assessable outcome and will also be tested during theory and practical examination.
7. Understand and apply the concept in productivity, quality tools, and labour welfare legislation in day to day work to improve productivity & quality.	7.1 Semester examination to test the concept in productivity, quality tools and labour welfare legislation.
	7.2 Applications will be assessed during execution of assessable outcome.
8. Explain energy conservation, global warming and pollution and contribute in day to day work by optimally using	8.1 Semester examination to test knowledge on energy conservation, global warming and pollution.
	8.2 Their applications will be assessed during execution of assessable outcome.

available resources.	
9. Explain personnel finance, entrepreneurship and manage/organize related task in day to day work for personal & societal growth.	9.1 Semester examination to test knowledge on personnel finance, entrepreneurship.
	9.2 Their applications will be assessed during execution of assessable outcome.
10. Utilize basic computer applications and internet to take benefit of IT developments in the industry.	10.1 Semester examination to test knowledge on basic computer working, basic operating system and uses internet services.
	10.2 Their applications will be assessed during execution of assessable outcome.

SPECIFIC LEARNING/ ASSESSABLE OUTCOME	
LEARNING / ASSESSABLE OUTCOME	ASSESSMENT CRITERIA
SEMESTER-I	
11. Prepare profile with an appropriate accuracy as per drawing.	11.1 Identify the trade tools; practice their uses with safety, care & maintenance.
	11.2 Identification of danger, warning, caution & safety signs.
	11.3 Preventive measures for electrical accidents and use of fire extinguishers.
	11.4 Practice on connecting of electrical accessories.
12. Prepare electrical wire joints, carry out soldering and crimping.	12.1 Practice on skinning, twisting and crimping.
	12.2 Identify various types of cables and measure conductor size using SWG and micrometer.
	12.3 Make joints on single strand conductors
	12.4 Practice in crimping and soldering of joints / lugs.
13. Understand characteristics of electrical and magnetic circuits.	13.1 Measure parameters in combinational DC circuits by applying Ohm's Law for different resistor values and voltage sources.
	13.2 Measure current and voltage in DC circuits to verify Kirchhoff's Law.
	13.3 Verify laws of series and parallel circuits with voltage source in different combinations
	13.4 Measure current and voltage and analyse the effects of shorts and opens in series and parallel circuits
	13.5 Measure power, energy for lagging and leading power factors in single phase circuits.
	13.6 Determine the relationship between Line and Phase values for star and delta connections
	13.7 Measure the Power of three phase circuit for balanced and unbalanced loads
14. Assemble, install and test wiring system.	14.1 Identification various conduits and different electrical accessories
	14.2 Practice cutting, threading of different sizes & laying Installations.
	14.3 Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, ELCB.
	14.4 Wire up PVC conduit wiring to control one lamp from two different places using two way switches
	14.5 Practice control panel wiring using wiring accessories and mounting of control elements, e.g. meters, fuses, relays,

	switches, push buttons, MCB, ELCB etc.
	14.6 Prepare different types of earthing and measure earth resistance by earth tester / Megger.
15. Use instruments for measurement of various electrical parameters.	15.1 Use of various analog and digital measuring Instruments.
	15.2 Practice on measuring instruments in single and three phase circuits e.g. multi-meter, Wattmeter, Energy meter, Phase sequence meter and Frequency meter etc.
	15.3 Test single phase energy meter for its errors
16. Perform basic Electric energy calculations and understand transmission and distribution of electrical power.	16.1 Measure power consumption for different loads with various times of use and calculate watt-hour
	16.2 Find out power ratings from product label and prepare a load calculation chart.
	16.3 Perform OC and SC test to determine and efficiency of single phase transformer.
	16.4 Draw circuit diagram of substation and indicate various components
17. Understand and verify natural planetary movements and sunlight's path.	17.1 Plot sun chart and locate the sun at your location for a given time of the day
	17.2 Measure intensity of solar radiation using Pyranometer and radiometers
	17.3 Analyse shadow effect on incident solar radiation and find out contributors.
	17.4 Plot curve of radiation measured with respect to time for a location
18. Demonstrate characteristics of Photovoltaic cells, Modules, Batteries and Charge controllers.	18.1 Connect solar panels in series & parallel and measure voltage and current.
	18.2 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
	18.3 Connect the charge controller (12V, 10A) with Solar battery (12V, 100Ah), Solar panel (75W) and DC load
	18.4 Test the charge controller working with the above circuit.
19. Construct and demonstrate Solar DC appliances.	19.1 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).
	19.2 Construct a Solar water pump using a DC pump (24 V), Solar Panel (250 W), Charge controller (24 V, 10 A).
SEMESTER-II	
20. Connect, test, undertake maintenance and disposal of solar	20.1 Prepare connecting wires for grouping of solar batteries
	20.2 Check the condition of electrolyte in a solar battery using hydrometer and add distilled water to the required level in the solar battery

batteries.	20.3	Connect two solar batteries (12V, 100Ah each) in series to a 24 Volt DC pump and Test the Voltage and current in the circuit.
	20.4	Connect two solar batteries (12V, 100Ah each) in series to a 24 DC pump and Test the Voltage and current in the circuit.
21. Connect and test solar panel, Charge controller, Battery bank and Inverter.	21.1	Connect MC 4 connectors to a solar panel using crimping tool.
	21.2	Connect the PWM controller with solar panel & solar battery and note input /output current and battery voltage at different time intervals
	21.3	Connect the MPPT controller with solar panel & solar battery and note input and output current and battery voltage, at different time intervals.
	21.4	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.
	21.5	Connect a 1 KW Solar PCU to 1 KW Solar panel installation using a suitable battery bank and test the performance
22. Prepare Bill of materials for small, medium and mega solar PV projects.	22.1	Prepare bill of material for a 1/5/10/20/100 KW solar PV installation
	22.2	Estimate cost of a 1 KW solar PV installation and prepare a quotation.
23. Perform various tests and measurement pertaining to PV Modules and their installation as per IEC standards.	23.1	Measure Insulation resistance and Wet Leakage Current of PV Modules
	23.2	Perform Bypass Diode test - Pmax at STC and Pmax at low irradiance.
	23.3	Measure Ground Continuity, Impulse Voltage, Reverse current and Partial Discharge
24. Assist in Installation and commissioning of Solar PV plant and Hybrid plant.	24.1	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.
	24.2	Connect the array junction box to the above installation and draw wires up to PCU.
	24.3	Wire the above installation panels, battery etc. to a 1 KW Solar PCU
	24.4	Prepare a First inspection report on the solar plant installation
	24.5	Prepare a list of Do's and Don'ts in the installation
	24.6	Evaluate windiness of a place using an anemometer
	24.7	Test with a blower and model windmill & record the observations
25. Perform Operation & Maintenance of PV	25.1	Demonstrate Standard Operating Procedures of PV system
	25.2	Demonstration of Solar Panel Maintenance:- Cleaning, DC

<p>system with best practices.</p>	<p>Array Inspection, Precautions While Cleaning</p> <p>25.3 Demonstration of Battery Maintenance - Checking of Electrolyte Level, Specific Gravity Using Hydrometer, Physical Damage, Terminal Voltage, Cleaning of Battery Terminals</p>
<p>26. Understand manufacturing of solar panel, prepare and commission marketable solar products.</p>	<p>26.1 Assemble a solar panel using the cell string</p> <p>26.2 Determine the I-V curve of finished solar PV panel and prepare a model certificate</p> <p>26.3 Assemble, install and commission a Solar water pump/street light/solar fertilizer spray.</p>

SYLLABUS - SOLAR TECHNICIAN (ELECTRICAL)			
FIRST SEMESTER – 06 Months			
Week No.	Reference Learning outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
1	<ul style="list-style-type: none"> Apply safe working practices Comply with environment regulation 	<ol style="list-style-type: none"> Visit of various sections of the institutes and identification of danger, warning, caution & safety signs. (05 hrs) Preventive measures for electrical accidents and use of fire extinguishers. (04 hrs) Practice elementary first aid and artificial respiration. (04 hrs) Disposal procedure of waste materials. (04 hrs) Use of personal protective equipments. (04 hrs) Familiarization with signs and symbols of electrical Accessories. (04 hrs) 	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.
2	<ul style="list-style-type: none"> Prepare profile with an appropriate accuracy as per drawing. 	<ol style="list-style-type: none"> Workshop practice on filing and hacksawing. (05 hrs) Practice sawing, planing, drilling and assembling for making a wooden switchboard. (05 hrs) Workshop practice on drilling, chipping, internal and external threading of different sizes. (10 hrs) Prepare an open box from metal sheet. (05 hrs) 	Concept of Standards and advantages of BIS/ISI. Trade tools specifications. Electrical symbols. Introduction to National Electrical Code-2011.
3	<ul style="list-style-type: none"> Prepare electrical wire joints, carry out soldering and crimping. 	<ol style="list-style-type: none"> Practice on skinning, twisting and crimping. (06 hrs) Identify various types of cables and measure conductor size using SWG and micrometer. (06 hrs) Make joints on single strand 	Fundamentals of electricity. Concept of current, voltage, power, resistors and capacitors Generation of DC electricity. Electrical conductors and insulators.

		<p>conductors. (06 hrs)</p> <p>14. Practice in crimping and soldering of joints / lugs. (07 hrs)</p>	<p>Differentiate between AC and DC current</p> <p>Types of joints and techniques of soldering.</p>
<p>4 - 6</p>	<ul style="list-style-type: none"> Understand characteristics of electrical and magnetic circuits. 	<p>15. Measure parameters in combinational DC circuits by applying Ohm's Law for different resistor values and voltage sources. (06 hrs)</p> <p>16. Measure current and voltage in DC circuits to verify Kirchhoff's Law. (06 hrs)</p> <p>17. Verify laws of series and parallel circuits with voltage source in different combinations. (06 hrs)</p> <p>18. Measure current and voltage and analyse the effects of shorts and opens in series and parallel circuits. (05 hrs)</p> <p>19. Verify the characteristics of series parallel combination of resistors. (05 hrs)</p> <p>20. Determine the poles and plot the field of a magnet bar. (05 hrs)</p> <p>21. Identify various types of capacitors, charging / discharging and testing. (05 hrs)</p> <p>22. Test AC circuit with resistive load like lamp, heater, etc. (05 hrs)</p> <p>23. Test AC circuit with inductive load like fan, pump, etc. (06 hrs)</p> <p>24. Measure power, energy for lagging and leading power factors in single phase circuits. (05 hrs)</p> <p>25. Measure Current, voltage,</p>	<p>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.</p> <p>Magnetic terms, magnetic materials and properties of magnet.</p> <p>Electrostatics: Capacitor- Different types, functions, grouping and uses. Inductive and capacitive reactance and their effect on AC circuit.</p> <p>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.</p> <p>Active and Reactive power. Single Phase and three-phase system. Advantages of AC poly-phase system. Concept of three-phase Star and Delta connection. Line and phase voltage,</p>

		<p>power, energy and power factor in three phase circuits. (06 hrs)</p> <p>26. Ascertain use of neutral by identifying wires of a 3-phase 4 wire system and find the phase sequence. (05 hrs)</p> <p>27. Determine the relationship between Line and Phase values for star and delta connections. (05 hrs)</p> <p>28. Measure the Power of three phase circuit for balanced and unbalanced loads. (05 hrs)</p>	<p>current and power in a 3 phase circuits with balanced and unbalanced load.</p>
<p>7 - 8</p>	<ul style="list-style-type: none"> Assemble, install and test wiring system. 	<p>29. Identify various conduits and different electrical accessories. (05 hrs)</p> <p>30. Practice cutting, threading of different sizes & laying Installations. (05 hrs)</p> <p>31. Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, ELCB, MCCB etc. (05 hrs)</p> <p>32. Drawing layouts and practice in PVC Casing-capping, Conduit wiring with minimum to number of points as per IE rules. (08 hrs)</p> <p>33. Wire up PVC conduit wiring to control one lamp from two different places using two way switch. (07 hrs)</p> <p>34. Practice testing / fault detection of domestic and industrial wiring installation and repair. (05 hrs)</p> <p>35. Practice control panel wiring using wiring accessories and mounting of control elements, e.g. meters, fuses, relays, switches, push buttons, MCB, ELCB etc. (05 Hrs)</p>	<p>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, 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. Lightning arrestor.</p>

		<p>36. Prepare different types of earthing and measure earth resistance by earth tester / megger. (05 hrs)</p> <p>37. Practice Installation of lightning arrestor. (05 hrs)</p>	
9	<ul style="list-style-type: none"> Use instruments for measurement of various electrical parameters. 	<p>38. Identify and practice of various analog and digital measuring Instruments. (05 hrs)</p> <p>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. (15 hrs)</p> <p>40. Test single phase energy meter for its errors. (05 hrs)</p>	<p>Classification of electrical instruments and essential forces required in indicating instruments.</p> <p>PMMC and Moving iron instruments.</p> <p>Range extension.</p> <p>Wattmeter, PF meter, Energy meter, Megger, Earth tester, Frequency meter, Phase sequence meter, Multimeter, Tong tester etc.</p> <p>Instrument transformers – CT and PT.</p>
10 - 11	<ul style="list-style-type: none"> Perform basic electric energy calculations and understand transmission and distribution of electrical power. 	<p>41. Measure power consumption for different loads with various times of use and calculate watt-hour. (8 Hrs)</p> <p>42. Find out power ratings from product label and prepare a load calculation chart. (08 hrs)</p> <p>43. Verify terminals, identify components and calculate the transformation ratio of single phase transformers. (04 hrs)</p> <p>44. Perform OC and SC test to determine and efficiency of single phase transformer. (05 hrs)</p> <p>45. Visit to transmission / distribution substation. (16 hrs)</p> <p>46. Draw actual circuit diagram of substation visited and indicate various components. (09 hrs)</p>	<p>Calculation of total watt hour of all loads per day and daily average watt hour from twelve months electricity bill.</p> <p>Working principle of transformer. Electric power demand, supply and gap in city, state and national level.</p> <p>Conventional energy Generation by thermal (coal, gas diesel) and hydel power plant. (small and large)</p> <p>Advantages of high voltage transmission.</p> <p>Transmission network of India</p> <p>Study of distribution of power and substation.</p> <p>Overhead v/s underground distribution system.</p>

<p>12 - 14</p>	<ul style="list-style-type: none"> Understand and verify natural planetary movements and sunlight's path. 	<p>47. Plot sun chart and locate the sun at your location for a given time of the day. (06 hrs)</p> <p>48. Find out relations between sunlight and earth motion by globe model. (05 hrs)</p> <p>49. Observe and compare sunlight and angle of inclination during 12 hours of a day on different days. (16 hrs)</p> <p>50. Locate magnetic poles (North and South) with the help of magnetic compass. (06 hrs)</p> <p>51. Observe on Globe, which countries are in the Northern hemisphere and which on the Southern hemisphere. (06 hrs)</p> <p>52. Prepare a list of places around India, their latitude and longitude. (06 hrs)</p> <p>53. Measure intensity of solar radiation using Pyranometer and radiometers. (06 hrs)</p> <p>54. Analyse shadow effect on incident solar radiation and find out contributors. (05 hrs)</p> <p>55. Plot curve of radiation measured with respect to time for a location. (06 hrs)</p> <p>56. Draw a solar map by collecting data of solar radiation in a location for one year. (06 hrs)</p> <p>57. Compare the effects of direct radiation, diffused radiation and reflected radiation and prepare reports. (07 hrs)</p>	<p>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.</p> <p>Solar energy fundamentals. Study of Sun path (east to west, North to south and south to north movement). Study of daily and seasonal changes of sunlight. Angle of inclination of 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 sun chart on shadow identification. Sunlight spectrum.</p>
<p>15 - 16</p>	<ul style="list-style-type: none"> Demonstrate characteristics of Photovoltaic cells, Modules, Batteries and Charge controllers. 	<p>58. Test an LED and a Photodiode to verify the photo emitting effect and light sensitivity. (05 hrs)</p> <p>59. Test a Photo voltaic cell for different illumination levels and verify photovoltaic property. (05 hrs)</p> <p>60. Plot I-V curve for photovoltaic</p>	<p>Semiconductor properties and types. P-type and N-type semiconductors, PN junction, etc.</p> <p>Conversion of solar radiation to electricity. Main materials used to develop solar cells (Silicon, Cadmium tellurides, etc.)</p>

		<p>cell based on the illumination at constant temperature. (05 hrs)</p> <p>61. Plot I-V curve for photovoltaic cell based on temperature at constant illumination. (05 hrs)</p> <p>62. Test photovoltaic cell in sunlight at various angles of inclination and direction. (05 hrs)</p> <p>63. Test different rated Photovoltaic modules (Panels) and plot I-V curve. (05 hrs)</p> <p>64. Record specification of different solar panels and compare specifications to select a panel. (05 hrs)</p> <p>65. Test different types of PV panels such as, mono crystalline, poly crystalline, amorphous silicon and thin film modules. Prepare a report on panels. (05 hrs)</p> <p>66. Determine the relation between number of cells and maximum voltage per module. (05 hrs)</p> <p>67. Connect suitably rated wires in the terminal box of a solar panel and connect end terminals using MC 4 connectors. (05 hrs)</p>	<p>Light sensitive properties of PN junction.</p> <p>Difference of photo electric and photo voltaic effects of a PN junction.</p> <p>PV cell characteristics, I – V curve, effects of temperature. Photovoltaic effect.</p> <p>Photo voltaic module: minimal functional specification, cells per module, max watts per module, maximum voltage at max power, maximum current at max power.</p> <p>Standard test conditions (STC) of a PV module.</p> <p>Terminal box and connectors of a Solar PV module.</p> <p>Identification of various test standards of PV module.</p> <p>Measurement of area of the cells and compare with the module area in data sheet.</p> <p>Identification of faulty PV module.</p>
<p>17 - 19</p>	<ul style="list-style-type: none"> • Demonstrate characteristics of Photovoltaic cells, Modules, Batteries and Charge controllers. 	<p>68. Connect solar panels in series and measure voltage and current. Repeat with different rated panels. (05 hrs)</p> <p>69. Connect solar panels in parallel and measure voltage and current. Repeat with different rated panels. (05 hrs)</p> <p>70. Shift the panels to rooftop or the place of installation using safe handling practices. (3Hrs)</p> <p>71. Check the structural and area requirement for installation of</p>	<p>Solar PV array; series and parallel calculation.</p> <p>Handling of PV modules.</p> <p>Module mounting; structures requirement.</p> <p>Photovoltaic cell and PV modules: types - mono crystalline, poly crystalline, amorphous silicon and thin film PV cells and their comparison.</p> <p>Recent thin film technologies (CdTe, GIGS, CIS etc.)</p>

		<p>1 KW solar panel. (05 hrs)</p> <p>72. Identify different solar panels as per specification. (04 hrs)</p> <p>73. Compare different types of solar panels and prepare a report. (05 hrs)</p> <p>74. Charge a solar battery rated 12V, 100 Ah using Battery charger by CV and CC method and Tabulate the observations during charging cycle. (05 hrs)</p> <p>75. Discharge a solar battery rated 12V, 100 Ah using DC load under Constant Current and tabulate the observations during discharging cycle. (05 hrs)</p> <p>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. (05 hrs)</p> <p>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). (05 hrs)</p> <p>78. Test the charge controller working with the above circuit and study the performance. (05 hrs)</p> <p>79. Construct home lighting system using solar panel. (05 hrs)</p> <p>80. Construct and test a solar powered mobile handset charger. (06 hrs)</p> <p>81. Construct a dusk to dawn charge controller (12V, 10A) with Solar battery (12V, 100Ah), Solar panel (75W) and</p>	<p>Safe handling of panels.</p> <p>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.</p>
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		<p>LED light (12V DC, 5W). (06 hrs)</p> <p>82. Construct a home lighting system with manual control. (06 hrs)</p>	
20 - 21	<ul style="list-style-type: none"> Construct and demonstrate Solar DC appliances. 	<p>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). (08 hrs)</p> <p>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). (08 hrs)</p> <p>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). (9 Hrs)</p> <p>86. Construct a Solar Street 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). (8 Hrs)</p> <p>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). (09 hrs)</p> <p>88. Construct a Solar water pump using a DC pump (24 V), Solar Panel (250 W), Charge controller (24 V, 10 A). (08 hrs)</p>	<p>Solar DC domestic application: Making of solar lantern Solar Day lighting Solar Garden Lights</p> <p>Safety in DC system. Quality standards List out the inventory list of equipments and tools for construction of a DC system.</p> <p>Solar DC industrial application: Solar street light Solar home lighting system Solar Security system Solar DC water pump</p> <p>Differentiate AC and DC solar pumps and their PV requirements for various HP capacity.</p>
22 - 23	<p>Project work / Industrial visit: -</p> <p>a) Appliances using solar power</p> <p>b) Prepare report on non renewable energy sources such as DG set and Thermal</p>		

	<p>power plant and determine pollution level.</p> <p>c) Prepare report on growth of Solar energy generation in India and future target by referring to websites, newspaper and magazines.</p> <p>d) Prepare report on various Solar energy systems - Thermal (heat energy based) and Electrical (light energy based) and their utilization.</p> <p>e) Prepare reports on electric power demand, supply and gap in city, state and national level.</p>
24 - 25	Revision
26	Examination

Note: -

1. *Some of the sample project works (indicative only) are given against each semester.*
2. *The Instructor may design their own project and also inputs from local industry may be taken in designing such new project.*
3. *The project should broadly cover maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, work to be assigned to a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and Application of Learning. They need to submit Project report.*
4. *If the instructor feels that for the execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*

SYLLABUS - SOLAR TECHNICIAN (ELECTRICAL)			
SECOND SEMESTER – 06 Months			
Week No.	Reference Learning outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
27 - 28	<ul style="list-style-type: none"> Connect, test, undertake maintenance and disposal of solar batteries. 	89. Prepare connecting wires for grouping of solar batteries. (06 hrs) 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. (07 hrs) 91. Connect two solar batteries (12V, 100 Ah each) in parallel to a parallel group of 12 Volts DC LED lights and Test the Voltage and current in the circuit. (06 hrs) 92. Check the condition of electrolyte in a solar battery using hydrometer and add distilled water to the required level in the solar battery. (06 hrs) 93. Remove complete electrolyte from a lead acid battery and refill. (07 hrs) 94. Shift 12V 100Ah battery on a trolley to different location following safe handling practices. (06 hrs) 95. Plan for rack system of battery bank storage. (06 hrs) 96. Prepare a report on maintenance and disposal of solar batteries (06 hrs)	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.

<p>29 - 31</p>	<ul style="list-style-type: none"> • Connect and test solar panel, Charge controller, Battery bank and Inverter. 	<p>97. Connect MC 4 connectors to a solar panel using crimping tool. (05 hrs)</p> <p>98. Connect the PWM controller with solar panel & solar battery and note input /output current and battery voltage at different time intervals. (05 hrs)</p> <p>99. Connect the MPPT controller with solar panel & solar battery and note input and output current and battery voltage, at different time intervals. (05 hrs)</p> <p>100. Compare the results of the above. (03 hrs)</p> <p>101. Open PWM and MPPT Charge controllers and identify components wired to understand mechanism. (05 hrs)</p> <p>102. Connect solar panels to an Array Junction box. (05 hrs)</p> <p>103. Connect and test a 12V DC/230V AC normal inverter. (06 hrs)</p> <p>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. (06 hrs)</p> <p>105. Prepare a comparative chart by collecting data sheets of different solar PCU and normal inverters. (06 hrs)</p> <p>106. Practice procedural switching 'ON' and Shutdown of solar PCU.</p>	<p>Solar panel terminal wires and MC-4 connectors.</p> <p>Choice of wires (DC cables) used in the solar PV Electrical system.</p> <p>Array junction box (AJB) or combiner box.</p> <p>Protection devices in AJB.</p> <p>PWM charge controller.</p> <p>MPPT charge controller.</p> <p>Block diagram of charge controller.</p> <p>Overview of Sequence of connection (step wise) in an off grid system.</p> <p>Inverter: working, front panel controls and back panel controls.</p> <p>Normal and solar inverter.</p> <p>Solar charge controller for a normal inverter.</p> <p>Selection of solar inverter or Power Conditioning Unit (PCU).</p> <p>Switching ON and shut down procedure of a solar inverter</p> <p>Types of Inverter:- Stand alone, Grid Tied (MPPT/Central/String), Micro inverter.</p> <p>IEC Std followed for Inverter in solar projects.</p> <p>Block diagram of Solar Photo voltaic electrical system.</p> <p>Classification of inverters - Stand alone or off-grid inverter, Hybrid inverter, Grid-tie inverter.</p> <p>Wall mount or array mount inverter.</p> <p>Inverter room planning for mega projects.</p> <p>Integration of inverters in large PV projects.</p> <p>Overview of PV System Software.</p>
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		<p>(06 hrs)</p> <p>107. Connect a 1 KW Solar PCU to 1 KW Solar panel installation using a suitable battery bank and test the performance. (06 hrs)</p> <p>108. Check of front panel features of a Solar PCU. (06 hrs)</p> <p>109. Check of back panel features of a Solar PCU. (06 hrs)</p> <p>110. Demonstrate Solar PV e-learning software. (05 hrs)</p>	
32 - 33	<ul style="list-style-type: none"> Prepare Bill of materials for small, medium and mega solar PV projects. 	<p>111. Prepare bill of material for a 1 KW solar PV installation. (08 hrs)</p> <p>112. Prepare bill of material for a 5 KW solar PV installation. (08 hrs)</p> <p>113. Prepare a Bill of materials for a 10 KW solar PV installation. (08 hrs)</p> <p>114. Prepare a Bill of materials for a 20 KW solar PV installation. (08 Hrs)</p> <p>115. Prepare a Bill of materials for a 100 KW solar PV installation. (09 hrs)</p> <p>116. Estimate cost of a 1 KW solar PV installation and prepare a quotation. (09 hrs)</p>	<p>Single Line Diagram (SLD) and identifying different component symbols in SLD.</p> <p>System sizing: Selection of components of the Solar Photovoltaic Electrical system.</p> <p>Load calculation and system sizing.</p> <p>Battery sizing.</p> <p>Solar panel sizing.</p> <p>Sizing small and medium solar PV projects and their SLDs.</p> <p>System types based on: Backup requirements, Grid availability, Budget and space.</p> <p>Various skill requirements during solar PV plant installation.</p> <p>Guidance for Solar Installation by MNRE</p>
34	<ul style="list-style-type: none"> Perform various tests and measurement pertaining to PV Modules and their installation as per IEC standards. 	<p>117. Carry out visual inspection of PV modules. (05 hrs)</p> <p>118. Measure Insulation resistance and Wet Leakage Current of PV Modules. (04 hrs)</p> <p>119. Perform Bypass Diode test - Pmax at STC and Pmax at low irradiance.</p>	<p>Performance standards IEC 62125/61646 (Diagnostic, Electrical, Performance, Thermal, Irradiance, Environmental, Mechanical)</p> <p>Safety Standards IEC 61730-1,2 (Electrical Hazards, Mechanical Hazards, Thermal Hazards, Fire Hazards)</p> <p>Hot spot on modules and</p>

		<p>(05 hrs)</p> <p>120. Measure Ground Continuity, Impulse Voltage, Reverse current and Partial Discharge. (04 hrs)</p> <p>121. Practice to undertake precautions against Module breakage. (04 hrs)</p> <p>122. Demonstrate hot spot on modules through audio visual aids. (03 hrs)</p>	<p>method to detect them at site.</p>
<p>35 - 37</p>	<ul style="list-style-type: none"> Assist in Installation and commissioning of Solar PV plant and Hybrid plant. 	<p>123. 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. (06 hrs)</p> <p>124. Prepare a layout of roof showing open areas and occupied areas and mark obstructions that can cause shadows. Take site photographs. (06 hrs)</p> <p>125. Mark locations for components of solar PV electrical system on site. (06 hrs)</p> <p>126. Perform shadow analysis in the rooftop of a 1 KW Solar PV plant. Use sun path diagram for the latitude and solar pathfinder. (07 hrs)</p> <p>127. Install a roof top Solar panel mounting structure for 1 KW installation that uses Solar panels 250 W x 4 Nos. (07 hrs)</p> <p>128. Mount Solar panels 250 W x 4 Nos. on the Mounting structure. (07 hrs)</p>	<p>Site survey: Inspection of field, Selection of site, Shadow analysis. Types of roofs, Weather monitoring. 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.</p> <p>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</p> <p>Wire (cable) requirement/ estimation.</p> <p>Special tools and material handling equipment required during installation. Solar panel mounting structures. Solar plant foundation planning.</p>

		<p>129. Wire Solar panels 250 W x 4 Nos. (6 Hrs)</p> <p>130. Connect the array junction box to the above installation and draw wires up to PCU. (06 hrs)</p> <p>131. Perform different angle of inclination of Solar panel mounting for various cities considering their latitude. (06 hrs)</p> <p>132. Perform Cable laying in the field. (06 hrs)</p> <p>133. Perform finishing work on mounting structure. Perform concrete foundation making over mounting pole base. (06 hrs)</p> <p>134. Perform setting of seasonal angles on mounting structure. (06 hrs)</p>	<p>Installation of solar panels. Solar panel facing direction.</p> <p>Changing the angle of inclination as per location and seasonal setting. MMS systems or using trackers.</p> <p>Solar plant, civil works: drilling, digging, finishing, Mixing concrete.</p>
<p>38 - 40</p>	<ul style="list-style-type: none"> Assist in Installation and commissioning of Solar PV plant and Hybrid plant. 	<p>135. Wire a battery bank for 1 KW installation, using 4X 12V, 100 Ah Solar batteries. (04 Hrs)</p> <p>136. Wire the above installation panels, battery etc. to a 1 KW Solar PCU. (04 hrs)</p> <p>137. Group and Distribute the loads as per economical planning. (05 hrs)</p> <p>138. Wire the AC mains connection to the Solar PCU (Do not switch 'ON'). (05 hrs)</p> <p>139. Prepare a Checklist for finding out errors during above installation. (05 hrs)</p> <p>140. Check as per the checklist and prepare a clearance</p>	<p>Battery Bank wiring, load wiring and distribution panel. Switching loads, economical planning of load distribution. Inverter wiring, Interface with the existing electrical system.</p> <p>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.</p> <p>First inspection report generation.</p>

		<p>certificate before commissioning. (05 hrs)</p> <p>141. Perform Procedural first switch ON, observe No load test results and record. (05 hrs)</p> <p>142. Perform 'ON Load' test, progressively add load till full load and record observation. (06 hrs)</p> <p>143. Perform Overload test and record observation. (06 hrs)</p> <p>144. Prepare a First inspection report on the solar plant installation. (06 hrs)</p> <p>145. Prepare a list of Do's and Don'ts in the installation. (06 hrs)</p> <p>146. Prepare a report on Customer orientation. (06 hrs)</p> <p>147. Prepare a report on visible and audio annunciations, alarms or alerts in a solar PCU. (06 hrs)</p> <p>148. Perform shutting down procedure of the above solar plant. (06 hrs)</p>	<p>Customer orientation. Documentation and record. Do's and Don'ts in the installation.</p> <p>Types of installation for solar array mounts based roof types: Manual Mount:</p> <ul style="list-style-type: none"> • Raft/rack mounts • Pillar or Pole mount • Building integrated mount • Ballast roof mounts • RCC rooftop mount <p>Tracking mounts:</p> <ul style="list-style-type: none"> • Manual track • Automatic track <p>Single axis and dual axis Safety at heights</p> <p>Condition monitoring and report generation.</p>
<p>41 - 43</p>	<ul style="list-style-type: none"> • Assist in Installation and commissioning of Solar PV plant and Hybrid plant. 	<p>149. Prepare a ballast foundation for tiled roof. (07 hrs)</p> <p>150. Prepare a rack mount for a tilted roof. (07 hrs)</p> <p>151. Plan and prepare a report on building integrated solar mount. (07 hrs)</p> <p>152. Prepare a foundation for a single Pillar mount. (08 hrs)</p> <p>153. Visit a Mega project and prepare a report including strings, array, inverter room, output</p>	<p>Maintenance of a solar plant. Alarms & security. Data logger and SCADA room.</p> <p>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</p>

		<p>transformers, plant layout and SCADA room. (08 hrs)</p> <p>154. Prepare a report on site suitable for windmill. (08 hrs)</p> <p>155. Observe the presence of obstacles in a site suitable for windmill. (08 hrs)</p> <p>156. Evaluate windiness of a place using an anemometer. (08 hrs)</p> <p>157. Prepare a report on wind mill energy conversion system through sufficient audio visual sessions. (07 hrs)</p> <p>158. Test with a blower and model windmill & record the observations. (07 hrs)</p>	<p>transmission of energy.</p> <p>Electrical generator and Charge controller for windmill.</p> <p>Small (mini) hydro electricity generation and charge controller.</p> <p>Basics of other renewable energy resources for power generation, such as bio gas plant.</p> <p>Windmill suitable for integration with solar PV plant and its integration.</p>
<p>44</p>	<ul style="list-style-type: none"> • Perform Operation & Maintenance of PV system with best practices. 	<p>159. Demonstrate Standard Operating Procedures of PV system. (05 hrs)</p> <p>160. Demonstrate Electrical Maintenance of Inverters/Cables/Junction Boxes, Fault Indications of Inverters/PCU. (05 hrs)</p> <p>161. Demonstration of Solar Panel Maintenance: - Cleaning, DC Array Inspection, Precautions While Cleaning. (05 hrs)</p> <p>162. Demonstration of Battery Maintenance- Checking of Electrolyte Level, Specific Gravity Using Hydrometer, Physical Damage, Terminal Voltage, Cleaning of Battery Terminals. (05 hrs)</p> <p>163. Inspection of Mounting</p>	<p>SOP (Standard Operation Procedures) of PV system.</p> <p>Types of Maintenance (Preventive/Corrective/Condition Based).</p> <p>Electrical maintenance /Solar Panel maintenance/ Battery maintenance/ Charge Controller maintenance / Solar Panel maintenance.</p>

		<p>Structure of Solar Modules, Procedure of replacement of defective Fixtures. (05 hrs)</p>	
<p>45 - 47</p>	<ul style="list-style-type: none"> Understand manufacturing of solar panel, prepare and commission marketable solar products. 	<p>164. Verify the I-V curve of solar cells. (06 hrs)</p> <p>165. Perform the incoming inspection of Solar PV cells and categorise according to the quality. (06 hrs)</p> <p>166. Construct a cell string. (06 hrs)</p> <p>167. Assemble a solar panel using the above cell string. (06 hrs)</p> <p>168. Perform the framework and seal the Solar panel. (05 hrs)</p> <p>169. Determine the I-V curve of finished solar PV panel and prepare a model certificate. (06 hrs)</p> <p>170. Visit a solar panel manufacturing industry and prepare a report. (or through an audio visual session) (05 hrs)</p> <p>171. Prepare a report on automatic manufacturing of solar panels through audio visual sessions. (05 hrs)</p> <p>172. Assemble, install and commission a solar street light. (06 hrs)</p> <p>173. Assemble, install and commission a model of Solar fertilizer sprayer. (06 hrs)</p> <p>174. Prepare a report on</p>	<p>Solar panel manufacturing: Skills for incoming inspection of PV cells. Making of cell string. Parts of solar panel. Assembly of panel parts.</p> <p>Framework and sealing of panel. Testing and certification. Quality standards. Manual and automatic manufacturing</p> <p>Solar water treatment plant Solar air conditioning Solar refrigeration. Solar agricultural products – sowing, digging, fertilizer or pesticide spraying.</p> <p>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.</p> <p>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</p>

		<p>possible innovative solar products for marketing. (06 hrs)</p> <p>175. Assemble, install and commission a Solar water pump. (06 hrs)</p> <p>176. Assemble, install and commission a solar traffic light. (06 hrs)</p>	<p>mobile apps where policies can be accessed.</p>
48 - 49	<p>Project work / Industrial visit: -</p> <p>a) Solar applications viz. Solar traffic light, solar water pump etc.</p> <p>b) Hybrid plant</p> <p>c) Report on skills required in the Solar PV installation.</p> <p>d) Report on existing National and state level energy policy.</p> <p>e) Report for setting up a small business in the solar industry.</p>		
50 - 51	Revision		
52	Examination		

Note: -

5. *Some of the sample project works (indicative only) are given against each semester.*
6. *The Instructor may design their own project and also inputs from local industry may be taken in designing such new project.*
7. *The project should broadly cover maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, work to be assigned to a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and Application of Learning. They need to submit Project report.*
8. *If the instructor feels that for the execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*

9.1 WORKSHOP CALCULATION AND SCIENCE:

S No.	Workshop Calculation	Workshop Science
1st Semester		
1	Unit: Systems of unit- FPS, CGS, MKS/SI unit, unit of length, Mass and time, Conversion of units	Material Science: properties -Physical & Mechanical, Types -Ferrous & Non-Ferrous, difference between Ferrous and Non-Ferrous metals, introduction of Iron, Cast Iron, Wrought Iron, Steel, difference between Iron and Steel, Alloy steel, carbon steel, stainless steel, Non-Ferrous metals, Non-Ferrous Alloys.
2	Fractions: Fractions, Decimal fraction, L.C.M., H.C.F., Multiplication and Division of Fractions and Decimals, conversion of Fraction to Decimal and vice versa. Simple problems using Scientific Calculator.	Mass, Weight and Density: Mass, Unit of Mass, Weight, difference between mass and weight, Density, unit of density, specific gravity of metals.
3	Square Root: Square and Square Root, method of finding out square roots, Simple problem using a calculator. Ratio & Proportion : Simple calculation on related problems.	Speed and Velocity: Rest and motion, speed, velocity, difference between speed and velocity, acceleration, retardation, equations of motions, simple related problems.
4	Percentage: Introduction, Simple calculation. Changing percentage to decimal and fraction and vice-versa.	Work, Power and Energy: work, unit of work, power, unit of power, Horsepower of engines, mechanical efficiency, energy, use of energy, potential and kinetic energy, examples of potential energy and kinetic energy.
2nd Semester		
1	Algebra: Addition, Subtraction, Multiplication, Division, Algebraic formula, Linear equations (with two variables).	Heat & Temperature: Heat and temperature, their units, difference between heat and temperature, boiling point, melting point, scale of temperature, relations between different scale of temperature, Thermometer, pyrometer, transmission of heat, conduction, convection, radiation.

2	<p>Mensuration: Area and perimeter of square, rectangle, parallelogram, triangle, circle, semi circle, Volume of solids - cube, cuboid, cylinder and Sphere. Surface area of solids -cube, cuboid, cylinder and Sphere.</p>	<p>Basic Electricity and Magnetism: Introduction, use of electricity, how electricity is produced. Voltage, resistance, their units etc. Conductor, insulator, Types of connections - series, parallel, electric power, Horse power, energy, unit of electrical energy. Introduction Magnetic Material for permanent magnet, temporary magnet, etc. Magnetic field, flux density, permeability, susceptibility etc.</p>
3	<p>Number system: decimal and binary, Octal Hexadecimal. BCD code, conversion from decimal to binary and vice-versa, all other conversions. Practice on conversions.</p>	<p>Electrical Engineering materials: Properties and uses in the electrical field of important materials to be selected from 3 categories as conducting materials, semi-conducting materials, Insulating materials. Insulating materials, including transformer oils.</p>
4	<p>Trigonometry: Trigonometrical ratios, measurement of angles. Trigonometric tables. Estimation & costing: Simple estimation of the requirement of materials, etc. as applicable to the trade. Problems on estimation and costing.</p>	<p>Levers and Simple Machines: Levers and its types. Simple Machines, Effort and Load, Mechanical Advantage, Velocity Ratio, Efficiency of machine, Relationship between Efficiency, velocity ratio and Mechanical Advantage.</p>

9.2 CORE SKILL - ENGINEERING DRAWING

S No.	CONTENTS
1ST Semester	
1	Engineering Drawing: Introduction and its importance <ul style="list-style-type: none"> • Relationship to other technical drawing types • Conventions • Viewing of engineering drawing sheets. • Method of Folding of printed Drawing Sheet as per BIS SP:46-2003
2	Drawing Instruments : their Standard and uses <ul style="list-style-type: none"> • Drawing board, T-Square, Drafter (Drafting M/c), Set Squares, Protractor. • Drawing Instrument Box (Compass, Dividers, Scale, Diagonal Scales etc). • Pencils of different Grades, Drawing pins / Clips.
3	Lines : <ul style="list-style-type: none"> • Definition, types and applications in Drawing as per BIS SP:46-2003 • Classification of lines (Hidden, centre, construction, Extension, Dimension, Section) • Drawing lines of given length (Straight, curved) • Drawing of parallel lines, perpendicular line • Methods of Division of line segment
4	Drawing of Geometrical Figures: <ul style="list-style-type: none"> • Definition, nomenclature and practice of angle measurement and its types, method of bisecting. • Triangle - different types • Rectangle, Square, Rhombus, Parallelogram. • Circle and its elements.
5	Lettering and Numbering as per BIS SP46-2003: - <ul style="list-style-type: none"> • Single Stroke, Double Stroke, inclined, Upper case and Lower case.
6	Dimensioning: <ul style="list-style-type: none"> • Definition, types and methods of dimensioning (functional, non-functional and auxiliary) • Types of arrowhead • Leader Line with text
7	Free hand drawing of: <ul style="list-style-type: none"> • Lines, polygons, ellipse, etc. • Geometrical figures and blocks with dimension • Transferring measurement from the given object to the free hand sketches.

8	<p>Sizes and Layout of Drawing Sheets:</p> <ul style="list-style-type: none"> • Basic principle of Sheet Size • Designation of sizes • Selection of sizes • Title Block, its position and content • Borders and Frames (Orientation marks and graduations) • Grid Reference • Item Reference on Drawing Sheet (Item List)
9	<p>Method of presentation of Engineering Drawing</p> <ul style="list-style-type: none"> • Pictorial View • Orthogonal View • Isometric view
10	<p>Symbolic Representation (as per BIS SP:46-2003) of:</p> <ul style="list-style-type: none"> • Fastener (Rivets, Bolts and Nuts) - Bars and profile sections • Weld, brazed and soldered joints. • Electrical and electronics element • Piping joints and fittings
11	<p>Construction of Scales and diagonal scale Practice of Lettering and Title Block</p>
12	<p>Dimensioning practice:</p> <ul style="list-style-type: none"> • Position of dimensioning (unidirectional, aligned, oblique as per BIS SP:46-2003) • Symbols preceding the value of dimension and dimensional tolerance. • Text of dimension of repeated features, equidistance elements, circumferential objects.
13	<p>Construction of Geometrical Drawing Figures:</p> <ul style="list-style-type: none"> • Different Polygons and their values of included angles. Inscribed and Circumscribed polygons. • Conic Sections (Ellipse & Parabola) • Drawing of Solid figures (Cube, Cuboids, Cone, Prism, Pyramid, Frustum of Cone and Pyramid.) with dimensions. •
14	<p>Projections:</p> <ul style="list-style-type: none"> • Concept of axes plane and quadrant. • Orthographic projections • Method of first angle and third angle projections (definition and difference) • Symbol of 1st angle and 3rd angle projection as per IS specification.

15	Drawing of Orthographic projection from isometric/3D view of blocks. Orthographic Drawing of simple fastener (Rivet, Bolts, Nuts & Screw).
2nd Semester	
1	Free Hand sketch of hand tools and measuring tools used in respective trades.
2	<p><u>Sign & Symbol Trade related</u> Alternating Current</p> <ul style="list-style-type: none"> • Drawing of simple electrical circuit using electrical symbols. • Drawing of sine square & triangular waves. • Diagram of battery charging circuit. • Practice in reading typical example of circuit containing R, L & C. • Reading of electrical drawing.
3	<p>Electronic components</p> <ul style="list-style-type: none"> • Symbols for electronic components. Diode, Transistor, Zener diode, SCR, UJT, FET, IC, Diac, Triac, Mosfet, IGBT etc. • Drawing of half wave, Full wave and Bridge rectifier circuit. • Drawing circuit for a single stage Amplifiers and Multi stage Amplifies and types of signals. • Drawing of circuit containing UJT, FET & Simple power control circuits. • Free hand drawing of Logic gates and circuits.
4	<p>Electric wirings & Earthing</p> <ul style="list-style-type: none"> • Detailed diagram of calling bell, & Buzzers etc • Free hand sketching of Staircase wiring. • Drawing the schematic diagram of plate and pipe earthing. • Diagram for electroplating from A.C / D.C source.
5	<p>DC machines and Transformer</p> <ul style="list-style-type: none"> • Graphic symbols for Rotating machines. • Layout arrangement of D.C. Generators & motors, control panel. • Exercises on connection to motors through Ammeter, voltmeter & K.W. meters of electrical wiring diagram. • Graphic symbols for Transformers. • Free hand sketching of transformer and auxiliary parts and sectional views. • Sketching a breather. • Drawing the diagram of typical marking plate of a distribution transformer.
6	<p>Illumination</p> <ul style="list-style-type: none"> • Free hand sketching of Mercury vapour lamp, sodium vapour lamp, fluorescent tube (Single & Twine), MHL lamp and their connection.

7	<p>Control Panel</p> <ul style="list-style-type: none"> • Practice in reading panel diagram. • Solar PV Panel – Integrated pitched roof. • Solar PV Panel Integrated pitched roof – Array dimensions. • Solar thermal panel – Integrated pitched tile roof. • Solar thermal panel – Integrated pitched slate roof. • PV wiring diagram
8	<p>Domestic Appliances</p> <ul style="list-style-type: none"> • Fire, Alarms, Electric Iron, Heater, Electric Kettle, Heater / Immersion Heater, Hot Plate, etc. • Solar heating system.
9	<p>Distribution of Power</p> <ul style="list-style-type: none"> • Types of insulator used in over head line. (Half sectional views) • Different type of distribution systems and methods of connections. • Layout diagram of a substation. • Single line diagram of substation feeders.

9.3 EMPLOYABILITY SKILLS:

CORE SKILL – EMPLOYABILITY SKILL	
First Semester	
1. English Literacy	
Duration : 20 hrs	
Marks : 09	
Pronunciation	Accentuation (mode of pronunciation) on simple words, Diction (use of word and speech)
Functional Grammar	Transformation of sentences, Voice change, Change of tense, Spellings.
Reading	Reading and understanding simple sentences about self, work and environment
Writing	Construction of simple sentences Writing simple English
Speaking/ Spoken English	Speaking with preparation on self, on family, on friends/ classmates, on known people, picture reading, gain confidence through role- playing and discussions on current happening, job description, asking about someone's job, habitual actions. Cardinal (fundamental) numbers, ordinal numbers. Taking messages, passing on messages and filling in message forms, Greeting and introductions, office hospitality, Resumes or curriculum vita essential parts, letters of application reference to previous communication.
2. IT Literacy	
Duration : 20 hrs	
Marks : 09	
Basics of Computer	Introduction, Computer and its applications, Hardware and peripherals, Switching on-Starting and shutting down of the computer.
Computer Operating System	Basics of Operating System, WINDOWS, The user interface of Windows OS, Create, Copy, Move and delete Files and Folders, Use of External memory like pen drive, CD, DVD etc. Use of Common applications.
Word Processing and Worksheet	Basic operating of Word Processing, Creating, Opening and Closing Documents, Use of shortcuts, Creating and Editing of Text, Formatting the Text, Insertion & Creation of Tables. Printing document. Basics of Excel worksheet, understanding basic

	commands, creating simple worksheets, understanding sample worksheets, use of simple formulas and functions, Printing of simple excel sheets.
Computer Networking and Internet	Basic of Computer Networks (using real life examples), Definitions of Local Area Network (LAN), Wide Area Network (WAN), Internet, Concept of Internet (Network of Networks), Meaning of World Wide Web (WWW), Web Browser, WebSite, Web page and Search Engines. Accessing the Internet using Web Browser, Downloading and Printing Web Pages, Opening an email account and use of email. Social media sites and its implication. Information Security and antivirus tools, Do's and Don'ts in Information Security, Awareness of IT - ACT, types of cyber crimes.
3. Communication Skills	
	Duration : 15 hrs Marks : 07
Introduction to Communication Skills	Communication and its importance Principles of effective communication Types of communication - verbal, non-verbal, written, email, talking on phone. Non-verbal communication -characteristics, components-Para-language Body language Barriers to communication and dealing with barriers. Handling nervousness/ discomfort.
Listening Skills	Listening-hearing and listening, effective listening, barriers to effective listening, guidelines for effective listening. Triple- A Listening - Attitude, Attention & Adjustment. Active listening skills.
Motivational Training	Characteristics essential to achieving success. The power of positive attitude. Self awareness Importance of commitment Ethics and values Ways to motivate oneself Personal goal setting and employability planning.
Facing Interviews	Manners, etiquettes, dress code for an interview Do's & don'ts for an interview

Behavioral Skills	Problem solving Confidence building Attitude
Second Semester	
4. Entrepreneurship Skills	Duration : 15 hrs Marks : 06
Concept of Entrepreneurship	Entrepreneur - Entrepreneurship - Enterprises: Conceptual issue Entrepreneurship vs. management, Entrepreneurial motivation. Performance & record, Role & function of entrepreneurs in relation to the enterprise & relation to the economy, Source of business ideas, Entrepreneurial opportunities, The process of setting up a business.
Project Preparation & Marketing Analysis	Qualities of a good entrepreneur, SWOT and risk analysis. Concept & Application of PLC, Sales & Distribution management. Difference between small scale & large scale business, Market survey, Method of marketing, Publicity and advertisement, Marketing mix.
Institution's Support	Preparation of project. Role of various schemes and institutes for self-employment i.e. DIC, SIDA, SISI, NSIC, SIDO, Idea for financing/ non-financing support agencies to familiarize with the policies / programmes, procedure & the available scheme.
Investment Procurement	Project formation, Feasibility, Legal formalities i.e., Shop act, Estimation & costing, Investment procedure - Loan procurement - Banking processes.
5. Productivity	Duration : 10 hrs Marks : 05
Benefits	Personal/ Workman - Incentive, Production linked Bonus, Improvement in living standard.
Affecting Factors	Skills, Working aids, Automation, Environment, Motivation - How it improves or slows down productivity.
Comparison with Developed Countries	Comparative productivity in developed countries (viz. Germany, Japan and Australia) in select industries, e.g. Manufacturing, Steel, Mining, Construction etc. Living standards of those countries, wages.
Personal Finance Management	Banking processes, Handling ATM, KYC registration, safe cash handling, Personal risk and insurance.
6. Occupational Safety, Health and Environment Education	Duration : 15 hrs Marks : 06

Safety & Health	Introduction to occupational safety and health Importance of safety and health at workplace.
Occupational Hazards	Basic hazards, chemical hazards, vibroacoustic hazards, mechanical hazards, electrical hazards, thermal hazards. occupational health, occupational hygiene, occupational diseases/ disorders & its prevention.
Accident & Safety	Basic principles for protective equipment. Accident prevention techniques - control of accidents and safety measures.
First Aid	Care of injured & sick at the workplaces, First-aid & transportation of sick person.
Basic Provisions	Idea of basic provision legislation of India. Safety, health, welfare under legislative of India.
Ecosystem	Introduction to environment. Relationship between society and environment, ecosystem and factors causing imbalance.
Pollution	Pollution and pollutants including liquid, gaseous, solid and hazardous waste.
Energy Conservation	Conservation of energy, re-use and recycle.
Global Warming	Global warming, climate change and ozone layer depletion.
Ground Water	Hydrological cycle, ground and surface water, Conservation and harvesting of water.
Environment	Right attitude towards environment, Maintenance of in-house environment.
7. Labour Welfare Legislation	
Duration : 05 hrs Marks : 03	
Welfare Acts	Benefits guaranteed under various acts- Factories Act, Apprenticeship Act, Employees State Insurance Act (ESI), Payment Wages Act, Employees Provident Fund Act, The Workmen's Compensation Act.
8. Quality Tools	
Duration : 10 hrs Marks : 05	
Quality Consciousness	Meaning of quality, Quality characteristic.
Quality Circles	Definition, Advantage of small group activity, objectives of quality



	circle, Roles and function of quality circles in organization, Operation of quality circle. Approaches to starting quality circles, Steps for continuation quality circles.
Quality Management System	Idea of ISO 9000 and BIS systems and its importance in maintaining qualities.
House Keeping	Purpose of housekeeping, Practice of good housekeeping.
Quality Tools	Basic quality tools with a few examples.

LIST OF TOOLS & EQUIPMENTS			
SOLAR TECHNICIAN (ELECTRICAL)			
S No.	Name of the Tools and Equipment	Specification	Quantity
A. TRAINEES TOOL KIT (16 + 1)			
1.	Measuring Steel Tape	5 meter	17 nos.
2.	Combination Plier Insulated	200 mm	17 nos.
3.	Screw Driver Insulated	4mm X 150 mm, Diamond Head	17 nos.
4.	Screw Driver Insulated	6mm X 150 mm	17 nos.
5.	Electrician screw driver thin stem insulated handle	4mm X 100 mm	17 nos.
6.	Heavy Duty Screw Driver insulated	5mm X 200 mm	17 nos.
7.	Electrician Screw Driver thin stem insulated handle	4mm X 250 mm	17 nos.
8.	Punch Centre	9mm X 150 mm	17 nos.
9.	Knife Double Bladed Electrician	100 mm	17 nos.
10.	Neon Tester	500 V	17 nos.
11.	Steel Rule Graduated both in Metric and English Unit	300 mm with precision of 1/4th mm	17 nos.
12.	Hammer, cross peen with handle	250 grams	17 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 stainless 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 centre position)		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	1 No.

		circuits using banana plugs and sockets	
52.	MCCB	100Amps, Triple pole	1 No.
53.	ELCB and RCCB	25Amps, double pole and 25Amps, double pole, I Δ n 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 microA 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 generation (Wind turbine with blower)	300 W	01 No.
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	2 KG	02 Nos.
154.	Fire Buckets	Standard size	02 Nos.
D. SHOP FLOOR FURNITURE AND MATERIALS			
155.	Working Bench	2.5 m x 1.20 m x 0.75 m	04 Nos.
156.	Wiring Board	3 meters x 1 meter with 0.5 meter projection on the top	01 No.
157.	Instructor's table		01 No.
158.	Instructor's chair		02 Nos.
159.	Trainee Chair		01 for Each Trainee
160.	Trainee table for two trainee		10 Nos.
161.	Metal Rack	100cm x 150cm x 45cm	04 Nos.
162.	Lockers with drawers		01 for Each Trainee
163.	Almirah	2.5 m x 1.20 m x 0.5 m	01 No.
164.	Black board/white board	(Minimum 4X6 feet)	01 No.
Note: - All the tools and equipment are to be procured as per BIS specification.			

TOOLS & EQUIPMENTS FOR EMPLOYABILITY SKILLS		
S No.	Name of the Equipment	Quantity
1.	Computer (PC) with latest configurations and Internet connection with standard operating system and standard word processor and worksheet software	10 Nos.
2.	UPS - 500VA	10 Nos.
3.	Scanner cum Printer	1 No.
4.	Computer Tables	10 Nos.
5.	Computer Chairs	20 Nos.
6.	LCD Projector	1 No.
7.	White Board 1200mm x 900mm	1 No.

Note: - Above Tools & Equipments not required, if Computer LAB is available in the institute.

FORMAT FOR INTERNAL ASSESSMENT

Name & Address of the Assessor:						Year of Enrollment:								
Name & Address of ITI (Govt./Pvt.):						Date of Assessment:								
Name & Address of the Industry:						Assessment location: Industry / ITI								
Trade Name:			Semester:			Duration of the Trade/course:								
Learning Outcome:														
S No.	Maximum Marks (Total 100 Marks)		15	5	10	5	10	10	5	10	15	15	Total Internal Assessment Marks	Result (Y/N)
	Candidate Name	Father's /Mother's Name	Safety Consciousness	Workplace Hygiene	Attendance/ Punctuality	Ability to follow Manuals/ Written instructions	Application of Knowledge	Skills to Handle Tools & Equipment	Economical use of Materials	Speed in doing work	Quality in Workmanship	VIVA		
1														
2														