14.1.0 SOLAR INSTALLATION SYSTEMS

14.1.01 Introduction

The solar system module unit is designed to equip the trainee with knowledge skills and attitude necessary to understand and install solar installation systems.

Trainees will appreciate and apply prior knowledge and skills acquired in Electrical Installation of this course.

14.1.02 General Objectives

At the end of module unit, the trainee should be able to:

a) Understand the basic principles of solar systems
b) Acquire relevant skills for installation solar systems
c) Create awareness in the application of solar systems
d) Observe safety rules and standards when installing solar system panels
e) Institute quality control measures while installing solar systems
f) Prepare, maintenance schedules and maintain solar systems

4.1.03 Module Unit Summary and Time Allocation

Solar Installation Systems

Code	Sub-Module Unit	Content	Time Hrs
14.1.1	Introduction to Solar Installation Systems	• Solar energy and its conversion • Terms used with solar systems • Methods of solar energy harvesting • Applications of solar energy	10
14.1.2	Solar (Photo Voltaic) Systems	• Parts of a photovoltaic • Functions of each part of a voltaic system • layout of the photo voltaic system	16
14.1.3	Solar Systems' Accessories	• Types of accessories • Types of cable joints • Wiring systems • Choice of wiring systems	12

		• Tests performed on completed installations • Regulations governing solar installations	
14.1.4	Maintenance and Servicing of Solar Systems	• Procedure for maintenance • Repair and trouble shooting	16
14.1.5	Solar System Sizing	• Terminologies • Sizing a solar system • Daily load energy demand • Equipment, cables and accessories sizing • Application of solar data	12
Total Time			**66**

14.1.1 INTRODUCTION TO SOLAR INSTALLATION SYSTEMS

Theory

14.1.1T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

a) explain solar energy and its conversion
b) define various terms used with solar energy
c) state various methods of solar energy harvesting
d) list applications of solar energy

Content

14.1.1T1 Solar energy and its conversion:

i) Sun as a source of energy
ii) Conversion of solar to chemical energy (photosynthesis)
iii) Solar to heat (thermal)
iv) Solar to electricity
v) Solar to biomass

14.1.1T2 Definition of terminologies:

i) Radiation
ii) Direct and indirect radiation
iii) Insolation

14.1.1T3 Methods of solar energy harvesting:

i) Solar module (solar cells)
ii) Parabolic reflectors
iii) Dish reflectors
iv) Box reflectors
v) Flat plate collectors (water heating)

14.1.1T4 Applications of solar energy:

i) Crop drying
ii) Cooking
iii) Water heating
iv) Electricity
v) Space heating
vi) Green houses

Practice

14.1.1P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

a) perform solar energy harvesting using various methods
b) apply solar energy in day – to – day life

Content

14.1.1P1 Solar energy harvesting:

i) Solar module (solar cells)
ii) Parabolic reflectors
iii) Dish reflectors
iv) Box reflectors
v) Flat plate collectors (water heating)

14.1.1P2 Applications of solar energy:

i) Crop drying
ii) Cooking
iii) Water heating
iv) Electricity
v) Space heating
vi) Green houses

14.1.1C Competence

The trainee should have the ability to:

i) Identify various forms of solar energy

ii) Harvest solar energy
iii) Utilize solar energy in various forms

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations
- Project work
- Visits to solar installation sites

Suggested teaching/Learning Resources

- Assorted accessories for solar systems
- Wooden vertical board
- Masonry wall
- Soldering gun
- Solder
- Tools
- Equipment and apparatus for solar systems

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project Report writing and presentation

Suggested Learning Resources

- Solar energy equipment and apparatus
- Solar module (solar cells)
- Parabolic reflectors
- Dish reflectors
- Box reflectors
- Flat plate collectors (water heating)
- Charts for solar installations
- Field visits to solar homes

14.1.2 SOLAR INSTALLATION SYSTEMS

Theory

14.1.2T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

a) list the various parts of a photovoltaic systems
b) explain the functions of each part of a voltaic system
c) illustrate the layout of a photo voltaic system

Content

14.1.2T1 Parts of a photovoltaic system.
i) Module array
ii) Charge controller
iii) Battery
iv) Inverter
v) Wires and accessories
vi) Loads

14.1.2T2 Functions of parts of Photo Voltaic Systems
i) Charge controller
ii) Battery
iii) Inverter
iv) Wires and accessories
v) Loads

14.1.2T3 Solar system lay out
i) Block diagram
ii) Schematic diagrams

Practice

14.1.2P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

a) identify various components of a photo voltaic systems
b) read and interpret a solar system layout.
c) install a photo voltaic (solar system) using the right tools.

Content

14.1.2P1 Components of a photo voltaic system
- i) Module array
- ii) Charge controller
- iii) Battery
- iv) Inverter
- v) Wires and accessories
- vi) Loads

14.1.2P2 Solar system lay-out
- i) Block diagram
- ii) Schematic diagrams.

14.1.2P3 Installation of a solar system

14.1.2C Competence

The trainee should have the ability to:

i) Identify the various parts of a photo voltaic system
ii) Read and interpret solar system drawings
iii) Install solar systems

Suggested Learning Resources

- Solar module
- Charge controllers
- Inverter
- Lead- acid cells
- Solar batteries
- Various accessories and wires
- Manila papers (Charts)
- Tools
- Solar system service kit

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

14.1.3 SOLAR SYSTEMS' ACCESSORIES

Theory

14.1.3T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

a) describe various types of accessories.
b) describe various types of cable joints
c) list various types of wiring systems for a solar systems
d) explain factors that are considered when choosing a wiring system
e) outline the tests, in the right procedures on a complete installation

f) apply various electrical regulations governing solar installations.

Content

14.1.3T1 Types of accessories
- i) AC and DC switches
- ii) Socket outlets
- iii) Lamp holders
- iv) Ceiling roses
- v) Patresses
- vi) Consumer control units
- vii) Consumer control units

14.1.3T2 Types of cable joints
- i) Telegraphic joint
- ii) T Joint Married joint
- iii) Bell hangers joint

14.1.3T3 Wiring systems
- i) Polyvinyl Chloride P.V.C Sheathed wiring systems
- ii) Tough rubber sheath,
- iii) Polyvinyl chloride(PVC) Conduit system
- iv) Polychloroprene (PCP)

14.1.3T4 Factors that are considered when choosing a wiring system
- i) Cost
- ii) Durability
- iii) Safety
- iv) Aesthetics
- v) Nature of building

14.1.3T5 Tests procedures for an Installation:
- i) Physical inspection
- ii) Electrical tests
- iii) Ring continuity tests
- iv) Effectiveness of the earth tests
- v) Insulation tests
- vi) Polarity tests

14.1.3T6 Electrical regulations governing solar installations

Practice

14.1.3P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:
- a) make various types of cable joints and terminations
- b) select suitable wring systems and install P.V systems
- c) perform in the right procedure, tests in a complete solar installation
- d) carry out quality control checks

Content

14.1.3P1 Cable joints and terminations
- i) Joints
- ii) Telegraph
- iii) Scarf
- iv) Britannia
- v) Bell hanger's
- vi) T Joint
- vii) Married
- viii) Terminations
- ix) Loop
- x) Claw
- xi) Spade
- xii) Crimped
- xiii) Lug
- xiv) Crimping

14.1.3P2 Wiring systems for solar systems
- i) sheathed wiring systems
- ii) tough rubber sheath

iii) Poly -Vinyl Chloride(PVC) sheath
iv) Poly-Chloroprene (PCP)
v) Regulations and standards for P.V installations
vi) conduit wiring systems for P.V systems
vii) PVC conduit wiring systems

14.1.3P3 Tests procedures for an installation:
i) Physical inspection
ii) Electrical tests
iii) Polarity
iv) Earthing
v) Insulation
vi) Ring continuity

14.1.3P4 Electrical regulations governing solar installations

14.1.3P5 Quality control checks for solar systems installations
i) Material selection
ii) Selection of tools and equipment
iii) Measuring, marking out and fixing of components and equipment and application of acceptable tolerance
iv) Termination techniques
v) Testing of the completed installation
vi) Compliance with the set standards
vii) Good quality finish and appearance

14.1.3C Competence

The trainee should have the ability to:

a) Identify the accessories for a photo voltaic system
b) perform cable joints
c) install electrical circuit using various types of wiring systems
d) test solar electrical systems in the right sequence
e) apply electrical regulations and standards in the photo voltaic installation work

Suggested teaching/Learning Activities

- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested Learning Resources

- Assorted accessories
- Chalk board
- Text books
- Instruments
- Resource persons
- Manuals

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

14.1.4 MAINTENANCE AND SERVICING OF SOLAR SYSTEMS

Theory

14.1.4T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

a) explain the procedures for solar system maintenance
b) outline troubleshooting and repair procedures of a solar system.

Content

14.1.4T1 Solar system maintenance procedure,
- i) Battery maintenance
- ii) Cleaning,
- iii) Topping up electrolyte level,
- iv) Checking the state of charge,
- v) equalizing charge
- vi) Module maintenance:
- vii) Dusting and testing modules
- viii) Checking of connections
- ix) System records and manuals

14.1.4T2 Trouble shooting procedures:
- i) Module condition
- ii) Battery condition
- iii) Control and Protection devices
- iv) Lamp conditions

Practice

14.1.4P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:
a) test a solar system for proper operation
b) service and maintain a solar system for proper operation

Content

14.1.4P1 Testing a solar system for proper operation
- i) Checking / testing the outputs of a module – Voltage, current and power
- ii) Checking parameters of a charge controller
- iii) Checking for loose connections

14.1.4P2 Servicing and maintaining a solar system
- i) Battery – topping up
- ii) Electrolyte level
- iii) Charge level
- iv) Module cleaning.
- v) Checking for loose connections
- vi) Checking all other connections,
- vii) Charge controller,
- viii) Inverter,
- ix) Loads
- x) Checking for burnt out lamps and replacing the same
- xi) Applying current electrical regulations and codes of practice in all areas of tests and inspection

14.1.4C Competence

The trainee should have the ability to:
- i) Install a photo voltaic system
- ii) Test a photo voltaic system
- iii) Service and maintain photo voltaic system

Suggested teaching/Learning Activities
- Illustration

- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested Learning Resources

i) Solar system tool kit
ii) Solar Battery
iii) Solar Module
iv) Solar energy inverter
v) Solar system service kit.

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

14.1.5 SOLAR SYSTEM SIZING

Theory

14.1.5T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

a) explain terminologies used with solar systems
b) explain the need for sizing a solar system
c) determine the daily load energy demand for any system specifications
d) determining the right size of equipment, cables and accessories
e) size a typical solar system given all the necessary data.

Content

14.1.5T1 Terminologies for solar system technology
i) Module outputs and specifications
ii) Daily energy requirement
iii) Number of battery storage days
iv) Battery capacity
v) Depth of discharge/depth of charge
vi) Insolation
vii) Tracking

14.1.5T2 Need for sizing
i) Need for the right size of the module
ii) Need for the right charge controller
iii) Need for the battery
iv) Need for the right size of fuse and circuit breaker

14.1.5T3 Determination of daily energy demand as:
i) Energy due to lamp
ii) Energy due to other loads
iii) Power required to cater for the loses
iv) Total daily energy demand

14.1.5T4 Determination the right size of equipment:
i) Module
ii) Cables and accessories factors to consider:
iii) Charge controller – Factors to consider:
iv) Inverter factors to consider
v) Battery.

14.1.5T5 Step – by –step sizing of solar systems
i) Total daily energy demand
ii) Systems voltage

iii) Systems current hours
iv) Insolation effect
v) Autonomy effect
vi) Tracking effect
vii) Choice of modules, battery charge controllers inverters
viii) Choice of cables and accessories.

Practice

14.1.5P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to size a typical solar system.

Content
14.1.5P0 Needs of an installations
i) Need for sizing
ii) Daily energy demand

14.1.5C Competence
The trainee should have the ability to: identify the right wires, apparatus for a solar system.

Suggested teaching/Learning Activities
- Illustration
- Demonstration
- Note taking
- Calculations
- Project work

Suggested teaching and learning resources
- Drawing board
- Calculator
- Catalogues
- Data for solar equipment

Suggested Evaluation Methods
- Oral tests
- Assignments
- Project