SHORT TERM VOCATIONAL
CERTIFICATE COURSE

COURSE NAME: **SOLAR POWER TECHNICIAN**
(6 MONTHS)

PREPARED BY

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STATE INSTITUTE OF VOCATIONAL EDUCATION
DIRECTOR OF INTERMEDIATE EDUCATION
HYDERABAD, TELANGANA

COURSE NAME: SOLAR POWER TECHNICIAN

SECTOR: ENGINEERING

COURSE CODE: SPT

ENTRY QUALIFICATION: 10th passed

PRE-REQUISITES: The student should have the basic knowledge about solar panels, inverters, batteries and various applications of solar equipment.

Terminal competence: After completion of this course the students will be able to attend the installations and repairs of various types of solar installation systems.

Duration: 6 Months- (40 Hours: English + Course Content: 200 Hours)

Introduction:

Nowadays solar energy has become the most important energy source as an alternative energy supplement to the conventional source of energy which abundantly available in the nature at free of cost as well pollution free. The utilisation of equipments working with solar energy is increasing day by day, therefore it is necessary to train the men as the skilled men in this area to attend the solar energy equipment installations and as well as the repairs of all types of solar equipment.

Objectives:

- To equip students with the essential skills and knowledge to install, maintain, and troubleshoot solar power systems, ensuring they can effectively work with photovoltaic (PV) panels and related electrical components.
- To prepare students for immediate employment in the solar energy industry by providing hands-on training and practical experience with current technologies and industry-standard practices.
- To educate students on the principles of renewable energy and sustainable practices, emphasizing the environmental benefits and economic advantages of solar power solutions.

Skills:

- Proficiency in installing solar photovoltaic (PV) systems, including mounting panels, wiring, and connecting inverters.

- Knowledge of safety protocols and practices to prevent accidents and ensure safe working conditions during installation and maintenance.
- Providing technical support, addressing customer concerns/with installed systems and troubleshooting solar power systems to ensure efficient and reliable operation

ON THE JOB TRAINING & PRACTICAL:

- Work with local Solar installation systems.
- Work with local Solar equipment repair centres.
- Visit the Solar panels manufacturing units
- Visit the Solar equipment

COURSE SYLLABUS

THEORY

Unit No.	Unit Name
1	Introduction to Renewable energy sources
2	Solar Energy- Basic Physics & Basic Components of a solar (photo voltaic) system
3	Tools & Equipment used in solar (photo voltaic) systems
4	Solar home system sizing
5	Site Survey, Mounting structure and Installation of Solar PV System
6	Safety Precautions, Basic Maintenance & Trouble Shooting of PV Systems

PRACTICAL/OJT

Unit No.	Unit Name
1	Identification of components
2	Make a list of electrical gadgets in your home and college and note the voltage rating, power rating, whether works on AC or DC
3	Identify various tools and equipment

4	Use various tools to measure the voltage output, current output, check polarity of the solar panel
5	Demonstration of the parts of a inverter
6	Battery voltage testing
7	Size a system (providing specifications for the PV panels, charge controller, battery and inverter) for TV, LAPTOP, DESKTOP COMPUTER, Refrigerator, different kinds of bulbs, Fans
8	Installation of Solar system at a local clinic
9	Installation of Solar system for operating a small fan by 24 Volts of DC
	Performance of a Solar Panel in a Shade
10	Practice on use of Electrical equipment, Practice on Disconnection-Reconnection of Equipment
9	Identify various Hazards & How They Can Be Prevented
10	Importance of safety management and safety precautions to be taken while operating the PV system
11	Servicing and Maintenance of PV system components
12	Trouble shooting cases i. It has been sunny all day but there is not enough power in your solar battery ii. If there are frequent power blackouts iii. You were watching television and the rooms were well lit for several hours. Suddenly the television goes off and you are in total darkness. Identify the possible reasons and corrective actions to be taken

SCHEME OF INSTRUCTIONS:

1. Communicative English: 40 Hours
2. Course Content : 200 Hours

Duration of course	Theory		Practical/OJT		Total	
	Hours	weightage	Hours	weightage	Hours	Weightage
Module-1 (06 Months)	60	30%	140	70%	200	100%

COURSE CONTENTS:

S.No.	Units (Theory)	Periods (60 Hours)	Practical Lab/ OJT	Periods (140 Hours)
1	**Unit-1** **Introduction to Renewable energy sources** 1.1 Energy Challenges in India 1.2 Introduction of energy (Renewable energy and Non-renewable energy) 1.3 Various types of Renewable energy 1.4 Advantages & disadvantages of Solar energy and other Renewable energies 1.5 Status of Renewable Energy in India 1.6 Solar Energy in India 1.7 Various applications of solar energy (Thermal and PV energy 1.8 Differentiate between Renewable and Non-Renewable energies 1.9 Solar radiation and its types.	06	**Unit-1** **Introduction to Renewable energy sources** 1.Study on energy challenges in India 2. Identifying various renewable and non – renewable energy sources 3.Study on availability of various renewable energy sources in India 4. Study on State and Central schemes available in India for using solar energy. 5. list the applications of solar energy in India 6.Identify, note down or take photos of nearby solar installations and its effect	20
	Unit-2 **Solar Energy- Basic Physics & Components of Solar Power system** 2.1. A Brief Introduction to		Unit-2 **Solar Energy- Basic Physics & Components of solar power system** 7. Study of solar	

2	Electricity 2.2. The Solar Resource 2.3. Solar Energy Conversion 2.4. Definition of Solar cell 2.5. Ohm's Law: Electric Current, Voltage, and Resistance 2.6. Work, Power and Energy 2.7. Electrical and Electronics components 2.8. Measuring Instruments 2.9. Solar Module 2.10. Grounding, Earthing and Lightning Protection 2.11. PV System Components 2.12. Solar (PV) panels and its types 2.13. Inverters 2.4.1Types of Inverters 2.4.2 Advantages of Inverters 2.4.3 Circuit diagram of inverter connection 2.14. Charge controllers Advantages & Disadvantages of charge controller 2.15. Batteries 2.16. Types of Batteries 2.11 Battery energy storage and	12	system and its parts 8. Study of defining & demonstration of various terms used in measuring electricity i.e. power, voltage, current, resistance, energy and their relationships. 9. Demonstration of types of currents and their importance 10. Building basic electrical circuits i.e. Series wiring and Parallel wiring connections 11 Demonstration of earth solar budget 12 Demonstration of solar Energy conversion to electricity and heat power 13 Study of different types of solar panels. 14. Study of different types of inverters & charge controllers and it parts 15. Study of different types of solar batteries and its parts 16. Practice of cabling connections to various equipment 17. Practice of testing of power supply to solar equipment 18 study on the	20

	its condition -DOD (Depth of Discharge) -SOD (State of Discharge) 2.12 Advantages of Batteries		working of a battery used in a solar PV panel 19 study on the working of a inverter & charge controller used in a solar PV panel 20 Reading the specifications given in a PV panel 21Measuring the state of the charge 22 Identifying various DC and AC loads 23 Study effects of a bad installation 24 Study why a car battery is not useful for PV panel	
3	**Unit-3** **Tools & Equipments used in solar (photo voltaic) systems** 3.1 Mechanical tools used in the solar PV system installation-spanner, drill machine, hammer, chisel, grinder, torque wrench, LN keys, saw, power drill, scrapers, screw driver. 3.2 Electrical tools used in the solar system-mustimeter, clamp meter, earth tester / megger, wire stripper, tester, electrical insulator, pliers, crimper. 3.3 Civil tools used in the solar	12	**Unit-3** **Practice on use of Electrical equipment** 25 Using a multimeter to measure the voltage output, 26 Using a multimeter to measure the current output, 27 Using a multimeter to check polarity of the solar panel 28 Demonstration of working of an Inverter	30

	system-line dori, pickaxe, spud, mortar pan, spade, water level pipe, crowbar, pliers. 3.4 Marking tools used in the solar system- compass, measurement level, marking thread, angle finder tape, spirit level. 3.5 fasteners-types Solar intensity measuring instruments Pyranometer Pyrheliometer Sunshine recorder.		29 Using a multimeter to test the Voltage of a battery 30 List and Identify the various mechanical tool 31. Draw the image of the mechanical tool and label it 32. Handling of the different mechanical tools (spanner, drill machine, hammer, chisel, grinder, torque wrench, LN keys, saw, power drill, scrapers, screwdriver) 33. Do the operations like cutting, spanner, drill machine, hammer, chisel, grinder, wrench, LN keys, saw, power drill, scrapers, screwdriver 34.Identify the various electrical tool for the specific task 35. Handling and operate the different electrical tools, earth tester, Wire stripper, tester electrical insulator, pliers, crimper) 36. Study of pyranometer and identification of its parts. 37. Practice of using	

			pyranometer to record radiation. 38.Study of pyrheliometer and identification of its parts. 39. Practice on using of pyrheliometer to record radiation 40. Study of solar sunshine recorder and its parts 41. practice on using of sunshine recorder to record solar intensity. 42.Identify the various Civil tools for the specific task 43.Sketch the Civil tool and label it 44.Demonstrate the different Civil tools (pickaxe, spud, mortar pan, spade, water level pipe, crowbar, pliers) 45.Perform practically all Civil tool operations (like a pickaxe, spud, mortar pan, spade, crowbar, and pliers) 46. Use of Measuring tools compass, measurement level, marking thread, angle finder tape, spirit level	
			Unit-4	

4	**Unit-4** **Solar Home System Sizing** 4.1 Introduction to system sizing 4.2 A sample design situation 4.3 Design a standalone PV system for a household with a TV, 4x15 Watt bulbs 4.4 steps in system sizing process 4.4.1 load assessment 4.4.2 PV module sizing 4.4.3 battery sizing 4.4.4 Charge controller sizing 4.4.5 Inverter sizing 4.4.6 wire sizing 4.4.1 load assessment 4.5 Sunshine hours method 4.5.1 determine the load 4.5.2 determine the available sunshine hours 4.5.3 determine the PV panel size 4.5.4 determine the size of the battery pack size 4.5.4 determine the size of charge controller 4.5.5 determine the size of the inverter to be used 4.6Erection of solar panel stands 4.7 Fixing of solar panels on the stands 4.8 Installation of Inverter 4.9 Installation of Batteries	14	**Solar Home System Sizing** 47 Study on Estimating electric loads 48 Study on Sizing and specifying PV modules 49 Study on Sizing and specifying batteries 50 Study on Specifying a charge controller 51 Study on Sizing and specifying an inverter 52 Study on Sizing system wiring 53 Size a system for the following (providing specifications for the PV panels, charge controller, battery and inverter TV, Refrigerator, Radio, laptop, computer, light bulbs etc	30
	Unit-5 **<u>Site Survey, Mounting structure and Installation of Solar PV System</u>**		**Unit-5** 54 Demonstration of Parallel circuit 55 Demonstration of series circuit	

5	5.1 The importance of Site Survey and Customer satisfaction 5.2 Steps for safe installation of Solar PV system 5.3 Basic on Mounting Structure and it's Types 5.4Install Civil and Mechanical Parts of Solar PV System 5.5 Installation of Electrical components 5.6 Install of Solar Photovoltaic Module 5.7 Site Assessment 5.7.1 shading 5.7.2 orientation 5.7.3 Tilt 5.8. Series type connections of solar panels 5.9. Parallel type connections of solar panels 5.10. Connecting a charge controller 5.11. Connecting a battery to solar system 5.12. steps to connect a charge controller to solar panel 5.13 battery installation 5.13.1 series connections of batteries 5.13.2 Parallel connections of batteries 5.14 Installation of various solar power equipment like., -Solar water heater - Solar Lighting - Solar water cooler	10	56 Performance of a Solar Panel in a Shade 57 Erecting of solar panels stands practice 58 Practice of fixing solar panels on solar stands. 59 Practice of installation of inverters 60.Practice of installation of batteries 61. practice installation of solar water heater 62.Practice of solar lighting installation 63.practice of solar water cooler installation 64.Practiceof solar refrigeration installation 65. Practice of solar agriculture pump installation, etc 66. Practice on Disconnection and reconnections of -Solar water heater -Solar lanterns Solar lighting -Solar water cooler -Solar Refrigerator -Solar water pump, etc	20

	-Solar Refrigerator - Solar Agriculture water pump, etc 5.15 Connections with cables to all these from solar panels. 5.16 Construction and working of 5.16.1 Solar water heater 5.16.2 solar lighting 5.16.3 Solar water cooler 5.16.4 Solar Refrigerator 5.16.5 Solar Agriculture pumps...etc			
6	**Unit-6** **Safety Precautions, Basic Maintenance & Trouble Shooting of PV Systems** 6.1 Site Risk and Hazard Assessment 6.1.1 Risks at on-site work 6.1.2 PV PANEL 6.1.3 Charge controller & Inverter 6.1.4 Batteries 6.1.5 Cables 6.1.6 Appliances 6.1.3 On—Site work 6.2 Hazards & How They Can Be Prevented 6.2 Safety management Clothes Safety equipment Work plan Work at site 6.3 Safety precautions 6.4 Maintenance of system components 6.5 Wire and Earthing	06	**Unit-6** **Safety Precautions, Basic Maintenance & Trouble Shooting of PV Systems** 67 study on Importance of safety management and safety precautions to be taken while operating the PV system 68 Servicing and Maintenance of PV system components 69 Trouble shooting cases i. It has been sunny all day but there is not enough power in your solar battery ii. If there are frequent power	20

	Continuity Test 6.6 Testing of CCR, Inverter and Battery 6.7 Trouble shooting of PV system Solar panels Charge controller Batteries Wiring 6.8 Sample Test and Commission Record Sheet 6.9 O & M of PV System 6.10 Prepare Bill of Materials (BOM) 6.11 Establish and Follow Safe Work Procedures 6.12 Use and Maintain Personal Protective Equipment (PPE) 6.13 Work Health and Safety at Heights		blackouts iii. You were watching television and the rooms were well lit for several hours. Suddenly the television goes off and you are in total darkness. Identify the possible reasons and corrective actions to be taken **70** Attend the servicing and maintenance of -Solar panels -Solar water heater -Solar lighting -Solar water cooler -Solar Refrigerator -Solar Agriculture water pump…etc 71. Visit and study of: -Local Solar installation systems. -Local Solar equipment repair centres. -Solar panels manufacturing units -Solar equipment manufacturing units.	

List of Tools and Equipment: (Each two No. at least)

A complete unit of Solar photovoltaic system model of solar photovoltaic power plant, Solar power meter (pyranometer), Solar photovoltaic inverter, energy meter, Battery, cable.

Tool kit, Electrician knife, water level indicator, PVC mallet, Fuse puller, Tong tester AC/DC, Multimeter,

Earthing rod, Soldering iron and flux, Phase sequence meter, Inclinometer. Clamp meter, earth tester, lux meter, drill machine and torque wrench, compass,

Spirit level/water level, drill machine, double-ended flat and ring spanner, combination plier, side cutting plier. Nose pliers, wire stripper, hacksaw frame with the blade, screwdriver, torque wrench, wire stripper, Measuring tape, line dori, plumb bob, Vernier caliper, Allen key set, Cable ties, Charge controller, Connecting wires, Lead solder, Load (AC/DC), Centre punch, Standard wire gauge, MC4 connectors, Mechanical fixtures required for panel installation, PUCs, Cable cutter, Screw driver set, solar chart, Solar conversion kits, Soldering flux, solar panels, soldering iron, wire stripper, safety helmet, safety belt, Nose mask, Safety goggles, ear plug, cotton hand glove,

Safety equipment: First-aid kit and other necessary equipment.

Basic Tools Needed for Installation

- Angle finder
- Torpedo level
- Fish tape
- Chalk line
- Cordless drill (14.4V or greater), multiple batteries
- Unibit and multiple drill bits (wood, metal, masonry)
- Hole saw
- Hole punch
- Torque wrench with deep sockets
- Nut drivers (most common PV sizes are 7/16”, ½”, 9/16”)
- Wire strippers
- Crimpers
- Needle-nose pliers

• Lineman's pliers
• Slip-joint pliers
• Small cable cutters
• Large cable cutters
• AC/DC multimeter
• Hacksaw
• Tape measure
• Blanket, cardboard or black plastic to keep modules from going “live” during installation
• Heavy duty extension cords
• Caulking gun
• Fuse Pullers

Additional Tools to Consider (especially for multiple installations)
• DC clamp-on ammeter
• Reciprocating saw / Jig saw
• Right angle drill
• Conduit bender
• Large crimpers
• Magnetic wristband for holding bits and parts
• C-clamps
• Stud finder
• Pry bar

Tools for Battery Systems
• Hydrometer or Refractometer
• Small flashlight (to view electrolyte level)
• Rubber apron
• Rubber gloves
• Safety goggles
• Baking Soda (to neutralizer any acid spills)
• Turkey Baster
• Funnel
• Distilled Water

• Voltmeter

Tools and Accessories for SPV System testing and maintenance

The following major Tools and Accessories are required for overall SPV System testing and maintenance.

1. First & Kit
2. Multimeter
3. Clamp-meter
4. Electrical Power Testers
5. Energy meter
6. Insulation Resistance Testers
7. Disconnection Detector for DC Current Circuit (NSEI-100D)
8. PV Characterization Testers
9. Commissioning and Safety Testers
10. Solar Power and Thermal Testers
11. Irradiance Meters
12. Light meter
13. Distance meter
14. Hydrometer
15. Hygrometer
16. Portable Test Equipment
17. Wire strippers
18. Crimping tool
19. Soldering Iron
20. Battery terminal cleaner
21. Compass
22. Hammer
23. Flashlight
24. Paper/pencil
25. Safety goggles
26. Rubber gloves
27. Shoes
28. Cleaning brush etc.

Solar products:

- Home lighting system
- Solar lantern,
- Solar torch,
- Solar water heater,
- Solar cooker,
- Solar power bank,
- Solar street light,
- Solar e-rickshaw,
- Solar charging station

QUALIFICATION OF TEACHING FACULTY:

B.E./ B. Tech or its equivalent in Mechanical, Electrical and Electronics Engineering, from a recognized Institute /University, with 55% aggregate marks and at least 1-year work / teaching experience.

Or
Diploma in Mechanical and Electrical and Electronics Engineering from a recognized Institute/ University, with 55% aggregate marks and at least 2-years work / teaching experience

REFERENCE BOOKS/INTERNET:

1. **PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION**
2. Intermediate Vocational Mechanical Engineering 2nd year text Book.
3. Skill course training handbook for solar PV trainer

DIVISION OF MARKS:

Theory: 100 Max Marks

1. Communicative English : 20 Marks
2. Short Questions : 6 X 5M = 30 Marks
3. Long Questions : 4 X 10 = 40 Marks
4. Multiple Choice Questions : 10 Marks

Practical: 100 Max Marks

1. External : 40 Marks
2. Record/Mini Project & Viva : 10 Marks
3. Internship/ OJT : 50 Marks

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REGD. NO:

TIME : 3 HRS **MAX MARKS: 100**

SOLAR POWER TECHNICIAN
MODEL QUESTION PAPER (THEORY)

SECTION- A

COMMUNICATIVE ENGLISH 20 MARKS

SECTION- B

Note: a) Answer ALL questions.

b) Each question carries **5 Marks**. **6X5M=30 MARKS**

1. Explain the advantages and disadvantages of using Solar PV technology and list at least 04 applications where solar PV technology can be used.
2. Compare various types of solar cells (i.e mono, crystalline, amorphous)
3. Write short notes on significance of an Inverter in the PV solar cell. List types of Inverters
4. A 12 V PV system has two DC appliances A and B requiring 15 and 20 W respectively. The average operational time per day is 6 hours for device A and 3 hours for device B. Calculate the daily energy requirements of the devices expressed in Ah
5. List various safety precautions that have to take while installing and working with a solar PV module.

6. What are the various hazards that can happen in a solar PV cell system and how they are prevented.

SECTION- C

Note: a) Answer any **Four** questions.

b) Each question carries **10 Marks**. **4X10M=40 MARKS**

1. List the components of a solar photovoltaic system and with a neat sketch, explain briefly the functions of each component.
2. Compare and contrast Renewable and Non Renewable Energy systems
3. Explain briefly about sunshine hours method
4. Explain briefly the procedure adopted for sizing of a solar Photo voltaic system (i.e. sizing of PV module, battery, charge controller, Inverter, wires)
5. Assume you are watching television and the rooms are well lit using a solar PV module for several hours. Suddenly the television goes off and you are in total darkness. What could be the cause and what are the corrective actions to be taken

SECTION-D 10X1=10 Marks

1. A solar cell converts light energy into _____

   a) Electrical energy b) Thermal energy c) Sound energy d) Heat energy

2. How much electrical energy is consumed if a 100-watt light bulb is used for 10 hours

(a) 1000 w (b) 1KWh (c) 10 KWh (d) 10 KW

3. What is the resultant voltage when four 1.5V DC batteries are connected in series

(a) 4 (b) 6 (c) 12 (d) 1.5

4. Solar cells are made of

(a) conductors (b) semi-conductors (c) insulators (d) super conductors

5. Material used for making solar cell is _____

a) Silicon b) Carbon c) Sodium d) Magnesium

6. The efficiency of a solar cell may be in the range

a. 2 to 5% b. 10 to 15% c. 30 to 40% d. 70 to 80%

7. Which type of solar cells has highest efficiency:

a) Amorphous. b) Poly-crystalline. c)Mono-crystalline

8. All the electricity produced by the solar panels is produced as

a) AC. b) DC c) both DC and AC d) Neither AC nor DC

9. The initial cost of PV systems is

a) low b) medium c) High d) No relation

10. The efficiency of PV systems in general is

a) high b) low c) medium d) no relation

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SOLAR POWER TECHNICIAN
MODEL QUESTION PAPER (PRACTICAL)

Note: a) Answer any one of the questions.

b) Each question carries **40 Marks**. **4X10=40MARKS**

1. Use various tools to measure the voltage output, current output, check polarity of the solar panel

2. Demonstration of various parts of solar panel, Battery, inverter of a solar PV module.

3. Determine specifications for the PV panels, charge controller, battery and inverter used for powering Television.

4. Determine the Performance of a Solar Panel in a Shade

Record/Mini Project & Viva **10 Marks**

Internship/OJT **50 Marks**