



Skill India  
कौशल भारत - कुशल भारत



# Participant Handbook



Skill India  
कौशल भारत - कुशल भारत



Sector  
Electronics

Sub - Sector  
Solar & LED

Occupation  
Installation

Reference ID : ELE/Q5901, Version 2.0  
NSQF Level 4

**Solar Panel Installation  
Technician**



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**“** Skilling is building a better India.  
If we have to move India towards  
development then Skill Development  
should be our mission. **”**

**Shri Narendra Modi**

Prime Minister of India



## Certificate

COMPLIANCE TO  
QUALIFICATION PACK – NATIONAL OCCUPATIONAL STANDARD

Is hereby issued by the

Electronics Sector Skills Council of India

for

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Complying to National Occupational Standards of

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## Acknowledgements

The need for having a standard curriculum for the Job Role based Qualification Packs under the National Skills Qualification Framework was felt necessary for achieving a uniform skill based training manual in the form of a Participant Handbook.

I would like to take the opportunity to thank everyone who contributed in developing this Handbook for the QP Solar Panel Installation Technician.

The Handbook is the result of tireless pursuit to develop an effective tool for imparting the Skill Based training in the most effective manner.

I would like to thank the team of KontentEdge for their support to develop the content, the SME and the team at the ESSCI along with the industry partners for the tireless effort in bringing the Handbook in the current format.

CEO

Electronics Sector Skills Council of India

## About this Book

This Participant Handbook is designed to enable training for the specific Qualification Pack (QP). Each National Occupational (NOS) is covered across Unit/s.

Key Learning Objectives for the specific NOS mark the beginning of the Unit/s for that NOS.

- Measure voltage, current and power of solar photovoltaic modules
- Identify the components of solar photovoltaic system
- Identify types of solar photovoltaic systems
- Define solar cell parameters
- List the types of connections of solar photovoltaic panel
- List the types of PV modules and their characteristics
- Identify the batteries used in PV system
- Describe standard parameter of battery
- Recognize functions of a charge controller
- Recognize the roles of a solar panel installation technician
- Identify prerequisites for installing a solar PV system
- Construct the design of the solar PV system
- Analyse the size and calculation of the components
- Evaluate the location for installation
- List the types of charge controllers
- Explain work ethics
- Interact with supervisor
- Interact with colleagues
- Evaluate the practices of working in a team
- Implement quality and safety procedure
- Explain the meaning of health
- List common health issues
- Discuss tips to prevent common health issues
- Explain the meaning of hygiene
- Discuss the purpose of Swacch Bharat Abhiyan
- Explain the meaning of habit

The symbols used in this book are described below.

### Symbols Used



**Key Learning Outcomes**



**Steps**



**Time**



**Tips**



**Notes**



**Unit Objectives**

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# 1. Basics of Electricity and Solar Energy

Unit 1.1 – Basics of Electricity and Power Generation System

Unit 1.2 – Renewable Energy and Solar Energy System

Unit 1.3 – Solar Cells

Unit 1.4 – Photovoltaic (PV) Panels

Unit 1.5 – Electrical Power System



## Key learning Outcomes



At the end of this module, you will be able to:

1. Measure voltage, current and power of solar photovoltaic modules
2. Identify the components of solar photovoltaic system
3. Identify types of solar photovoltaic systems
4. Define solar cell parameters
5. List the types of connections of solar photovoltaic panels
6. Explain the main factors affecting the output of solar photovoltaic modules

## UNIT 1.1: Basics of Electricity and Power Generation System

### Unit Objectives



At the end of this unit, you will be able to:

1. Measure voltage, current, power and energy
2. Define Ohm's law
3. Explain the difference between alternating current (AC) and direct current (DC)
4. Identify the use of multimeter
5. Explain the power generation system



#### 1.1.1 Introduction to Electricity

Electricity is a natural force that comes into existence whenever there is a flow of electric charge between two components. When working with circuits, there is need for the users to be aware about some of the basic concepts of electricity, otherwise an incorrect connection in a circuit may cause high damage to people and the circuit components.

The main terms associated with electricity are as follows:

- Current
- Voltage
- Power
- Energy

#### Current

When electrons inside any material move, flow of electricity takes place. This flow is called current. It is measured in ampere.

#### Voltage

In an electrical circuit, the current flows only when there is a voltage source. Voltage is the force pushing electrons through the wire.

#### Power

When electricity flows in an electrical circuit, it results in some work done. For example, when electricity flows in a fan, the blades of the fan rotate and when the electricity flows in a refrigerator, it cools things inside. Thus, when electricity flows through an appliance, it results in some work done.

Electrical power is the rate at which an electric circuit transfers electrical energy. Electrical power is similar to mechanical power and can be considered as the rate at which electrical work is done. It is measured in watts (one joule per second) and represented as  $P$ . Electric power in watts is also called wattage. Consider the formula:

$$P = \text{work done per unit time} = VQ/t = VI$$

Where  $P$  is the electric power in watts determined when an electric current represented by  $I$  in amperes with a charge  $Q$  in coulombs passes through an electrical potential difference denoted by  $V$  in time  $t$  seconds.

Electric power is produced by electric generators in an electric power generation unit called a grid. This power is further supplied to residential and commercial location. It can also be produced by other sources such as electric batteries. The energy delivered and consumed by electric utilities is measured using an electricity meter.

### Energy

If the electrical power is the rate or speed of work done, then electrical energy is the total amount of work done in a given time period. It is product of power of electrical appliance and duration of its usage. Consider the following equation to determine electrical energy:

$$\text{Electrical Energy (E)} = \text{Power (P)} \times \text{Duration of Energy usage (T)} = \text{Power (Watt)} \times \text{Time (hour)}$$

$$E (\text{Wh}) = P (\text{W}) \times T (\text{h})$$

$$\text{Power} = \text{Energy} / \text{Time}$$



### 1.1.2 Ohm's Law

According to Ohm's law, current flowing through a conductor is directly proportional to the voltage across the conductor. The mathematical equation of Ohm's law is as follows:

$$I=V/R$$

Where,

$I$  is current flowing through the conductor,

$V$  is the potential difference or voltage across the conductor, and

$R$  is proportionality constant, known as the resistance of the conductor.

**Problem Statement:** A fan works on 24V DC and while running it takes 3A current. Calculate the DC power consumed by the fan?

**Solution:** The fan is a DC fan and the current flowing through the fan,  $I_{dc}$  is 3A. The voltage of the fan,  $V_{dc}$  is 24V. Then DC power consumed by the fan is:

$$P_{dc}=I_{dc} \times V_{dc}$$

$$P_{dc}= 3 \times 24= 72 \text{ watts}$$



### 1.1.3 Electrical Circuit

The interconnection of various electrical components is called electrical circuit. The basic components of a circuit are:

- Power source such as a battery
- Wire running from the hot side to a load
- Wire running from the load to the power source
- Switch to open or close the circuit

The load will operate when the circuit is closed or complete. The following figures show an open and a close circuit:

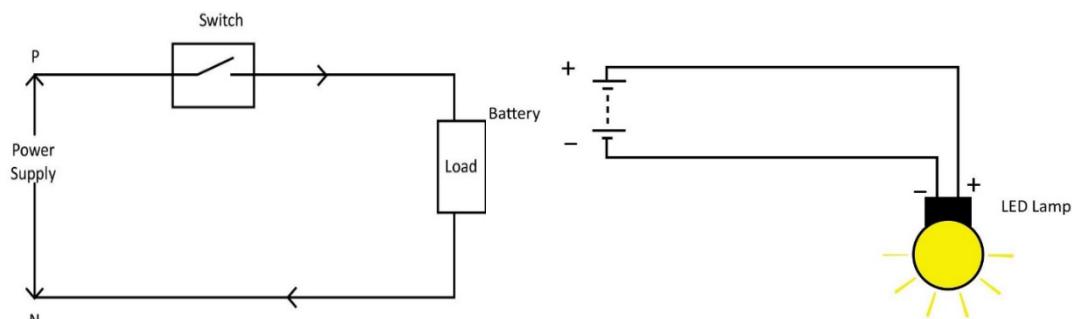


Fig. 1.1.1: An open and a close circuit

In an electrical circuit, power flows in two forms:

- DC power
- AC Power

#### DC Circuit and AC Circuit

DC power flows in a DC circuit. A DC circuit is a circuit in which current flows in only one direction. The direction of current does not change with time.

In AC circuit, current flows in both the directions; clockwise and counter clockwise. For time period 0 to  $T/2$  current flows in clock wise direction and for time period  $T/2$  to  $T$ , the charge flow reverses to counter clockwise direction. It is not only the direction but the value of current that keeps changing with time.

The AC current changes its direction 50 times in one second which means the power supply has 50 Hertz frequency. The following figure shows the voltage-time relationship between AC and DC:

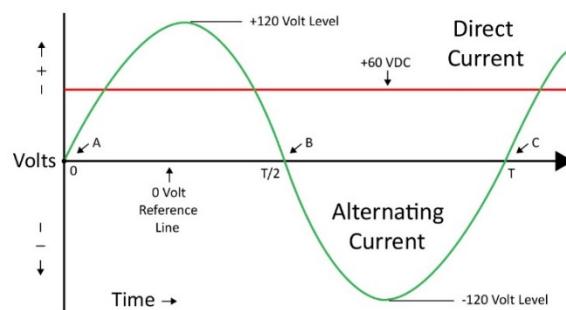


Fig. 1.1.2: Voltage-Time relationship for AC and DC

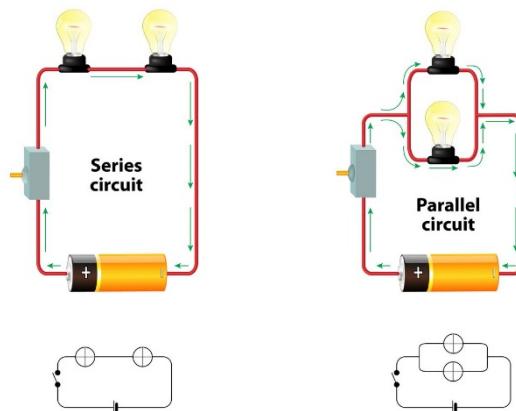
Most of the home appliances such as light bulbs and TV, fans operate on AC power at 220 volts. Solar panels and batteries produce DC power. Appliances such as DC CFL lights, DC LED lights and DC fans can run on DC power by connecting them to solar panels or batteries. These are incapable of running on AC power supplied from the national grid.

### **Series and Parallel Circuit**

Complex circuits, in which more than one load is connected, may be either in series or in parallel or a combination of both. The basic working of the circuits is explained as follows:

- In a series circuit, all the components are connected as a chain and the current flowing through the components is same all over the circuit. There is only one path in the circuit in which the current can flow. So, the current passes through each and every component. Opening or breaking any point of a series circuit causes the whole circuit to stop functioning and the entire circuit needs to be replaced.
- In a parallel circuit, two or more components are connected in parallel. All the components have the same voltage across them. The current flow varies across the components. If any point of the circuit gets damaged, only that part needs to be replaced.

The following figure shows a series and a parallel circuit:



*Fig. 1.1.3: Series and parallel circuits*

Typically circuit breakers and fuses are in series with the load and multiple loads are in parallel.

## **1.1.4 Measurement of Electrical Parameters**

There are many types of measuring tools available such as voltmeter, ammeter and multimeter, which can measure voltage, current, power and energy. Among these, one of the most versatile measuring tools is called multimeter.

### **Measurement Voltage, Current and Resistance**

A multimeter can be used for measuring voltage, current and resistance. It can also be used for fault detection in small circuits or to find out the broken wires in a circuit.

It can be of two types:

- Analog Multimeter
- Digital Multimeter

The following image shows the different types of multimeters:

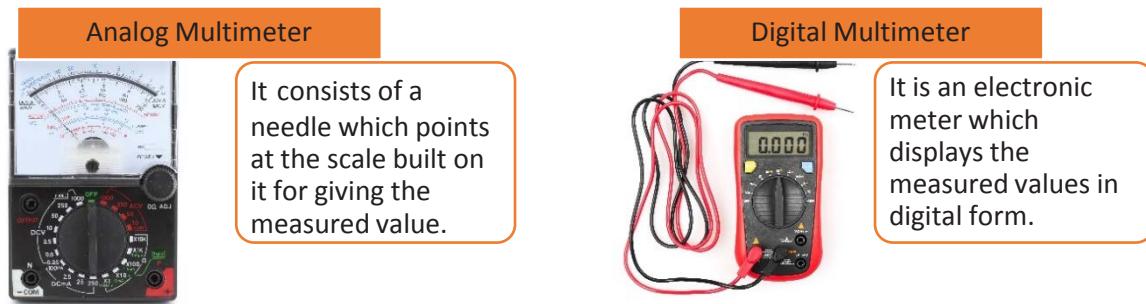


Fig. 1.1.4: Types of multimeters

Usually, a standard multimeter can measure the following electrical quantities:

- DC Voltage
- AC Voltage
- DC Current
- AC Current
- Resistance

#### Measurement of DC Voltage and Current

Voltage can be measured by directly connecting the voltage meter or the multimeter to the terminals of the voltage source. To measure the voltage using the multimeter, it should be used in voltmeter mode. The range selector knob of the meter should point towards the sign, volts or 'V'.

Current can be measured by connecting the current meter or the multimeter to the terminals of voltage source, provided the current is controlled by appropriate value of resistance or load in path. Multimeter should be in current mode to measure current. The range selector knob of the meter should point towards sign, amperes or 'A'.

Appropriate precaution should be taken to position the knob or the probe properly for:

- Expected range of voltage or current level
- AC or DC form
- Position of the red probe for AC or DC current measurement
- Position of the red probe for AC or DC voltage measurement

The following figure shows measurement of DC voltage using multimeter:

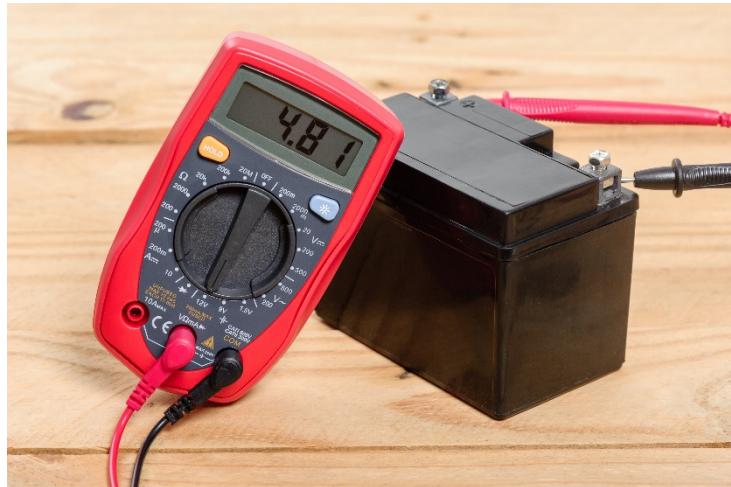


Fig. 1.1.5: Measurement of DC voltage

### Measurement of AC Voltage and Current

In principle, the procedure for measurement of both DC and AC, current and voltage are similar. For measurement of AC voltage by using a multimeter, it is essential to select the AC form ( $\sim$ ) with the range selector knob on the multimeter. It is also essential to check the position of the red probe, as it should be kept in voltage or current mode in the multimeter as per the measuring parameter.

The red and black probes are to be connected to phase and neutral points in the circuit, respectively. The following figure shows measurement of AC current using multimeter:



Fig. 1.1.6: Measurement of AC current

### Measurement of Resistance

Resistance measurement is an important part in the field of electricity. The flow of current in a circuit depends on its resistance. Thus, it is very important to know the value of resistance in a circuit.

For measurement of resistance using a multimeter, the range selector knob should be first placed on the 'Resistance' mode or Ohms mode, which is normally shown on a multimeter with  $\Omega$  symbol.

The following figure shows measurement of resistance using a multimeter:



Fig. 1.1.7: Measurement of resistance

### Measurement of Electrical Power

Current and voltage can be measured by using an ammeter and a voltmeter respectively. The output power in an electric circuit can be measured using the formula:

$$\text{Power} = \text{Voltage} \times \text{Current}$$

### Measurement of Electrical Energy

Electrical energy is the power consumed by a load during a specified time period. The product of power and time gives the value of electrical energy consumed by the load in watt-hour.

The meters available for measurement of energy are called energy meter. As the unit of energy is watt-hour, the meters are also called watt-hour meter. The following image show a meter:



Fig. 1.1.8: Energy meter



## 1.1.5 Power Generation System

There are different processes, such as chemical, photo-voltaic, and electromechanical, with which energy is transformed into an electrical form to generate electrical power. This transformation or conversion process happens at a power station or a power plant. A power station has generators and a rotating machine that converts mechanical power into electric power.

Typically, electricity is generated using fossil fuels such as coal, oil, and natural gas. Nuclear power is also used to generate electricity but nowadays renewable source of energy are such as solar, wind, wave and hydroelectric are becoming popular choice. The fuel cost and the efficiency of the power station determines the operating costs of generating electrical energy.

The following image shows the electric power being generated at a plant and supplied to the customer or end user:

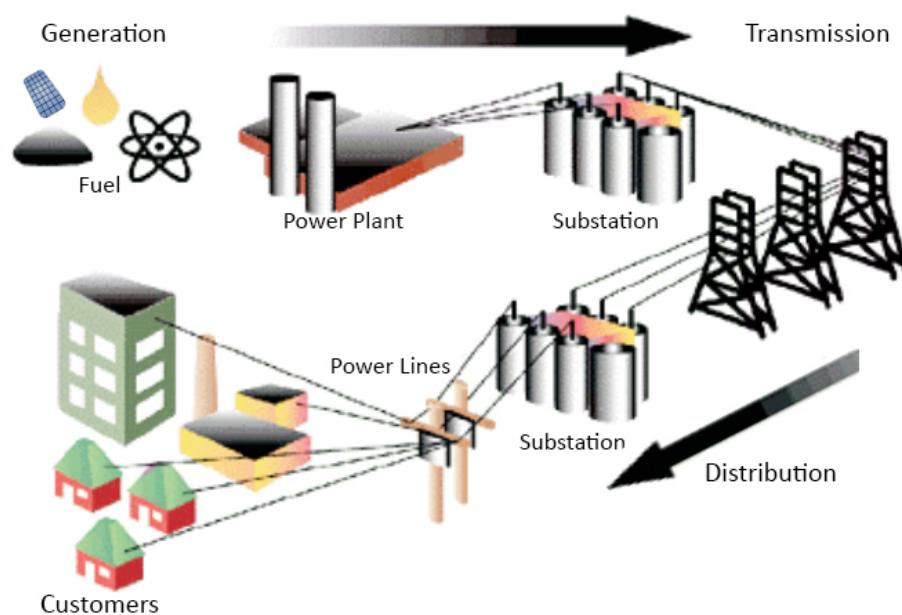


Fig. 1.1.9: Electric power supply from generating plant to end users

## Activity



1. Fill in the following table for various DC loads.

| Name of DC Load | Voltage across load<br>Vdc (Volts) | Current Through the Load,<br>Idc (Ampere) | Power Consumed by the<br>load, Pdc (Watt) |
|-----------------|------------------------------------|---|---|
| Fan             | 12                                 | 2.5                                       | -   |
| LED             | -                                  | 0.5                                       | 1.5                                       |
| TV              | -                                  | 3.3                                       | 80  |
| Refrigerator    | 48                                 | -   | 500                                       |
| Motor           | 36                                 | -   | 746                                       |

2. Fill the following table on estimation of electrical energy consumed by electrical appliances.

| Type of appliance | Power of the<br>appliance | Daily duration of usage<br>of appliance | Electrical energy<br>consumed |
|-------------------|---------------------------|---|-------------------------------|
| Tube Light        | 40 W                      | 4 hours                                 | = ..... Wh                    |
| Tube Light        | 40 W                      | ..... hours                             | = 400 Wh                      |
| Fan 1             | 60 W                      | 12 hours                                | = ..... Wh                    |
| Fan 2             | 30 W                      | 12 hours                                | = ..... kWh                   |
| TV                | 150 W                     | 2 hours                                 | = ..... Wh                    |
| Cooler            | 200 W                     | 10 hours                                | = ..... kWh                   |
| Computer          | ..... W                   | 2 hours                                 | = 400 Wh                      |
| LED Light         | 5 W                       | ..... hours                             | = 20 Wh                       |
| AC                | 1.5 kW                    | 10 hours                                | = ..... kWh                   |
| AC                | 1.5 kW                    | ..... hours                             | = ..... 7.5kWh                |
| Unknown Appliance | ..... W                   | 10 hours                                | = 500Wh                       |
| Unknown Appliance | ..... W                   | 5 hours                                 | =10 kWh                       |

## Activity



Solve the following problems.

**Problem 1.0:** What does electric power depend on? An electrical appliance is connected to 48V which results in 3A current through the load. What is the power consumed by the load?

**Problem 2.0:** For a 75W lamp, a voltage of 220V is applied. What is the value of the resultant current?

**Problem 3.0:** An electrical bulb consumes energy at the rate of 40 W per hour and is used for 12 hours. What is the energy consumed by the bulb?

**Problem 4.0:** Consider two bulbs, A and B with same power of 100 W. Bulb A is used for 12 hours and Bulb B is used for 25 hours. Which bulb will consume more energy? Assuming utilities charges of Rs. 6, what would be the cost of electricity consumed by the bulbs?

## UNIT 1.2: Renewable Energy and Solar Energy System

### Unit Objectives



At the end of this unit, you will be able to:

1. Identify renewable energy sources
2. Define the fundamentals of solar energy
3. Explain the basic working of a solar energy system
4. List the advantages and disadvantages of solar energy system

In this modern world, energy has become an integral part of everyone's daily life. Energy is required in one form or the other. This energy to be used must come from somewhere. Normally, the energy to be used is supplied in the form of diesel, petrol, coal, LPG, CNG and electricity.

In India, people do not get sufficient amount of energy. There is a huge shortage of energy supply. There are around 5, 90,000 villages in India and 700 million people live in rural India. Most households in rural India do not get sufficient electricity, which hinders the growth of rural India both at the social and economic front. There is either lack of sufficient infrastructure to supply energy to all or sufficient fuel is not available at a reasonable cost. Therefore, there are efforts to use infinite or renewable energy sources.



### 1.2.1 Renewable Energy

The renewable or natural energy sources are continuously produced by natural processes and forces occurring in the environment. These energy sources are also available in a distributed manner around everyone, which means that the required energy can be generated where there is a need. The following figure shows some renewable energy sources:



Wind Energy

Transforming kinetic energy of wind into electricity



Solar Energy

Converting solar radiation into electrical energy



Hydro Energy

Converting energy of water flow into electricity



Biomass Energy

Transforming plant materials into energy

Fig. 1.2.1: Sources of renewable energy

These sources are available in variable form or available occasionally in cycles and can be harnessed during their specific cycle. For instance, solar radiation energy is available in day-night cycle. Any amount of solar energy can be harnessed without affecting the availability of solar energy for the next day, and therefore, it is termed renewable energy source.

Similarly, wind energy and hydro energy are renewable energy sources and can be harnessed in any amount and cannot be depleted. If the balance is made between consumption of biomass energy and growth of biomass, then biomass energy can also be considered as renewable energy.

### Solar Energy

The sun is the main, natural source of energy on Earth. The energy received from the sun by the earth is in the form of electromagnetic radiations. Then, this energy gets converted into various forms of renewable energy. On reaching the earth, some of the energy from the solar radiations:

- Is reflected back
- Gets absorbed in the atmosphere
- Reaches earth surface without any conversion
- Is converted into wind energy and biomass energy
- Is used in water evaporation, thus causing rain, and is available in the form of hydro energy

The amount of energy from the sun that reaches Earth is very large as compared to what is being produced from fossil fuels. In 2013, the annual energy consumption from all possible sources including electricity, coal, gas, diesel, petrol and biomass was 567 Exa joules or 157,481 TWh and total electricity consumption was 70 Exa joules or 19,504 TWh. The availability of total solar energy source is 3,850,000 Exa joules, which is many thousand times more than is consumed annually.

### TIP



Exa joule = 1000,000,000,000,000,000 joules

1 Joule= 1 Ws (watt-second)

1Wh = 3600 Ws= 3600 J

1kWh = 3600KJ = 3600,000 J

| Power Unit | Equivalent Unit     |
|------------|---------------------|
| 1 Watt     | 1 joule-second = 1W |
| 1 kilowatt | 1000 watt or 1000 W |
| 1Megawatt  | 1,000,000 W         |
| 1Gigawatt  | 1,000,000,000 W     |

Fig. 1.2.2: power unit and equivalent unit



## 1.2.2 Solar Energy System

India is blessed with a large amount of sunlight. Solar radiation is received in a range of 4 to 7 kWh/m<sup>2</sup> /day. Such amount of radiation is good enough to generate electricity to fulfil electricity requirement of an entire region using this technology. Importantly, the energy can be generated in any area, where there is a need, by installing the solar energy system.

The solar power system works as follows:

- The solar radiation hits the solar cells and gets transformed into DC energy.
- The DC energy is converted to AC energy with the help of an inverter.
- The generated AC electricity is identical to the power that is provided by the utility companies. The AC electricity can be supplied to gadgets such as computers and lights directly.
- The generated electricity can also be transmitted to the national electricity grid and from there may be supplied all over the country.

The following image shows the conversion of solar energy into electricity:



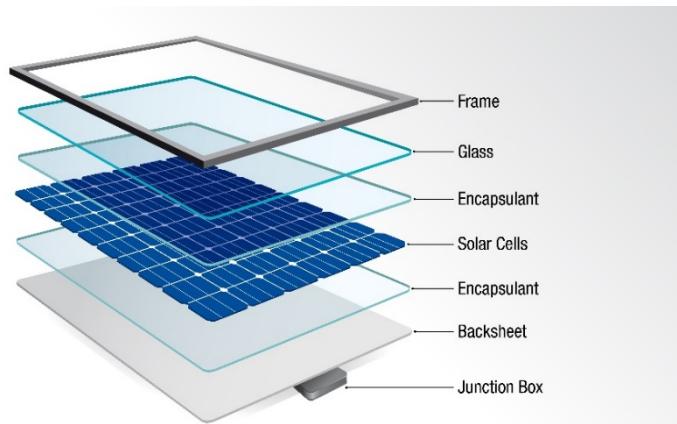
*Fig. 1.2.3: Basic solar energy conversion process*

A solar energy system or a PV system is a power setup devised to supply the available solar power in the form of electricity. In this system, a solar panel is the main component. It is constructed in such a manner that it absorbs the sunlight as an energy source and uses it to supply electricity or provide heating.

Solar panel has to be placed in the sun to generate electricity. It is very simple to use but it is very expensive. The basic unit of a solar panel is called a solar cell or PV cell. It is made of silicon which is also used in computer chips. Though there is greater availability of silicon, but solar cells are manufactured in a clean environment leading to high production cost.

A PV cell is made from two types of silicon, monocrystalline and polycrystalline. When these two silicons receive solar energy, they develop a voltage difference across themselves. Current flows when this cell is connected to an electric circuit. So, the solar panels in the solar power comprise of solar PV cells fitted into a frame. The cells are made from two kinds of silicon, which are monocrystalline and polycrystalline.

A PV system can be said to be comprised of several PV modules. A PV module is a packaged collection of generally  $6 \times 10$  PV cells, connected. It forms the PV display of a PV system that produces and provides solar energy to applications in both residential and commercial areas. The rating of the modules is done as per their DC output under STC. The range of this output is generally from 100 to 365 watts. Several PV cells are connected to form a PV module, then encapsulated in a glass frame which is mounted according to the requirement. The produce a defined voltage, the cells are wired in series or parallel in a module. For example, a 12V panel produce around 16V in sun shine hours and charge a 12V battery. The following image shows the parts of a solar panel:



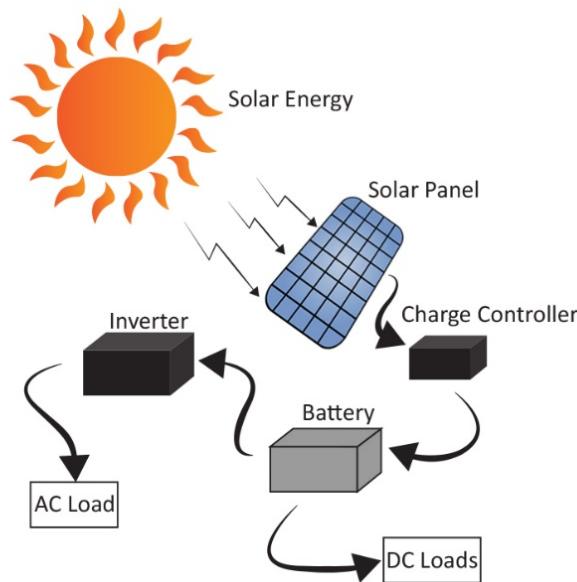
*Fig. 1.2.4: Parts of a solar panel*

Solar PV modules are the most important part of the system. They are also called the power generators of the system. In addition to PV modules, a PV system also includes various other parts. The following figure shows the other parts of a solar PV system:

|                     |   |
|---------------------|---|
| Batteries           | For those PV systems which are required to operate at night or during the absence of sunlight, storage of energy is important. Batteries are used to store electricity.   |
| Charge Controller   | The PV module output depends on the intensity of sunlight and the temperature of the cell. Charge controllers or regulators are the components which control the DC output and deliver that to the grid, batteries, and/or loads and ensures smooth operation of the PV system. |
| Inverter            | For applications that are run by AC power, the DC/AC inverters are required to be installed in PV systems.  |
| Mounting Structures | They are required to fix the PV modules and to ensure that the modules are directed towards the sun.  |
| Load                | The household appliances and equipment that require to be powered by the PV solar system are called load.   |

*Fig. 1.2.5: Parts of a solar PV system*

The following image shows different components of a solar energy system:



*Fig. 1.2.6: Components of a solar energy system*



### 1.2.3 Types of Solar Energy Systems

A solar energy or solar PV system can be of several types depending on the way the energy is generated and used.

PV systems could be a simple PV module and load, for example, in the case of a water pump motor where the usage of water pump may be restricted just to sun shine hours when solar energy is available. It can be a complex system to power a residential building or a house where the power requirement is in the day as well as in the night when there is no solar energy. This kind of system may require a back-up generator, run AC/DC loads, and even store power.

Based on the system configuration, PV systems are classified as:



*Fig. 1.2.7: Main types of PV systems*

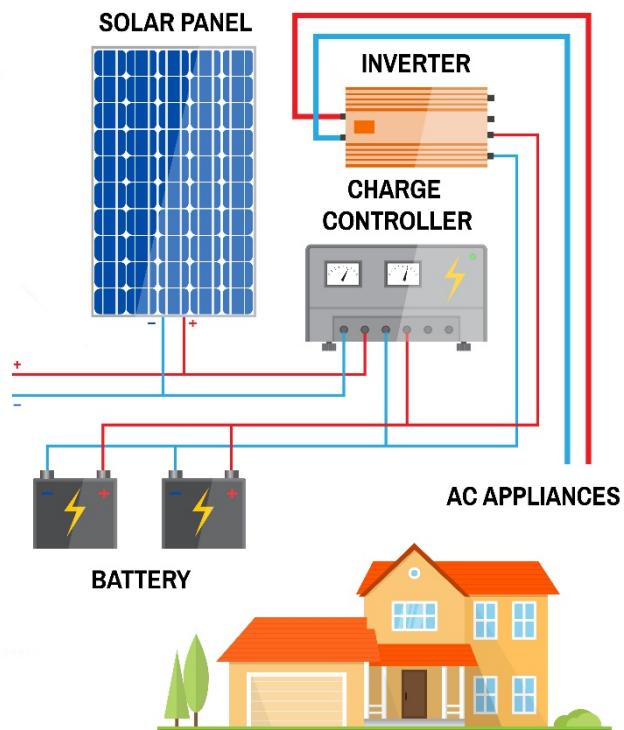
The basic principle behind PV systems remain same but different types of systems provide energy solution for different requirements.

#### Standalone Solar PV System

These systems are self-sufficient. They are independent of any other source of energy to supply electricity to appliances or load. Since the standalone solar PV systems are independent of any other energy source, they invariably use some means to store energy, typically in the form of batteries. Since batteries are used, it is important to use electronic devices such as a charge controller to protect

them. Also, for conversion of DC electricity from PV modules and battery into AC electricity, an inverter must be used.

The examples of standalone solar PV systems include solar lantern, solar PV home lighting system and solar PV water pumping system. The following figure shows a standalone solar PV system:



*Fig. 1.2.8: Stand-alone solar PV system*

### Grid-connected Solar PV System

In this type of PV system, the system is connected with a nearby, available electricity grid. In this way, the generated electricity is fed into the grid. No battery storage is used in this case. However, conversion of DC electricity into AC electricity is required before feeding to the grid.

A typical arrangement of grid-connected solar PV system is shown in the following image:

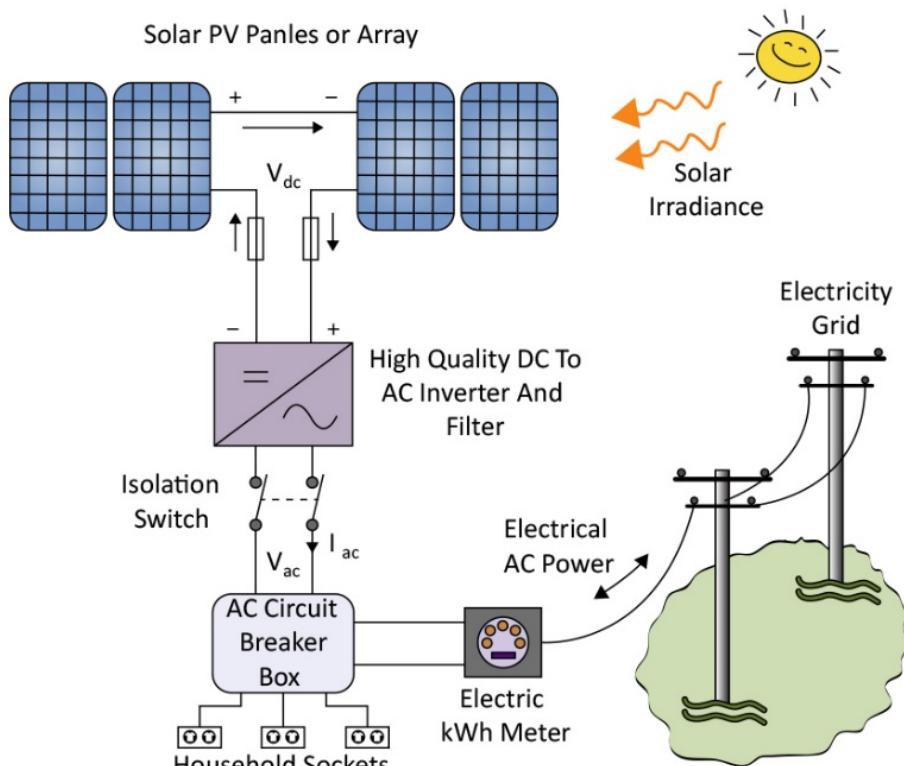


Fig. 1.2.9: Grid-connected solar PV system

Electricity grid voltage and frequency are well defined and, therefore, the PV electricity can be fed to electricity grid only after proper power conditioning, that is converting PV generated electricity to appropriate voltage and frequency level.

Therefore, in grid-connected solar PV system, the inverter not only performs the function of DC to AC conversion but also performs the function of grid synchronization, which is related to adjusting the generated PV energy to appropriate voltage and frequency level. This type of PV system is used in India for large scale solar PV power plants.

## Hybrid Solar PV System

In some cases, an auxiliary source of energy such as a diesel generator is used in addition to solar PV modules and/or grid. This needs to be done when solar PV modules are not designed to supply the full energy required by the load (may be due to cost reason). In such cases, auxiliary source of solar PV systems are used, called as hybrid solar PV system.

The following figure shows a hybrid solar PV system:

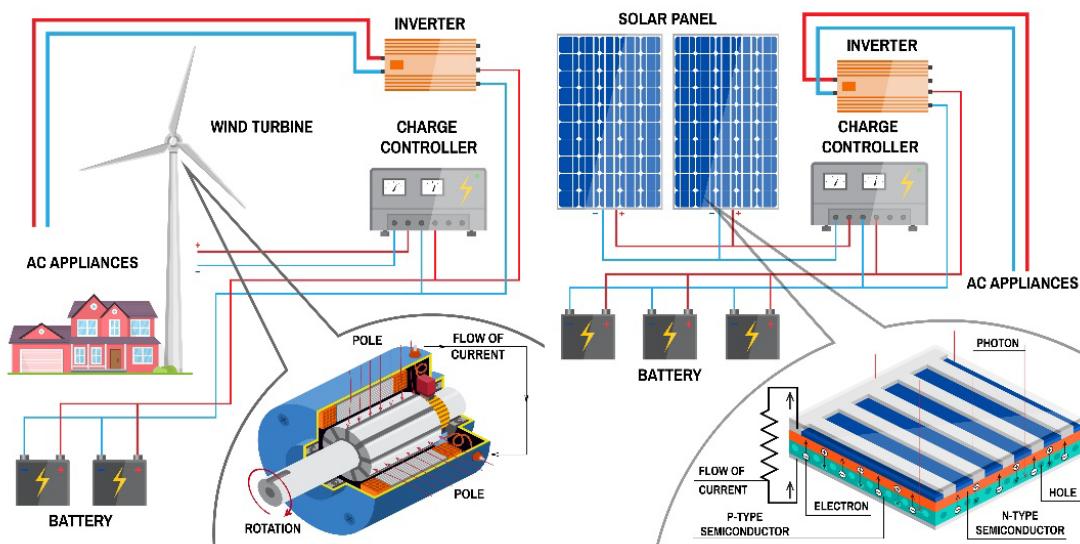


Fig. 1.2.10: Hybrid solar PV system

## 1.2.4 Advantages and Disadvantages of Solar Energy System

The following figure shows the advantages and disadvantages of solar energy system:



| Advantages  | Disadvantages   |
|---|---|
| <ul style="list-style-type: none"> <li>● It is clean and non-polluting.</li> <li>● It is renewable energy.</li> <li>● Solar cells do not produce noise and are totally silent.</li> <li>● They require very little maintenance.</li> <li>● They are long lasting sources of energy which can be used almost anywhere.</li> <li>● They have long life time.</li> <li>● There is no fuel cost or fuel supply problems.</li> </ul> | <ul style="list-style-type: none"> <li>● Solar power cannot be obtained in night time.</li> <li>● Solar cells (or) solar panels are very expensive.</li> <li>● Energy has to be stored in batteries.</li> <li>● Air pollution and weather can affect the production of electricity.</li> <li>● They need large area of land to produce efficient power supply.</li> </ul> |

Fig. 1.2.11: Advantages and disadvantages of solar energy system

# -Activity



### **Answer the following questions.**

1. List two renewable energy sources.
  2. Mention three demerits of solar energy system.
  3. Draw a flow diagram for solar energy conversion process.

## UNIT 1.3: Solar Cells

### Unit Objectives



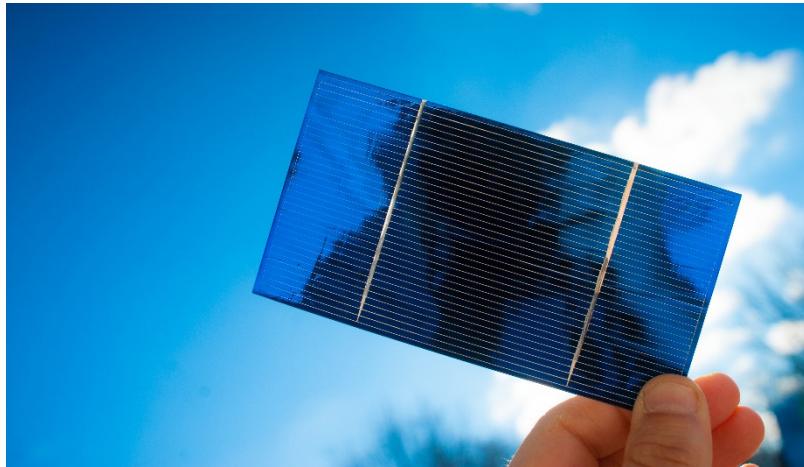
At the end of this unit, you will be able to:

5. Describe how solar cells generate electricity
6. List the parameters of solar cells
7. Explain solar cell technologies
8. Identify the factors affecting electricity generated by a solar cell



#### 1.3.1 Solar Cell

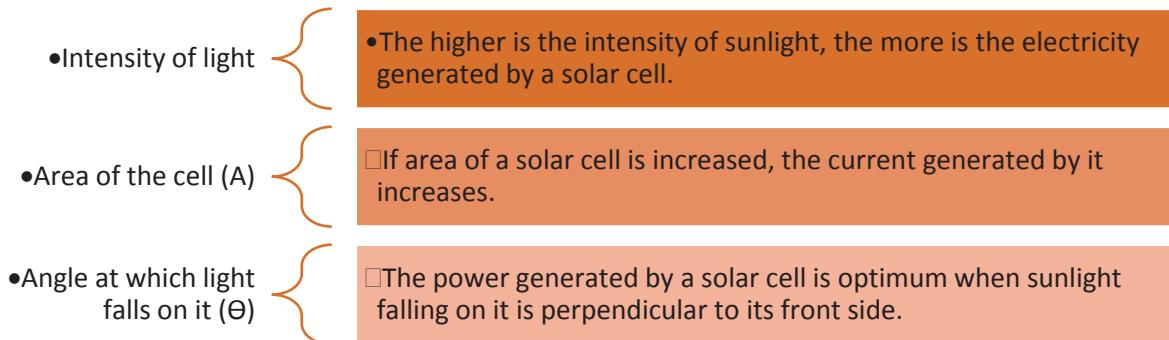
Solar cell is a semiconductor device which directly converts sunlight into electricity by photovoltaic effect. Hence, they are also called photovoltaic cell. The following image shows a typical silicon solar cell:



*Fig. 1.3.1: Solar cell*

Solar cell is the basic block of solar photovoltaic technology. It is a device that directly converts sunlight into electricity without any other intermediate conversion step. Input to solar cells is energy in the form of solar radiation and output from the solar cells is energy in the form of electricity.

The electricity generated by a solar cell depends upon some factors as listed in the following figure:



*Fig. 1.3.2: Factors affecting electricity generated by a solar panel*

Besides these factors, conversion efficiency ( $\eta$ ), amount of light ( $P_{in}$ ) and operating temperature ( $T$ ) also effect the electricity generation.

### Parameters of Solar Cell:

A solar cell converts sunlight into electricity. There are several parameters of solar cells that determine the effectiveness of conversion of sunlight into electricity. The list of these parameters is as follows:

|  |   |
|--|---|
| Short circuit current ( $I_{sc}$ )       | It is the maximum current that can be produced by a solar cell without affecting its construction. The higher the $I_{sc}$ , better is the cell. It is measured in ampere (A) or milli-ampere (mA). The value of this maximum current depends on the cell technology, cell area, amount of solar radiation failing on the cell, angle of cell and so on.  |
| Open circuit voltage ( $V_{oc}$ )        | It is the maximum voltage that can be produced by a solar cell when there is no load connected to it. The higher the $V_{oc}$ , the better is the cell. It is measured in volts (V) or sometimes in milli-volts (mV).   |
| Maximum power point ( $P_m$ )            | It is the maximum power that a solar cell produces under the STC. The higher the $P_m$ , the better is the cell. It is given in terms of watt (W). A solar cell can operate at many current and voltage combinations. But it will produce maximum power only when operating at certain current and voltage. This maximum power point is denoted as $P_m$ . Typically, the maximum power point for a I-V curve of solar cells occurs at the 'knee' or 'bend' of the curve. |
|  | $P_m \text{ or } P_{max} = I_m \times V_m$  |
| Current at maximum power point ( $I_m$ ) | This is the current which solar cell will produce when operating at maximum power point. The $I_m$ will always be lower than $I_{sc}$ . It is given in terms of ampere (A) or milli-ampere (mA).  |
| Voltage at maximum power point ( $V_m$ ) | This is the voltage which solar cell will produce when operating at maximum power point. The $V_m$ will always be lower than $V_{oc}$ . It is given in terms of volt (V) or milli-volt (mV).  |
| Fill factor (FF)                         | FF is the ratio of the areas covered by $I_m$ - $V_m$ rectangle to the area covered by $I_{sc}$ - $V_{oc}$ rectangle whose equation is given below. Typical FF values range from 0.5 to 0.82.   |
|  | $\begin{aligned} FF &= I_m \times V_m / I_{sc} \times V_{oc} \\ FF &= P_m / I_{sc} \times V_{oc} \end{aligned}$   |
| Efficiency ( $\eta$ )                    | It is defined as the maximum output power ( $P_m$ or $P_{max}$ ) divided by the input power ( $P_{in}$ ). The efficiency of a cell is given in terms of percentage (%), which means that the given percentage of input radiation power is converted into electrical power.  |
|  | $\eta = P_m / P_{in}$   |

Fig. 1.3.3: Parameters of solar cell

The following graph shows solar cell I-V curve based on the parameters explained:

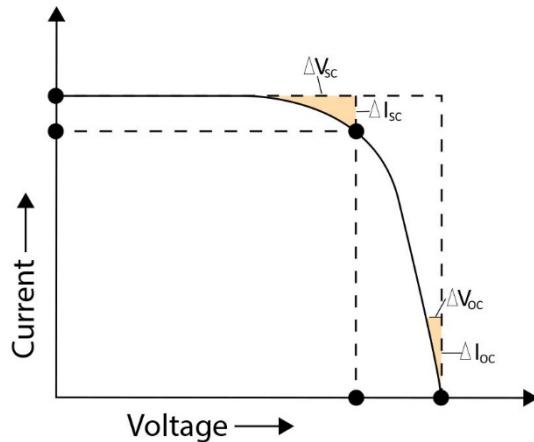


Fig. 1.3.4: Solar cell I-V curve

### 1.3.2 Solar Cell Technologies

The solar cell technology is named after the material used. The materials used in solar cells have different properties. Hence, different types of solar cells have different values for parameters such as efficiency, short circuit current density, fill factor (FF) and open circuit voltage. The following table lists commercial cell technologies, materials and efficiency:

| Commercial Solar Cells Technology, Material and Efficiency |  |  |                            |
|--|--|--|----------------------------|
| Solar photovoltaic technology                              | Solar cell type  | Material Used  | Efficiency (?) in per cent |
| Crystalline Silicon (c-Si) solar cell                      | Mono-crystalline silicon<br>Poly or multicrystalline Si (mc-Si)                          | Mono-crystalline silicon<br>Multi-crystalline silicon                              | 14-16<br>14-16             |
| Thin film solar cell                                       | Amorphous Si (a-Si)<br>Cadmium telluride (CdTe)<br>Copper-Indium-Gallium-Selenide (CIGS) | Amorphous silicon<br>Cadmium and tellurium<br>Copper, Indium,<br>Gallium, Selenium | 6-9<br>8-11<br>8-11        |
| Multi-junction solar cell                                  | GaInP/GaAs/Ge Gallium indium phosphide/Gallium arsenide/<br>Germanium                    | Gallium (Ga), Arsenic (Ar), Indium (In), Phosphorus (P), Germanium (Ge)            | 30-35                      |

Fig. 1.3.5: commercial cell technologies, materials and efficiency

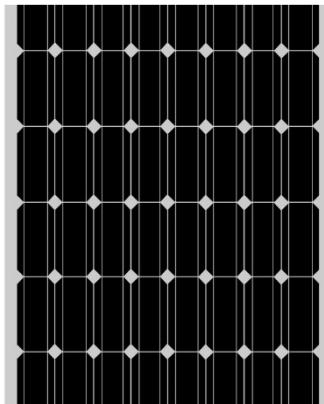
The following table lists commonly available commercial solar cells along with  $\eta$ , area (A), maximum current density ( $J_{sc}$ ),  $V_{oc}$  and FF:

| Typical Solar Cell Parameters of Commercial Solar Cells with Available Cell Areas |                |                                     |  |  |                         |
|---|----------------|-------------------------------------|--|--|-------------------------|
| Solar Cell Type   | Efficiency (?) | Cell area (A) (in cm <sup>2</sup> ) | Output voltage (V <sub>oc</sub> ) (in V) | Output current (J <sub>sc</sub> ) (in mA/cm <sup>2</sup> ) | Fill factor (FF) (in %) |
| Mono-crystalline silicon  | 14-17 %        | 5-156                               | 0.55-0.68                                | 30-38  | 70-78                   |
| multi-crystalline silicon   | 14-16 %        | 5-156                               | 0.55-0.65                                | 30-35  | 70-76                   |
| Amorphous silicon   | 6-9 %          | 5-200                               | 0.70-1.1                                 | 8 – 015  | 60-70                   |
| Cadmium telluride   | 8-11 %         | 5-200                               | 0.80-1.0                                 | 15-25  | 60-70                   |
| Copper-indium-Gallium-Selenide  | 8-11 %         | 5-200                               | 0.50-0.7                                 | 20-30  | 60-70                   |
| Gallium indium Phosphide / Gallium arsenide/Germanium                             | 30-35 %        | 1-4 cm <sup>2</sup>                 | 1.0-2.5                                  | 15-35  | 70-85                   |

Fig. 1.3.5: Commercial solar cells

In the market, a wide variety of solar cells are available. These cells are made by using different materials such as mono crystalline, poly crystalline and non-crystalline.

The following figure shows different types of solar cells:



Monocrystalline cells contain pure silicon that are in cylindrical shape.

To lower the cost and optimize the performance of a monocrystalline cell, four sides of the cylinder are cut out to make silicon wafers. It provides the monocrystalline solar panels their appearance.

These cells can be easily recognized from their uniform look and even, coloured external surface because of high-purity silicon contents.

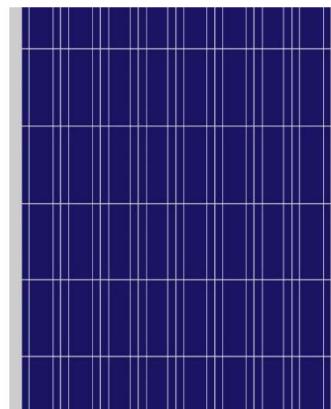
These cells are highly efficient and must be mounted in a rigid frame to ensure protection.

Polycrystalline (or Multi-crystalline) cells are comprised of several small crystals called crystallite.

The raw silicon is melted and kept in square mould. Then, it is cooled and sliced to make square wafers.

Polycrystalline solar panels are of rectangular shape without having any rounded edges.

These cells are less efficient and less expensive than mono crystalline cells but like the latter, require to be mounted in a rigid frame.



Amorphous cells are formed by placing a thin film of non crystalline (amorphous) silicon onto a wide range of surfaces. Due to the amorphous nature, these are flexible.

Amorphous silicon cells usually have low efficiency but are eco-friendly as they do not utilize harmful heavy metals such as cadmium or lead.

The power output of amorphous cells reduces over time, specially during the first few months, after that they are generally stable. The specified output of the amorphous cells should be one that is generated after the stabilization stage.

Fig. 1.3.6: Different types of solar cells

## Activity



Answer the following questions.

1. The current density of a solar cell having an area of  $100 \text{ cm}^2$  at STC is given as  $35 \text{ mA/cm}^2$ . Find the output current of a solar cell.
2. A solar cell having an area of  $100 \text{ cm}^2$  gives  $3.1 \text{ A}$  current at maximum power point and  $0.5 \text{ V}$  at maximum power point at STC. The cell gives  $3.5 \text{ A}$  short circuit current and  $0.6 \text{ V}$  open circuit voltage. What is the maximum power point of the solar cell? Also, find out the efficiency of solar cell.
3. Calculate the output power from a solar cell if its efficiency (in %) is 30, 24, 19, 16 and 12, input power density is  $1000 \text{ W/m}^2$ , and area of the solar cell is  $100 \text{ cm}^2$ .
4. Mention the basic difference between monocrystalline and polycrystalline solar cell.

## UNIT 1.4: Photovoltaic (PV) Panels

### Unit Objectives



At the end of this unit, you will be able to:

9. Identify the working process of PV panels
10. Describe the solar panel array configurations
11. Identify the factors affecting generation of electricity of a solar PV module
12. Describe the function of blocking diode and bypass diode

### 1.4.1 How PV Panel Works?

A solar panel consists of several solar cells assembled together for converting solar energy into electricity. A solar cell is a two-terminal power generating device in which one is positive terminal and the other is negative terminal. Solar cells are comprised of silicon which is a semi-conductor (it has properties of both metals and an electrical insulator.) The following image shows the cross section of a solar panel:

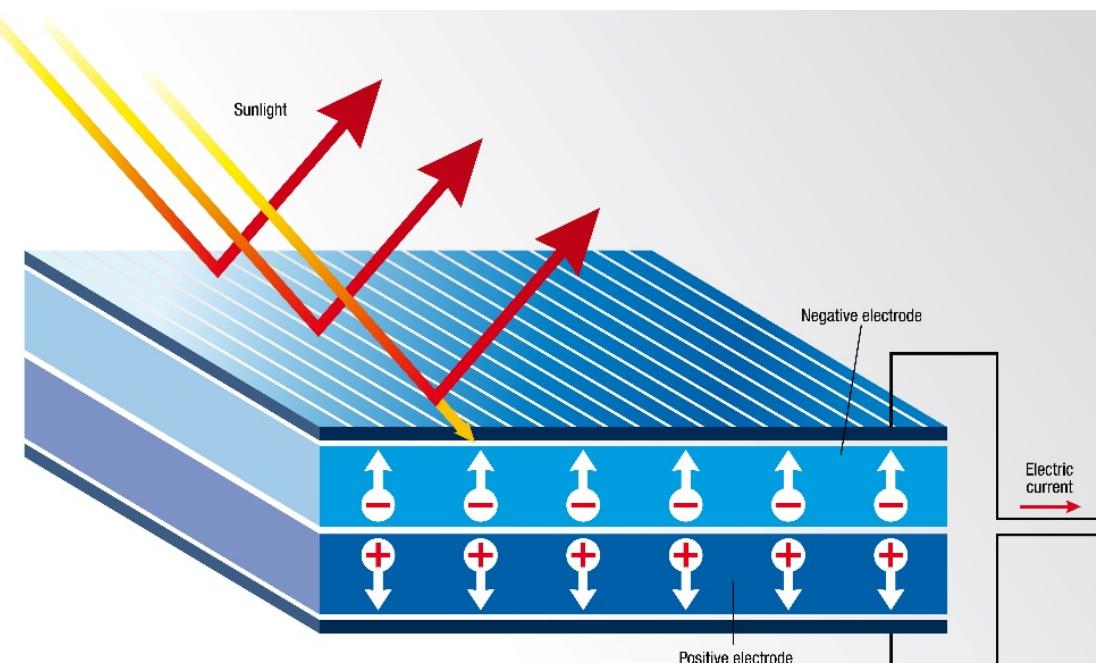


Fig. 1.4.1: Cross section of a solar panel

The solar panel works on the principle of photoelectric effect, the emission of electrons from a material when it is exposed to light. The working of a solar panel is explained as follows:

Sunlight is made up of minute particles known as photons which are emitted from the sun.

When they strike the silicon atoms of a solar cell, their energy is transferred to the loose electrons, dislodging them from the atoms.

The photons are similar to the white ball in a pool game, which transfers its energy to the coloured balls it hits.

After freeing the electrons, a solar cell needs to direct these free electrons into electric current.

An electric imbalance has to be created inside the cell.

This will serve as a slant, down which the electrons can move in the same direction.

This imbalance is brought about with the help of the internal composition of silicon.

The silicon atoms are tightly packed together.

When little quantity of some other element is put into this structure, two kinds of silicon are formed: n-type having spare electrons and p-type having holes due to missing electrons.

When these two types of silicon are placed adjacent to each other within a solar cell, the spare electrons from the n-type silicon cross over to occupy the space in the p-type silicon.

An electric field is created inside the cell as the n-type silicon gets a positive charge and the p-type silicon gets a negative charge.

This imbalance is maintained by silicon as being a semiconductor, it can do the work of an insulator.

When the photons from the sunlight knock off the electrons from the silicon atoms, the electric field makes them flow in a systematic manner.

This produces electric current which is used to operate appliances, satellites and various other objects.

*Fig. 1.4.2: Working of solar panel*

## 1.4.2 Panel Construction

A solar panel used for electricity generation in rural areas consists of several solar cells. The solar cells may be of round, square or some other shape. Irrespective of the size of solar cell, they produce half a volt. The size of a cell determines the amount of amperes that the cell can produce. Thus, larger the cell more amperes it can produce.

A cell has a limitation of producing half a volt and hence, many cells are assembled in a series connection to produce enough voltage for charging a 12 V battery. This requires 30 to 36 cells on a panel to ensure that voltage requirement of 12 V is accomplished.

Similarly, panels in tropical area should have at least 33 cells as less than that is not sufficient to charge a 12 V battery in such areas. Panels with 34 to 36 cells, or higher, are optimum in tropical area but are expensive.

### 1.4.3 PV Solar Panels Array Configurations

Sometimes, the power requirement is more than the power that a single solar PV panel can produce. For increasing the power generation, panels are connected in any one of the three ways:

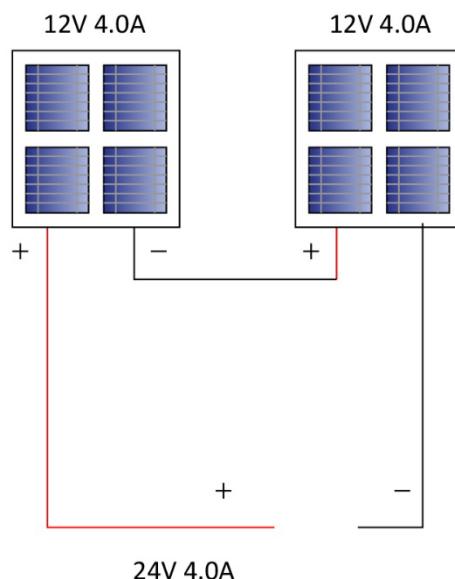
- Series connections
- Parallel connections
- Series-parallel connections

#### Series-Connected Panels

In case the requirement for voltage is more than that a panel can produce, then extra panels are connected in series. Hence, for example, if a panel can provide 12 V, then two such panels in a series connection can provide 24 V. Similarly, three panels of 12 V each, connected in series will provide a total of 36 V.

The amperes provided by the solar in a series connection remains the same as that provided by a single panel since the same electricity flows through all the panels. In other words, every panel raises the electrical pressure but the flow remains the identical as that of a single panel. Since the power in watts is equal to the volts time's amperes, therefore, the power increases with the number of panels.

The following figure shows the solar cells connected in series:



*Fig. 1.4.3: Solar cells - series connection*

In case the PV panels connected in series are of different voltage and current (ampereage), then the total voltage is calculated by totalling their individual voltages. However, the minimum ampere capacity will be the criteria for the current available at maximum.

In a series connection, if a panel can produce 2A and another panel in series can produce 3A, then the result is a current of a little over 2A from the combined panels. Therefore, to get maximum current in series-connected panels which are of different ampere capacity, then the ampere ratings of the panels should match. Moreover, since amperes are affected by the size of the PV cells, it should be ensured that panels in a series connection should be of the same size.

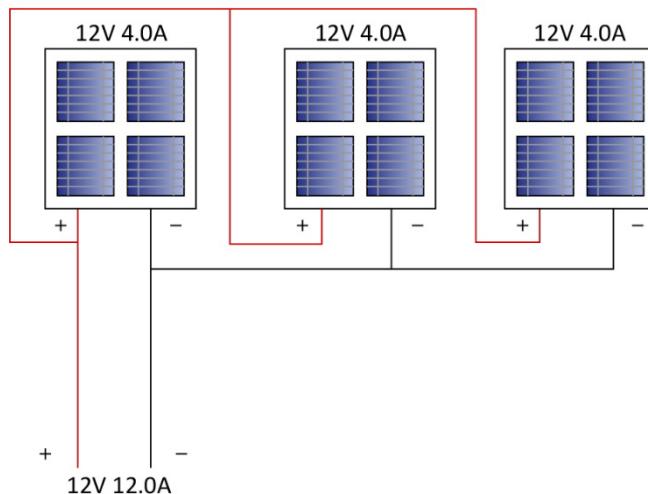
### Parallel-Connected Panels

Panels are connected in parallel, when a single panel produce sufficient voltage but not enough current. If one panel generates 2A in bright sunlight, two panels in parallel will generate 4A. For each of the 2A panels that are connected in parallel, an extra 2A current will be generated in bright sunlight. With panels that are in parallel connection, the voltage remains same as that of a single panel but the ampereage increases with every additional panel connected in parallel.

#### TIP

Two panels in parallel produce the same power as two panels in series, but the voltage and ampereage are different.

The following figure shows solar cells connected in parallel:



*Fig. 1.4.4: Solar cells - parallel connection*

If PV panels having different voltage and current levels are connected in parallel, their currents must be totalled similar to that when panels with same characteristics are connected in parallel. Hence, if one panel generates 3A and the other 2A, a total of 5A will be produced.

However, the available voltage from the panels connected parallel at maximum power will be limited by the smaller voltage of the two panels. If a panel with output 16V is connected in parallel with the one with output of 17V, it results in a voltage a little greater than 16V. Thus, for getting the most out of the parallel-connected panels, the panels should have identical characteristics of voltage and same number of cells.

### **Series-Parallel Connections**

Solar PV systems that power large appliances such as refrigerators, generally use a 24V battery in place of a 12V battery. Some appliances even use 48V batteries. Since solar panels are usually designed to charge 12V batteries, two panels are required to be connected in series to charge a 24V battery and four panels need to be connected in series for providing charge to a 48V battery. If amperes more than one panel can produce are required, the panels should be connected in parallel as well. The combination of series and parallel connections may be extended to:

- As high a voltage as needed by adding more panels in series.
- As high amperage as needed by adding more panels in parallel.

There are many ways of connecting a large number of panels to get the desired voltage and current. The following figure lists two ways of making series-parallel connection:

Connect the panels in series until the desired voltage is reached and then connect more sets of panels that are connected in series, in parallel until the amperage is reached.

Connect panels in parallel to get the desired amperes, then connect more sets of panels that are connected parallelly, in series to get the voltage required.

*Fig. 1.4.5: Two ways of making a series-parallel connection*

### **1.4.4 Blocking Diode and Bypass Diode**

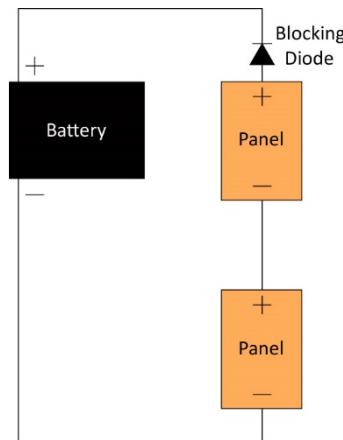
A diode is a specialized electronic component with two terminals known as the anode and the cathode. It has asymmetric conductance, which means that it conducts mainly in one direction. It has very less resistance, ideally zero, to the flow of current in one direction whereas it has high resistance, ideally infinite, in the other direction. Diodes are usually made up of semiconductor materials such as germanium, silicon or selenium.

Diodes may have same characteristics, but their functionalities depend on the way they are used. The diodes which play important roles in the functioning of solar panels are:

- Blocking diode
- Bypass diode

## Blocking Diodes

The following diagram shows a simple setup, with two panels wired in series charging a battery (for simplicity no controller is shown) and a blocking diode connected in series with the two panels:

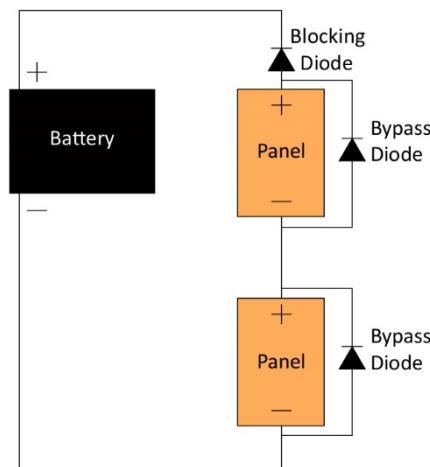


*Fig. 1.4.6: Blocking Diode*

During sunshine hours, battery is charged as long as the voltage generated by the two solar panels is greater than the specified voltage of the battery. However, in the absence of sunshine, while no voltage is being generated by the panels, a flow of current is caused through the panels by the voltage of the battery in the opposite direction. This would result in the discharge of the battery, if there is no blocking diode in the circuit. Blocking diodes are useful for a system that uses solar panels for charging the battery. They are generally used in the construction of solar panels.

## By-Pass Diodes

If one of the solar panels in the preceding diagram is shaded, the panel will not be able to produce significant power and it will also possess a high resistance which will block the flow of power generated by the un-shaded panel. The following diagram shows working of by-pass diodes:



*Fig. 1.4.7: By-pass diode*

In this case, when one panel is shaded, the current generated by the un-shaded panel will flow through the by-pass diode so that it can avoid the high resistance of the shaded panel. If the panels are not connected in series that will allow production of high voltage, by-pass diodes will not be of any use. They are most efficient whereas string inverter or a maximum power point tracking (MPPT) controller involves series connected panels for producing voltages that are greater than the minimum input voltage. Some solar panels are formed with cells grouped together, each group consisting of a built-in bypass diode. Shading of a panel may be caused by a branch of a tree, debris or snow.

### 1.4.5 Factors Affecting Electricity Output of PV Panels

The following figure lists the factors that affect output of PV panels:

- Effect of panel area {
  - The larger the solar panel, the more electricity is produced. If the amount of surface covered by the panels is made twice as large, the electricity output is also doubled.
- Effect of sun's brightness {
  - The more sunlight that falls on the panel, the more electricity is produced. If there is shade on it, the electricity output falls greatly.
- Effect of panel direction {
  - To get the most electricity from a solar panel, it must be facing the sun.
- Effect of heat {
  - Solar panels work best when kept cool. The hotter the panel, the less power it provides.
- Mounting of Panels {
  - Because solar panels are constantly exposed to wind and weather, it is important that their mounting is secure and resistant to corrosion or loosening.
  - Mounting panels on a roof is usually cheaper than mounting them on a pole. But if the roof is shaded or facing the wrong way, a pole must be used.

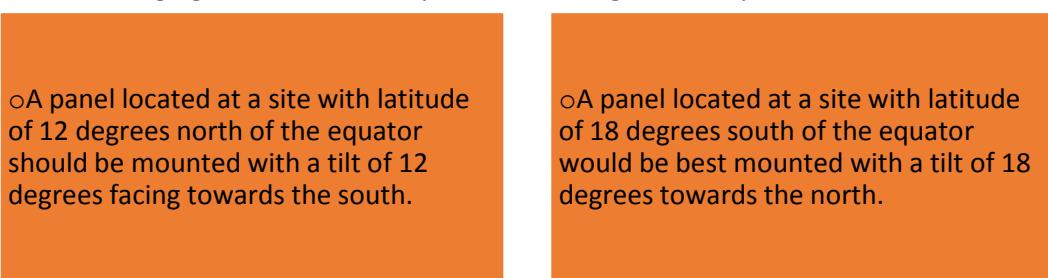
*Fig. 1.4.8: Factors affecting output of PV panels*

## 1.4.6 Getting Maximum Electricity from a Panel

It is always preferred to get as much electricity as possible from the PV panels as they are expensive. To get maximum electricity:

- **Ensure that the panels receive the brightest sunlight**
  - Even if a small part of a solar panel is shaded, it loses most of its electricity output. Hence, it is important that the panels are placed at such a location where the sunshine will be available on them for at least 6 hours (09:00 to 15:00).
  - It must be considered that over the year the position of the sun shifts from north to south as well as during the day from east to west.
  - The position of trees and buildings to the north and south of the panel must be considered to make sure that they will not cause any shade on the panels at any time of year.
- **Ensure that the panels are facing towards the sun**
  - The panels produce maximum electricity when they point towards the sun directly.
  - The movement of the panels is not practical in most of the places. If the panels are fixed in such a way that they face the direction where the brightest sun is located, then they produce maximum electricity.

The following figure lists two examples of mounting the solar panel:



*Fig. 1.4.9: Examples of mounting the solar panel at a particular latitude*

- A panel that is mounted on the equator is required to have a tilt of 5 degrees towards any direction. A small tilt (5 to 10 degrees) is always needed for allowing the rain wash off any dirt from the panel. In tropical regions where the latitude is 15 degree or less, high accuracy in pointing the panel towards the equator is not needed.
- At latitudes that are higher than 15 degrees, the panels are required to be pointed carefully towards the equator for receiving the maximum power output.
- **Ensure that the panel is kept as cool as possible**
  - As the solar panels are required to be in the bright sun, it is hard to prevent them from getting hot. Hence, they are mounted in such a way that the flow of air can reach to both sides of the panels.
  - The panels must not be mounted directly on the roof but at least at a gap of 10 cm above the roof, to allow air flow around the panels and cool them.

## Activity



Answer the following questions.

1. A solar PV string is rated for  $V_{mp} = 400\text{ V}$  and  $I_{mp} = 8\text{ A}$ . Design a series-parallel connected solar PV array to generate 16 kW DC power. What will be the DC output voltage and current on the array?
  
2. A Solar PV string is rated for  $V_{mp} = 460\text{ V}$  and  $I_{mp} = 100\text{ A}$ . Design a series-parallel connected solar PV array to generate 46 kW DC power. What will be the DC output voltage and current of the array?

## UNIT 1.5: Electrical Power System

### Unit Objectives



At the end of this unit, you will be able to:

13. Explain an electric grid
14. Identify the components of electrical power system
15. List the type of power system

Electrical power system is a system of various electrical components interconnected to generate, transfer and utilize electric power. If this system supplies power to homes and industries in a region of a considerable area, it is called as grid. The grid is divided into the following sections:

- Centralized generators that supply the power. These may be located far from highly populated areas and transmit large amount of electricity in to the transmission lines.
- Transmission lines that carries the high voltage electricity power from the generating stations to the substations.
- Substations where high voltage electricity is converted in to lower voltage electricity.
- Distribution lines that feeds the lower voltage electricity power to nearby homes and industries.
- Distributed generation which is located at or near the location of load. It can be connected to the distribution lines of the utility, or it can just provide power to a standalone load.

The following figure shows an electric grid:

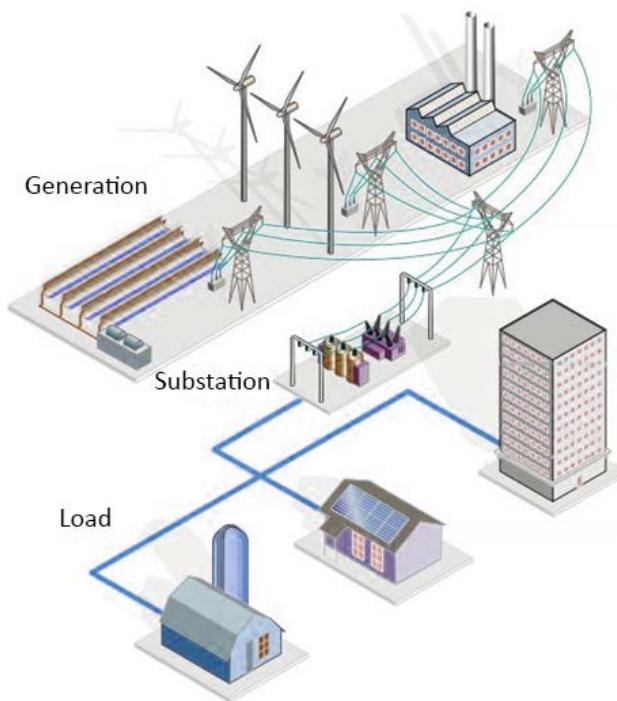


Fig. 1.5.1: An electric grid

Smaller electrical power systems are generally found in residential and commercial buildings, small industries, and hospitals. These systems usually rely on three-phase AC power which is considered as the standard for transmission and dissemination of large-scale power over the world. There are some specialized power systems which do not depend on three-phase AC power. These specialized power systems are used in aircrafts, electric rail systems and automobiles.

### **Components of Electrical Power System**

Several components together form a power system. The basic components of an electrical power system are:

- Supplies
- Loads
- Conductors
- Capacitors and reactors
- Power electronics
- Protective devices
- Supervisory Control and Data Acquisition (SCADA) systems

#### **Supplies**

The electrical power system may utilize one or more than one sources of power to generate electricity. DC power is mainly supplied by batteries, solar PV cells and fuel cells. AC power is usually supplied with the help of a turbo generator. There are several techniques used to spin the rotor of the turbine such as by means of falling water that is hydro power, with the help of steam heated using fossil fuel or nuclear energy, and using wind energy.

The phases of power generated by AC generators depends on how the electric poles are fed. Higher the number of phases, higher will be the efficiency of the power system. But it also leads to an increase in the infrastructure requirements for the system. An electricity grid connects a number of loads and generators operating at the similar number of phases (commonly three-phase) and frequency (commonly at 50 or 60 Hz).

#### **Loads**

Power systems are capable of supplying and transferring electricity to loads varying from any small household equipment to large industrial machines. Majority of the loads have a requirement of a certain voltage level.

For AC devices, with specific voltage, it is also important to consider the specified frequency level and the number of phases. For example, the home appliances, generally operates at single-phase power with frequency of 50 or 60 Hz and a specified voltage range of 110 - 260 volts.

Each device has a wattage specifying the quantity of power it expends at any instant of time.

Total quantity of power utilized by the loads connected to a power system = Quantity of power generated by the supplies – Quantity of power loss during the transmission.

## Conductors

Conductors are used to carry the power from the power generating stations to the load center. Conductors, in an electric grid may be categorized as a part of:

- The transmission system which allows high voltage power (generally more than 69 kV) of huge amount to be carried from the power stations to different load centers.
- The distribution system which carries low voltage power (usually less than 69 kV) of smaller amounts from the load centers to residential buildings and industry.

Few of the considerations on which the choice of conductors depends are cost, transmission losses and tensile strength of the metal.

## Capacitors and Reactors

Capacitors are usually put near inductive loads with the purpose to reduce the present demand of electricity on the power system. The reactors that consume the reactive power are used to control the voltage over long distance transmission lines.

## Note:

In an AC power system, most of the loads are inductive which means that the current is behind the voltage as the loads resist the changes in current. The difference in the phases of current and voltage results in the generation of reactive power.

Reactive power is an imaginary power that does not perform any measurable work but it is transmitted back and forth in every cycle, between the load and the source of reactive power. Reactive power may be supplied by adjusting the generator excitation. It is cheaper to provide it through capacitors.

## Power Electronics

Semi-conductor based devices that are used as power electronics components are able to switch the huge amount of power especially in the range of few hundred watts and several hundred megawatts. The power electronics is basically used for:

- Rectification
- Conversion of AC power to DC power

Hence, every digital equipment having an AC source that may be an adapter which plugs into the wall or any other component which is internal to the equipment is based on power electronics. It is also important for a power source which needs to produce an AC output but inherently produces a DC output. High-voltage Direct current (HVDC) is high-powered power electronics that is used in the conversion of AC to DC power over a long-distance transmission. HVDC systems are used by many industrial and residential photovoltaic installations.

## Protective Devices

Power systems are equipped with protective devices that helps to protect the system from any damage during power failures. A fuse is the most common protective device. If the amount of current passing through the fuse surpasses the threshold limit of the fuse, the material of the fuse melts and interrupts the circuit. There are few limitations with fuses, which are:

- Fuse cannot be reset, it can only be replaced
- Replacement of fuse at a remote site is inconvenient
- Unavailability of a spare fuse
- Fuse allows current flow so it may be hazardous for man

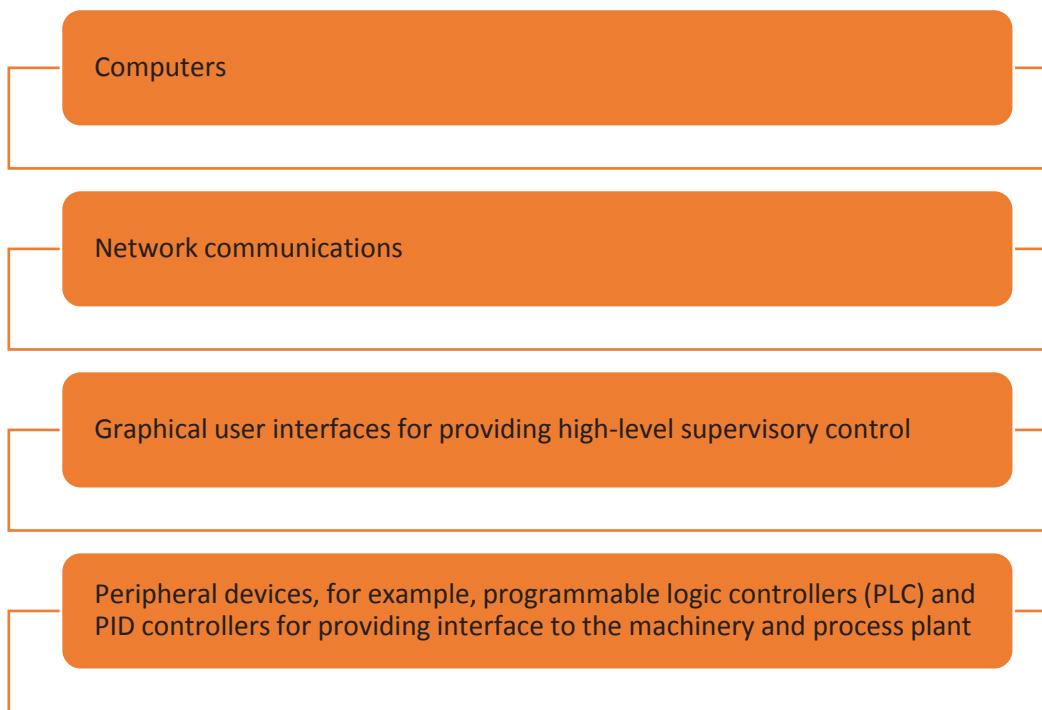
It is possible to reset the circuit breakers after they have interrupted current flow. Mini circuit breakers are used in modern systems using less than 10 kW. In higher powered systems, protective relays initiate a trip after detecting a fault.

## SCADA systems

SCADA stands for Supervisory Control and Data Acquisition. In large power applications, it is used to:

- Switch on the generators
- Control the generator output
- Switch in/out system elements for maintenance purpose

The following figure lists the components of a SCADA system:



*Fig. 1.5.2: Components of the SCADA system*

### Types of Power System

Though different power systems have common components, but they vary widely in their design and working procedure. The power system can be categorized as:

- Residential power systems
- Commercial power systems

The following figure shows the electric power systems:

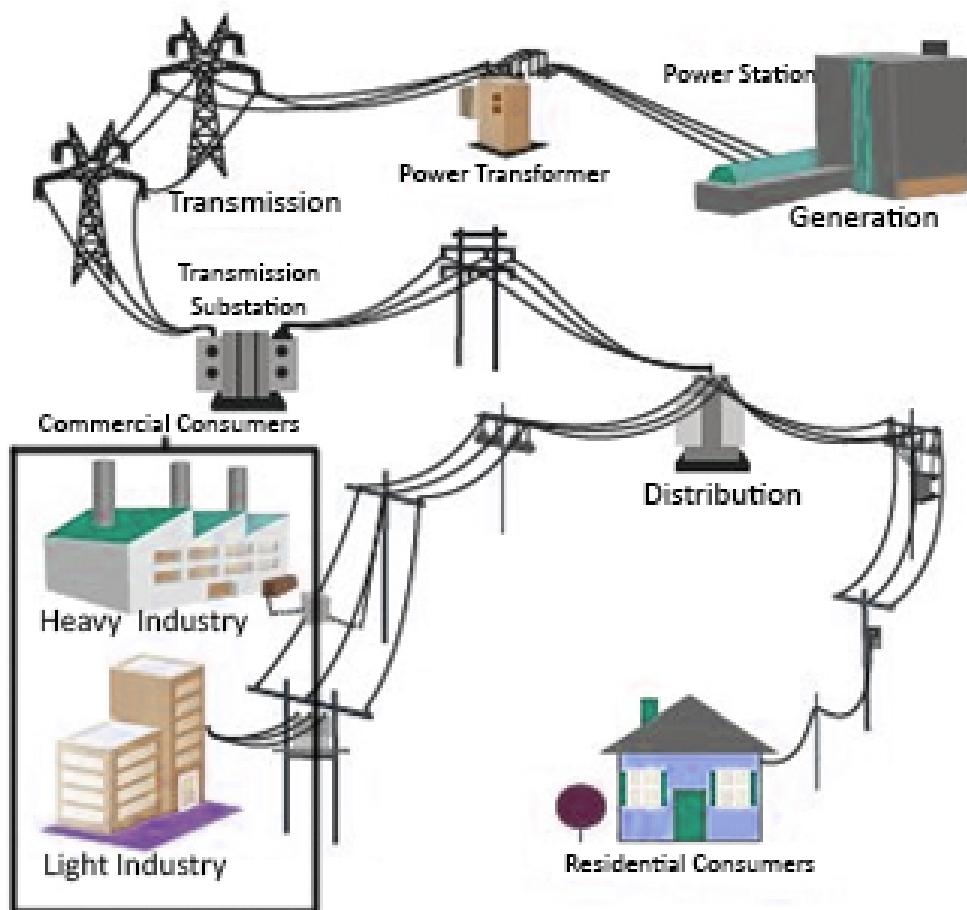


Fig. 1.5.3: Electric power systems

The following figure lists the characteristics of residential and commercial power system:

#### Residential Power Systems

- Receive electricity from the distribution lines having low voltage, that run past the dwelling.
- Operating voltage ranges between 110 and 260 volts.
- Majority of the residential wiring are of single phase with 120 Volts, consisting of positive, negative, and neutral wires.
- Some appliances, such as air conditioner, refrigerators, dryers and washers use a two phase circuit with 240 Volts.
- Residual current devices (RCDs) are installed, for safety reasons, on the appliance circuits as well as on the lighting circuits.
- Wiring is usually hidden from users within the walls and attic crawl spaces.
- Protective earths are run in combination with lighting circuits allowing the metallic lamp holders to be grounded.
- Incorporating microgenerators especially photovoltaic cells.

#### Commercial Power Systems

- High-rise buildings and shopping centers require power larger than residential systems.
- Large commercial installations require a well ordered system of sub-panels, which are separated from the main distribution board.
- Wiring uses a three-phase design and run through conduits or ceiling rafters where it is easily accessible to service. In three phase electrical systems, there are two smaller legs running 120 Volts each and wider leg running 208 Volts.
- Commercial wiring often has a higher level of insulation, known as TTHT (Thermoplastic, high-heat resistant, nylon coated) to protect the electrical wiring from corrosive gases and liquids.
- HVAC unit connected to it must be adequately supplied.

*Fig. 1.5.4: Residential and commercial power systems*





## 2. Components for Solar PV System

- Unit 2.1 – Solar PV Modules
- Unit 2.2 – Batteries in a PV System
- Unit 2.3 – Charge Controller
- Unit 2.4 – Inverters
- Unit 2.5 – Mounting Structures



## Key learning Outcomes



At the end of this module, you will be able to:

1. List the types of PV modules and their characteristics
2. Identify the batteries used in PV system
3. Describe standard parameter of battery
4. Recognize functions of a charge controller
5. List the types of charge controllers
6. List the types of inverters
7. Explain mounting structures

## UNIT 2.1: Solar PV Modules

### Unit Objectives



At the end of this unit, you will be able to:

1. Identify the characteristics of PV modules
2. Evaluate the rating of a PV module

### 2.1.1 Solar PV Modules

The basic component of a solar PV system, a solar cell, is able to generate a very small quantity of electricity as compared to the electricity needs. For example, single solar cell can generate daily electricity in the range of 6Wh to 10Wh while daily residential and commercial requirements are much higher. Also, a crystalline silicon solar cells with an area of  $10 \times 10$  square cm, can generate 1.5 Wattpeak ( $W_p$ ) output power approximately, with open circuit voltage ( $V_{oc}$ ) 0.6 V and short circuit current ( $I_{sc}$ ) 3.5 A approximately. Therefore, to generate more electricity, solar cells are connected in combination of series and parallel to form a PV module. The following image shows a solar PV module:

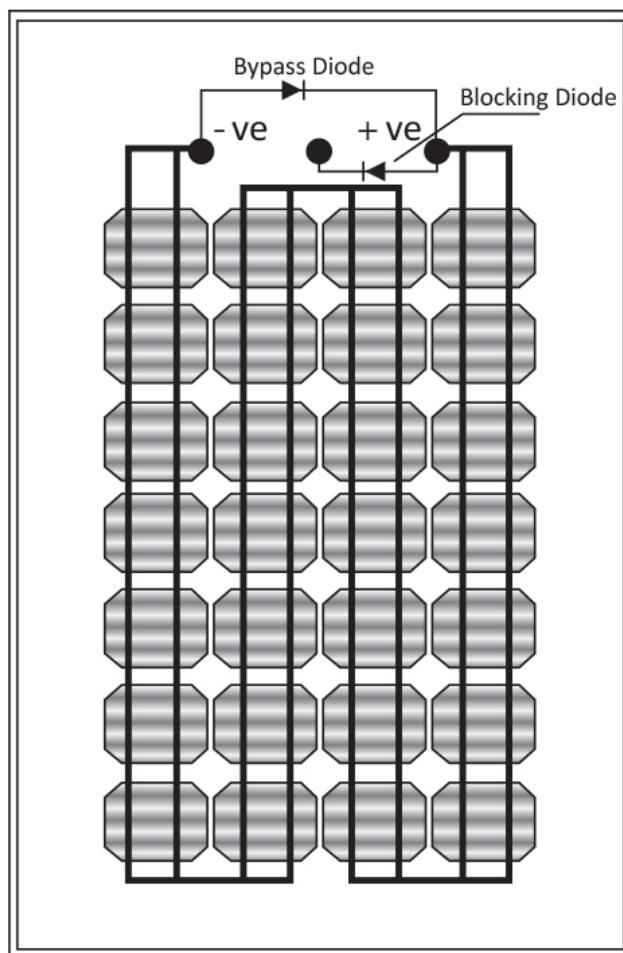


Fig 2.1.1: Solar PV module

The amount of the output current from a PV module is directly proportional to the solar irradiance. The output of solar PV module can be increased by connecting more solar cells in a parallel connection. The solar cell voltage primarily depends on its temperature not on the solar irradiance. PV modules, when formed by connecting the solar cells in series can operate at different voltages. The number of solar cells and the way they are connected in a PV module determines the current and voltage that the modules can provide, and the average energy they can produce every day. PV modules are very important part of PV systems.

**TIP**

Irradiance means the solar energy received per unit area in form of electromagnetic radiation.

### 2.1.2 Characteristics of Solar PV Modules

Like solar cells, the solar PV modules are named after the type of solar cells used in manufacturing them. The following figure lists some commonly available PV modules:

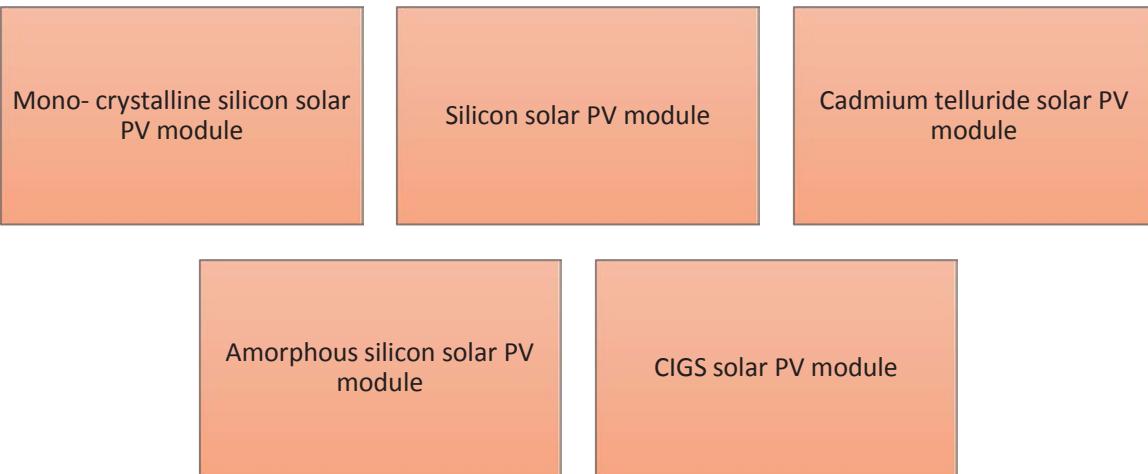


Fig. 2.1.2: Some commonly available PV modules

Mono-crystalline silicon solar PV module and multi-crystalline solar PV module are the most commonly manufactured and used PV modules.

The following table shows the efficiency of different PV modules:

| Module Type  | Efficiency                  |
|--|-----------------------------|
| Advanced crystalline silicon modules                                     | more than 18%               |
| Commercial modules of mono-crystalline silicon solar cells               | 12 to 16%                   |
| Modules of poly-crystalline silicon solar cells                          | 11% to 13%                  |
| Amorphous silicon modules  | between 4% and 8%           |
| Copper, Indium and Selenium (CIS) modules                                | 11%                         |
| Commercial CIS modules   | below 10%                   |
| Modules having gallium arsenide solar cells built for space applications | more than 20% and up to 30% |

Fig. 2.1.3: PV modules efficiency

The performance warranty of most of the crystalline silicon commercial modules is a minimum of 20 years. Depending on climate and region, the energy pay-back time ranges from 2 years to 6 years. Most amorphous silicon modules available in the market have a stable efficiency level ranging from 4- 8%. The estimated energy pay-back time of amorphous silicon modules is 1-3 years.

### TIP



$EPBT = E_{input}/E_{saved}$ , where

EPBT is energy pay-back time

$E_{input}$  specifies the amount of input energy for the life cycle of a module. It comprises of energy required for manufacturing and installing activities, energy required for module to operate and then finally to decommission it.

$E_{saved}$  is the annual saving of energy from the electricity produced by the PV module.

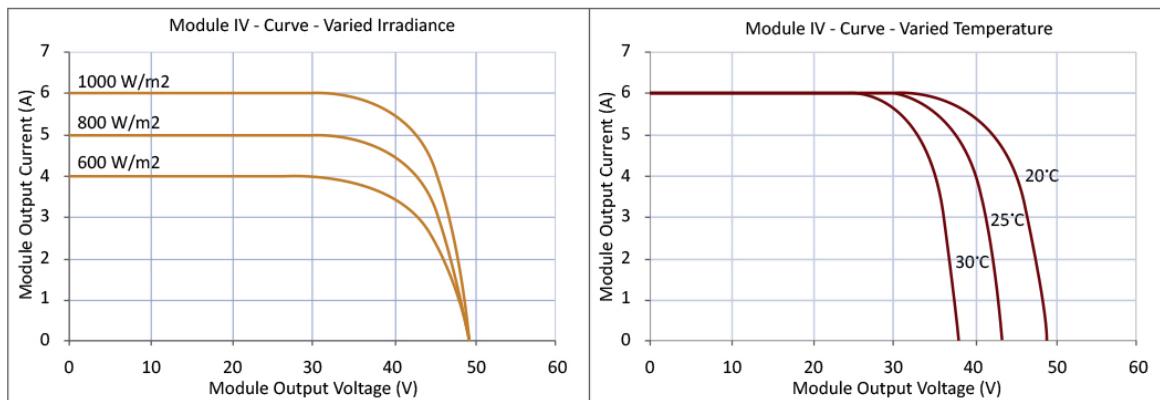
Some important features of PV modules are listed as follows:

- A solar cell converts radiation energy into electrical energy when sunlight falls on it. Since solar cell is the basic component of a PV module, it generates electricity only when sunlight falls on it. Thus, in absence of sunshine or at night, there is no output energy from a PV module.
- The amount of electricity which a PV module can generate, depends on its physical size. Large size of the module enables large amount of electricity generation.
- PV modules are mainly characterized in terms of their power rating, which is known as 'peak power' rating denoted by 'Wp'. The Wp rating is maximum power rating that a PV module can provide under best condition, called standard test condition. The PV modules are available in Wp rating starting from 1 Wp to 300 Wp.

**TIP**

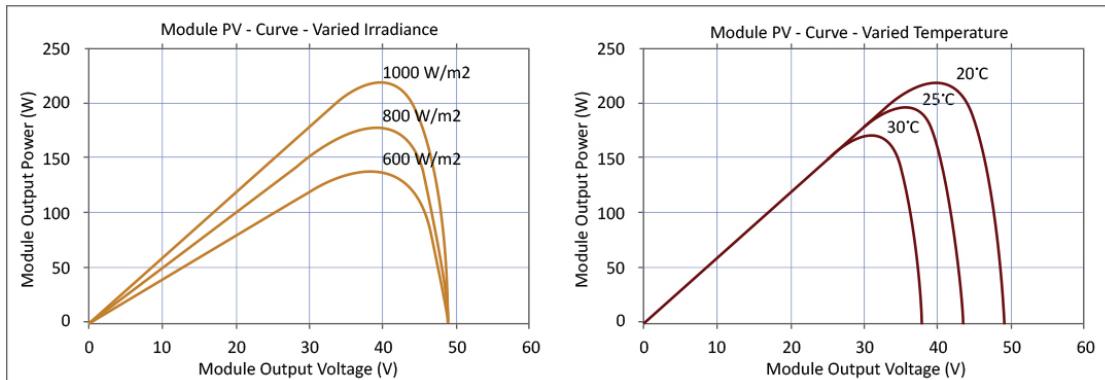
Commonly available Wp rating of PV modules are 3 Wp, 10 Wp, 18 Wp, 36 Wp, 50 Wp, 75 Wp, 150 Wp, 175 Wp, 220 Wp, and 300 Wp.

- Electricity generated from a PV module is DC in nature. The conventional electricity supply available is AC in nature. All the appliances such as TV, CFL, tube light, refrigerator, washing machine and so on run on AC. Therefore, if solar PV electricity has to be used, it must be first converted into AC. To convert DC electricity into AC electricity, an additional device called inverter is used.
- Since PV modules generate electricity only during day time, the batteries store electricity to be utilized by the load especially in the night for a seamless supply. Several devices such as LED bulbs, DC fans, DC water pumps and so on can directly be operated using DC electricity.
- Even other devices such as mobile phone, computer and refrigerator can also be run directly on DC. So, if we are using DC appliances, the use of inverter can be avoided. Also, the use of DC appliances is not very common.
- For large energy generation, many PV modules are connected. The interconnection of these modules is called PV module array.
- The I-V characteristics of a solar PV module is a graph in which different values of current (I) for different voltage (V) is plotted on Y-axis and X-axis respectively. A typical I-V characteristic curve of a solar PV module is shown in the following figure:



*Fig. 2.1.3: I-V curve of a solar PV module*

- A P-V curve is plotted between power of a solar PV module on Y-axis and voltage of a PV module on X-axis. The following figure shows a typical P-V curve of a solar PV module:



*Fig. 2.1.4: P-V curve of a solar PV module*

### 2.1.3 Rating of PV Modules

PV modules are rated by the manufacturers, generally at standard test conditions (STC). The STC rating for temperature is 25°C, irradiance is 1000W/m<sup>2</sup> and sunlight spectrum is AM [air mass] 1.5G[global]. The solar irradiation is corresponding to the condition when solar radiation travels 1.5 times the thickness of the earth's atmosphere. Therefore, this irradiation is called Air Mass 1.5. However, the real energy produced by PV modules installed in a field is a consequence of varied operating temperatures, sunlight spectra and irradiances. Hence, it is important to rate the PV modules after analysing them at diverse temperatures and irradiances.

The International Electrotechnical Commission (IEC) Technical Committee 82 Working Group 2(IEC/TC82/WG2) has framed one of the most pertinent PV standards. It is the IEC 61853 standard with the title Photovoltaic Module Performance Testing and Energy Rating (IEC, 2011).

It is comprised of four sections:

- 
- IEC 61853-1 It specifies the measurement of temperature and irradiance and power rating of a PV module. It specifies the need for assessing the performance of a PV module as per its power rating at different temperatures and irradiances.
- 
- IEC 61853-2 It specifies the measurement of the incidence angle, spectral response and the operating temperature. It specifies about the testing methods used for the measurement of the effect of changing angles of incidence and sunlight spectra. It also describes the estimation of the speed of wind, the temperature of the module from irradiance as well as the ambient temperature.
- 
- IEC 61853-3 It specifies the rating of energy level of PV modules. It specifies the calculations involved in this rating in watt-hours.
- 
- IEC 61853-4 It specifies the standard time span and weather conditions which are ideal for calculating the energy rating.
- 

*Fig. 2.1.5: IEC rating of PV module*

Electrical parameters are determined at STC. Rated specifications of a PV module are determined from the maximum power point (MPP) of the I-V curve of PV module. The PV modules are sealed to protect them against moisture, pollution, corrosion and weathering. In this way, the performance specifications of the modules can be guaranteed.

## Activity



1. Some PV Module Parameters are given in the following table. Fill in the blanks by estimating the other PV module parameters. Assume  $V_m = 0.85 \times V_{oc}$  and  $I_m = 0.93 \times I_{sc}$ . All the parameters are given at STC.

| <b><math>V_{oc}</math><br/>(Volts)</b> | <b><math>V_m</math><br/>(Volts)</b> | <b><math>I_{sc}</math><br/>(ampere)</b> | <b><math>I_m</math><br/>(ampere)</b> | <b>Cell area (cm<sup>2</sup>)</b> | <b><math>P_m</math>(watt)</b> |
|--|-------------------------------------|---|--------------------------------------|-----------------------------------|-------------------------------|
| 21                                     |                                     | 5.0                                     |                                      | 145                               |                               |
|  | 13.5                                | 2.0                                     |                                      | 55                                |                               |
|  | 14.5                                |   | 0.8                                  | 30                                |                               |
| 19                                     |                                     |   | 1.5                                  | 50                                |                               |
|  | 14.2                                |   | 3.2                                  | 100                               |                               |
|  | 15                                  | 5.7                                     |                                      | 160                               |                               |

2. Fill in the blanks in the following table for IV characteristics of solar panel.

| <b>Sr. No.</b> | <b>Current I (A)</b> | <b>Voltage, V (V)</b> | <b>Power, P (W)= I x V</b> |
|----------------|----------------------|-----------------------|----------------------------|
| 1              | 0.00                 | 0.58                  |                            |
| 2              | 0.01                 | 0.58                  |                            |
| 3              | 0.39                 |                       | 0.22                       |
| 4              | 0.79                 | 0.57                  |                            |
| 5              | 1.19                 | 0.56                  |                            |
| 6              |                      | 0.55                  | 0.88                       |
| 7              | 1.99                 | 0.54                  |                            |
| 8              | 2.39                 | 0.53                  |                            |
| 9              | 2.79                 |                       | 1.47                       |
| 10             | 3.19                 | 0.51                  |                            |
| 11             |                      | 0.46                  | 1.65                       |

## UNIT 2.2: Batteries in a PV System

### Unit Objectives



At the end of this unit, you will be able to:

1. Define the function of batteries in a PV module
2. List the types of batteries
3. Perform the installation of a battery
4. Explain battery maintenance

### 2.2.1 Introduction to Batteries

Batteries, an electrical storage medium, are integral part of a standalone solar PV system. The battery stores electricity generated which can be used later. They are important because without energy storage, a solar PV system will not be able to deliver the energy to the load when there is no sunlight. In case of a standalone system, electrical energy for running appliances in non-sunshine hours is needed whereas in a grid-connected PV system, energy storage is not required. In other words, it supplies electricity at night or in absence of sunlight when the solar panel is not able to produce electricity or power.

The battery is an expensive component and has a shortest life among the PV system components. The battery gets damaged when maintained poorly or not used properly. A typical battery used in the PV system is shown in the following figure:

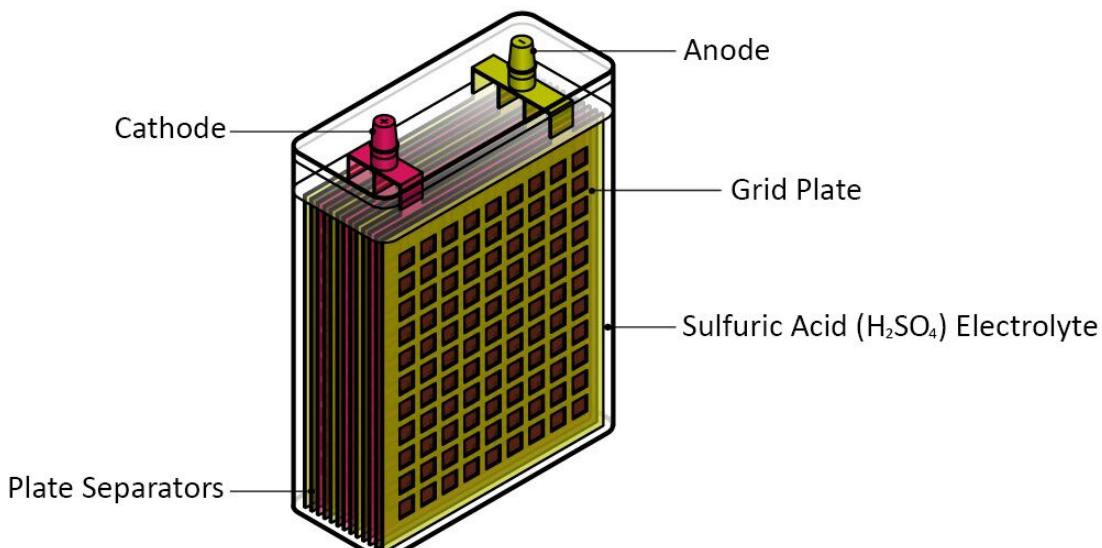


Fig. 2.2.1. Batteries

## 2.2.2 Components of Batteries

The components of a battery are listed in the following figure:

### Anode

- It is generally referred as positive terminal, positive node or positive lead.
- It is the electrode which gives up electrons to the external circuit, as a result of which the electrode is oxidized during the discharging reaction.

### Cathode

- It is generally referred as negative terminal or negative node.
- It is the electrode which gains electrons from the external circuit, as a result of which the electrode is reduced during the discharging reaction.

### Electrolyte

- It is a medium which provides conductivity to ions between anode and cathode. One can say that an electrolyte is a medium through which current flows internally in a battery.
- An electrolyte is typically a liquid, such as water or other solvents which can dissolve salts, acids or alkalis.

### Salt bridge

- It is a porous material used to keep the two electrodes connected but yet separated from each other; otherwise the chemical reaction would stop.
- It is also referred as separator.

Fig. 2.2.2: Components of a battery

## 2.2.3 Types of Batteries

There are variety of batteries available in the market for different types of applications. Each battery type is more suited for one type of application.

The following figure shows the classification of batteries:

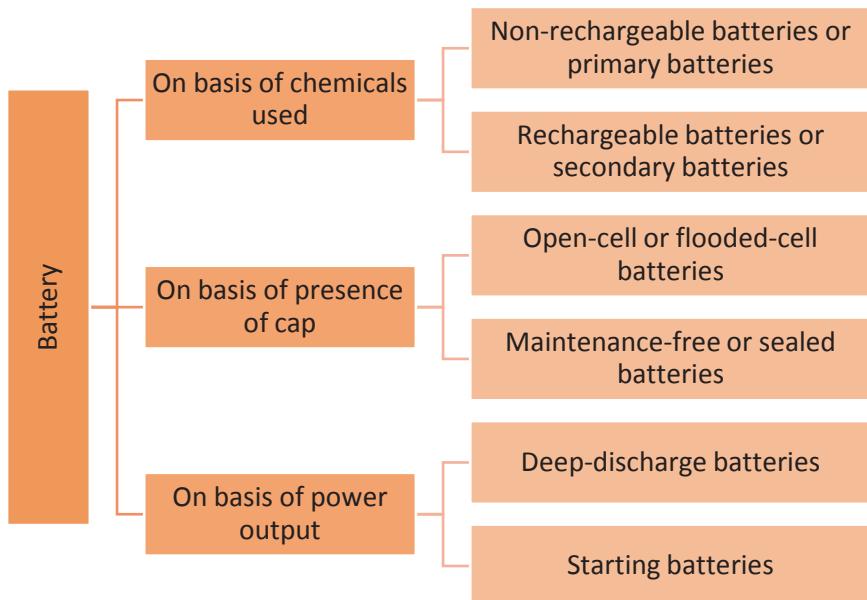


Fig. 2.2.3: Classification of batteries

Few of the primary and secondary batteries are listed in the following figure:

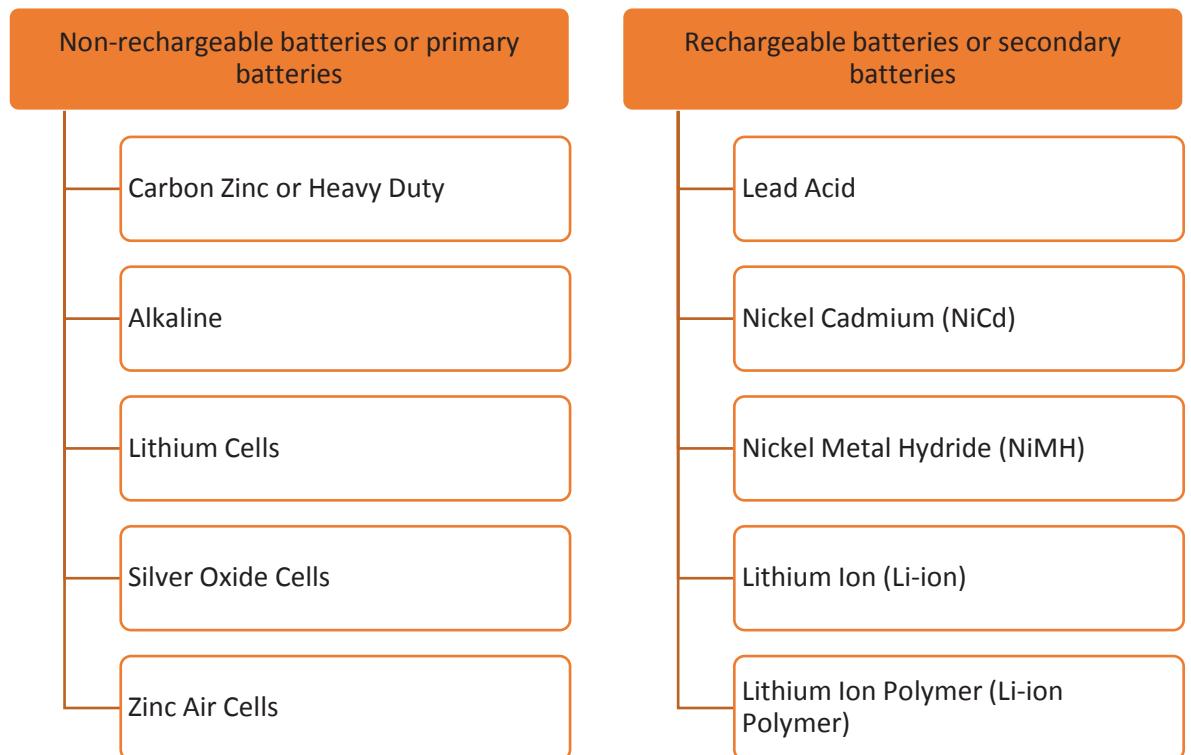


Fig. 2.2.4: Primary and secondary batteries

Other types of batteries are:

Open-cell or flooded-cell batteries

- Have removable caps on top
- Facilitates testing the cells and adding water when needed

Maintenance-free or sealed batteries

- Are sealed and can be maintained only at a factory
- Does not have filler caps though have a smooth top
- Used for a PV system
- Does not last as long as open-cell batteries if maintained properly

Deep-discharge battery

- Best-suited for most PV because they are specially designed to deliver a high percentage of their power without any damage
- 80% of the power stored in a deep-discharge battery can be regularly used without damage

Starting battery

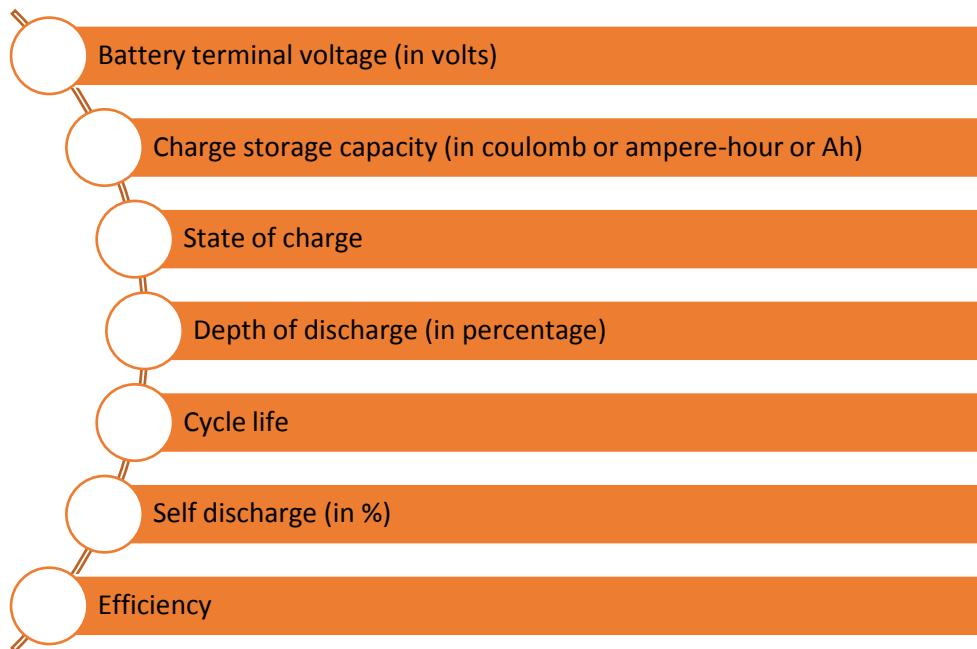
- Used for vehicles
- Is designed to provide high power for a short time to start an engine
- Are easily damaged by using a high percentage of the electricity stored in them

Fig. 2.2.5: Different types of batteries

Battery is the component of a PV system which requires careful handling and maintenance. The liquid level in the battery must be checked regularly to ensure correct level is maintained. The ionized distilled water or the purest form of water must be added if water level in the cell is low.

## 2.2.4 Parameters of Batteries

The standard parameters of a battery specified by the manufacturers are listed in the following figure:



*Fig. 2.2.6: Standard parameters of batteries*

### Battery Terminal Voltage

Batteries supply electrical energy to the load connected across its terminals. The electrical energy transfer from the battery to load is possible only when there is voltage difference between the two terminals. Thus, a battery's terminal voltage is the voltage difference between its two terminals or electrodes. The voltage difference between its terminals is the driving force for the current to flow.

For a given appliance, an appropriate level of terminal voltage must be available, otherwise the device does not work. The supply requirement may vary from 1.5V to 6V to 12V. Some devices may also need higher voltages. Thus, battery terminal voltage is one of the important parameters that determines the choice of the battery. For solar PV system applications, there are batteries which are available with 6V and 12V ratings.

Each battery is made up of cells. The terminal voltage of cells is determined by the components they are made up of. The battery terminal voltage changes with the condition of battery. It increases when the battery gets charged and decreases when it gets discharged.

The following figure lists different voltage terminologies associated with battery:

**Open Circuit Voltage ( $V_o$ )**

- Also called voltage as this is the maximum possible voltage at output terminals of a battery when the circuit is open.
- Also referred as the electromotive force (e.m.f.) of the battery or  $V_{emf}$ .

**•Nominal Terminal or Operating Voltage**

- Actual voltage available at the output terminal of the battery on which the load can operate.
- When current flows through battery, its terminal voltage is normally lower than the  $V_o$  due to the internal resistance of the battery.
- The standard battery nominal voltages available are 1.5V, 3V, 6V, 12V, 24V, 48V.

**•Cut-off Voltage**

- Voltage to which the load operates and below which the battery should be disconnected from the load preventing over-discharge.

Fig. 2.2.7: Different voltage terminologies associated with a battery

## Battery Storage Capacity

The capacity of a battery refers to its charge storage capacity and is expressed in terms of ampere-hour (Ah). One Ah is the amount of charge delivered when constant current of one ampere (A) is used for one hour (h). The capacity of a battery is given by the expression:

$$\text{Capacity (C)} = \text{Current (A)} \times \text{Hour (h)}$$

The capacity of non-rechargeable batteries normally varies in few mAh to several Ah. The capacity of rechargeable batteries can vary from few Ah to thousands of Ah.

## State of Charge (SOC)

SOC of a battery refers to the percentage of its capacity that can be used. For example, a battery having 100 Ah rating but depleted by 20 Ah will have an SOC measurement of 80%. The ratio of the quantity of energy currently saved in the battery to its given rated capacity is known as the battery state of discharge (BSOC or SOC). A 500 Ah capacity rated battery will have 400 Ah of energy saved in the SOC is 80%. A simple way of measuring the BSOC of a battery is to measure its voltage and compare it with the voltage of a battery that is fully charged.

## Depth of Discharge (DOD)

The depth of discharge (DOD) of a battery ascertains the amount of power of the battery that can be used. For example, if the manufacturer of a battery marks its DOD as 25%, then the load can utilize only 25% of its capacity.

Almost all batteries, especially the ones used for renewable energy appliances, get their rating as per their capacity. However, the real energy that can be obtained from the battery, especially for lead acid batteries, is much less than the given rated capacity. This happens because taking out the entire capacity from the battery can reduce its lifetime considerably. The amount of the battery capacity that can be utilized from the battery is called its DOD. If a battery has its rated capacity as 500Ah and DOD of 20%, then it can give  $500 \times .2 = 100$  Ah of energy.

Percentage of maximum capacity of the battery is the percentage of its capacity that has been discharged. A discharge of minimum 80% DOD is known as deep discharge.

Therefore, normally, deep discharge batteries are preferred for PV applications. The batteries used for solar PV applications have high DoD, about 50%. In practice, there is no battery for which the allowable DoD is 100%. Normally, the batteries used for starting, lighting and ignition applications, for instant, the car batteries, have small DoD, about 10% to 20%. The Li-ion batteries have DoD of 80% to 90%.

## Cycle Life

Cycle life is defined as the number of cycles a battery or cell carries out before capacity reaches 80% of its original capacity.

Every cycle of charge and discharge of the cell is linked to a simultaneous conversion cycle of the active chemicals within the cell. This is accompanied by gradual degradation of the chemicals in the cells that is not visible to the user. The degradation could be a consequence of undesirable and unavoidable chemical reactions within the cell or an alteration in the morphology of the electrode particles due to growth of dendrites and crystal. The cell capacity is reduced or the effective resistance within the cell may rise as the volume of the active chemicals in the cell could diminish over time.

The cell does not die after the cycle life is over but its gradual degradation carries on. It works normally but its capacity decreases considerably as compared to when it was new.

## Self-Discharge Rate

The rate at which a cell gets discharged while not in use, because of undesirable chemical reactions inside it, is called its self-discharge rate. It depends on the temperature and components of the cell. The following table lists the self-discharge rates per month for some batteries:

| Type                  | Self-Discharge Rate/month |
|-----------------------|---------------------------|
| Lead Acid             | 4% to 6%                  |
| Alkaline              | 2%-3%                     |
| Primary Lithium Metal | 10%                       |
| Nickel Based          | 10%-15%                   |
| Lithium ion           | 1%-2%                     |

Fig. 2.2.8: Self discharge rate

### Battery Efficiency

The charging voltage for any rechargeable battery is greater than the discharging voltage.

- Charging voltage = battery electromotive force (e.m.f.) + voltage drop because of the internal resistance of the battery
- Discharging voltage = battery electromotive force (e.m.f.) – voltage drop due to the internal resistance of the battery

The discharged energy is always less than the charging energy of the battery due to its internal resistance. Typically, a lead-acid battery is 80% to 90% efficient in doing charge transfer. The expression for the charge transfer efficiency is as follows:

$$\text{Ampere-hour}/\text{Charge transfer efficiency} = \text{Discharged energy (Ah)} \times 100 / \text{Charging Energy (Ah)}$$

## 2.2.5 Batteries Used in PV System

The batteries used for PV system:

- Must be rechargeable
- Must allow deep discharge
- Should have long life span
- Should be easily serviced
- Have high capacities and low self-discharge rate

### Lead Acid Battery

Lead acid battery is the most common battery that is used in PV applications. The name comes from the main components in the battery which are lead and sulphuric acid.

The following figure lists some characteristics of lead-acid batteries which make it a good choice for PV applications:

These are rechargeable.

These have capacities in the range of 1 to 12,000 Ah.

These have 500-800 charge-discharge cycles.

Their life time is of about 2 to 3 years. If maintained properly and used with suitable charge controller, the operational life can be 5 - 7 years.

They perform very well for a wide range of temperatures, from -15°C to 60°C.

They can easily be replaced and maintained.

Fig. 2.2.9: Characteristics of a lead-acid battery

The most commonly used lead-acid battery is the car battery. A car battery is designed to provide a high current for a short duration for starting the engines. They are sometimes used for small photovoltaic systems because of their low cost but their operational life in solar PV applications is likely to be short. Hence, the car batteries are not suitable for deep discharge cycle that is experienced by the batteries in PV systems.

### Flooded Tubular Plate Design

The most common lead-acid battery used in PV systems is of flooded tubular plate design, having low antimony plates. Longer operational life may be achieved if the maximum DOD is limited. If the batteries are wrongly treated, it will lead to a shorter lifetime. Flat plate lead-acid batteries are often used as stationary batteries for the stand-by applications. However, these batteries do not allow deep cycling. Hence, these are not the best choice for most of the PV applications.

### Sealed Lead-Acid Battery

A sealed lead-acid battery is designed mainly to avoid spillage problems and the need to top up the electrolyte. Some of this type batteries are sold specifically to be used in the PV systems. They are attractive for applications in the remote regions where visit to the site is a problem. Sealed lead acid batteries are considerably more expensive and generally less resistant to extreme temperatures than the conventional flooded batteries.

### Nickel Cadmium Batteries

The nickel-cadmium battery (NiCd or NiCad) is a rechargeable battery which has porous plaques of nickel hydroxide as positive plates of the electrodes and porous plaques of cadmium hydroxide as negative plates of the electrodes.

The following figure lists two types of NiCd batteries:

| Sintered Plate NiCd Batteries  | Pocket Plate NiCd batteries  |
|--|--|
| <ul style="list-style-type: none"> <li>These suffer from memory effect, in which the useful capacity of the battery appears to drop after it has been discharged over many cycles or if it is discharged at low rates.</li> <li>These batteries are not, therefore, attractive for use in PV systems.</li> </ul> | <ul style="list-style-type: none"> <li>These can be used in PV systems because they have additives in their plates to prolong their operational life and to minimize the memory effect.</li> <li>These are highly resistant to extremes of temperature and can safely be taken down to less than 10% SOC.</li> <li>Their main disadvantage is their high cost as compared to lead-acid batteries.</li> </ul> |

Fig. 2.2.10: Types of NiCd batteries

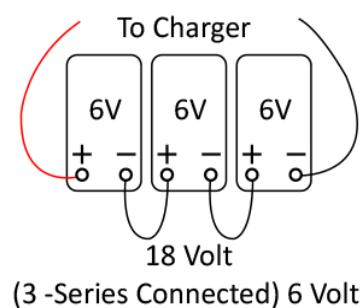
### Comparison between Lead Acid Batteries and Nickel Cadmium Batteries

The following table lists the comparison between lead acid batteries and nickel cadmium batteries based on their performance and prices:

| Battery type         |                            | Lead-acid          | NiCd                |
|----------------------|----------------------------|--------------------|---------------------|
| Cycle time           |                            | 600 to 1500 cycles | 1500 to 3500 cycles |
| Efficiency           | [Ah extracted/Ah restored] | 83 to > 90%        | 71%                 |
| Self discharge rate  |                            | 3 to 10%/month     | 6 to 20%/month      |
| Range of operation   |                            | -15 to +50°C       | -40 to +45°C        |
| Investment cost      | [€/kWh capacity]           | 160                | - 200               |
| Specific energy cost | [€/kWh from battery]       | 0.11               | - 0.33              |
|                      |                            |                    | 690 - 1590          |
|                      |                            |                    | 0.20 - 1.06         |

## 2.2.6 Connection of Batteries in a Photovoltaic System

In a PV system, the batteries can be connected in series, parallel or in both. The following figure shows the connections of the batteries:



### Series Connection

Batteries are connected together in series when the required PV system voltage is higher than the individual battery terminal voltage.

Negative terminal of one battery is connected to the positive terminal of the other.

The positive terminal of the first one and the negative terminal of the last one are used to obtain high voltage.

Connecting the batteries in series increases the voltage.

Ideally, it is desired that the terminal voltage of all the series connected batteries is same.

### Parallel Connection

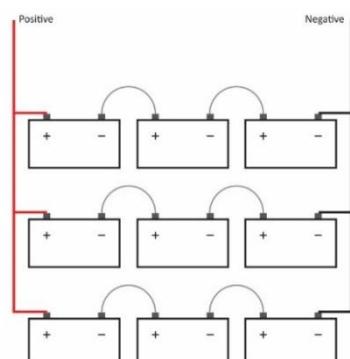
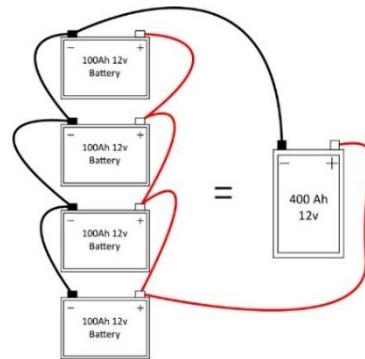
Batteries are connected in parallel when high current is required.

Same type of terminals are connected together at one point.

The positive terminal of all the batteries is connected as one and negative terminal of all the batteries are connected together as one.

The capacity of each battery is additive.

Connecting the batteries in parallel increases the capacity but the voltage remains same, which is equal to the voltage of a single battery.



### Mixed Connection

Combinations of series and parallel connection are used.

This type of connection is used when both voltage and current/capacity requirement increases the standard values of available batteries.

Depending on the voltage requirement, the calculated numbers of batteries are connected in series and depending upon the current/capacity requirement, the numbers of such series combinations are connected in parallel combinations.

Fig. 2.2.11: Different connections of the batteries

## 2.2.7 Maintenance of Batteries

Batteries can be used for a longer period if they are properly maintained. To keep the battery in a good condition, the following actions should be taken:

### Keep the battery clean

- If the top of the battery is dirty, corrosion will soon be a problem and electricity will begin to leak from the battery connections through the dirt.
- To clean the battery, use only fresh water and a rag.

### Test each cell with the hydrometer

- All the cells should measure about the same when tested with the hydrometer.
- If one or more cells measure very differently from the others, the battery is probably beginning to fail.

### Keep the battery cells full of electrolyte

- The battery cells should be checked at least once a month and special, high-purity water added if the liquid is below the correct level.
- If water has to be added often to one or two cells but not the rest of the cells, the battery is failing and it will have to be replaced soon.

### Equalization of a battery

- Sometimes the battery can be repaired by deliberate overcharging. This is called an equalizing charge.
- To equalize the cells in a battery, give them a slow, controlled overcharge.

Fig. 2.2.12: Actions to be taken to maintain the battery

## Activity



- Fill in the following table on capacity, discharge rate and current of battery.

| Capacity | Discharge Duration | Current Produced |
|----------|--------------------|------------------|
| 50 Ah    | 10 h               | 5.....           |
| 120 Ah   | ..... h            | 4 A              |
| 250..... | 20 h               | 12500 mA         |
| .....    | 12 h               | 30 A             |
| 450 Ah   | 15 h               | .....            |
| 1200 mAh | ....h              | 10               |

- If you have 12 V battery of capacity 500 Ah, then calculate the power of battery and the amount of energy stored in the battery. Assume battery duration is 10 hours.

## UNIT 2.3: Charge Controller

### Unit Objectives



At the end of this unit, you will be able to:

1. List the functions of charge controller
2. Identify the types of charge controller
3. Explain different charge controller technologies
4. Explain the maintenance of a charge controller

The PV panels can overcharge the battery by forcing too much electricity into it. Hence, a charge controller is required. The battery gets hot and loses water rapidly when it is overcharged. This may cause damage to the battery. A charge controller controls the charge by working similar to a valve on a rainwater collection system which prevents overflowing of the water tank.

### 2.3.1 Defining Charge Controller

The charge controller must be connected between the battery and PV panels. The voltage of battery is constantly under a check. A controller restricts extra charge from getting into the battery if a high voltage indicates full battery. The following image shows charge controller in a PV system:

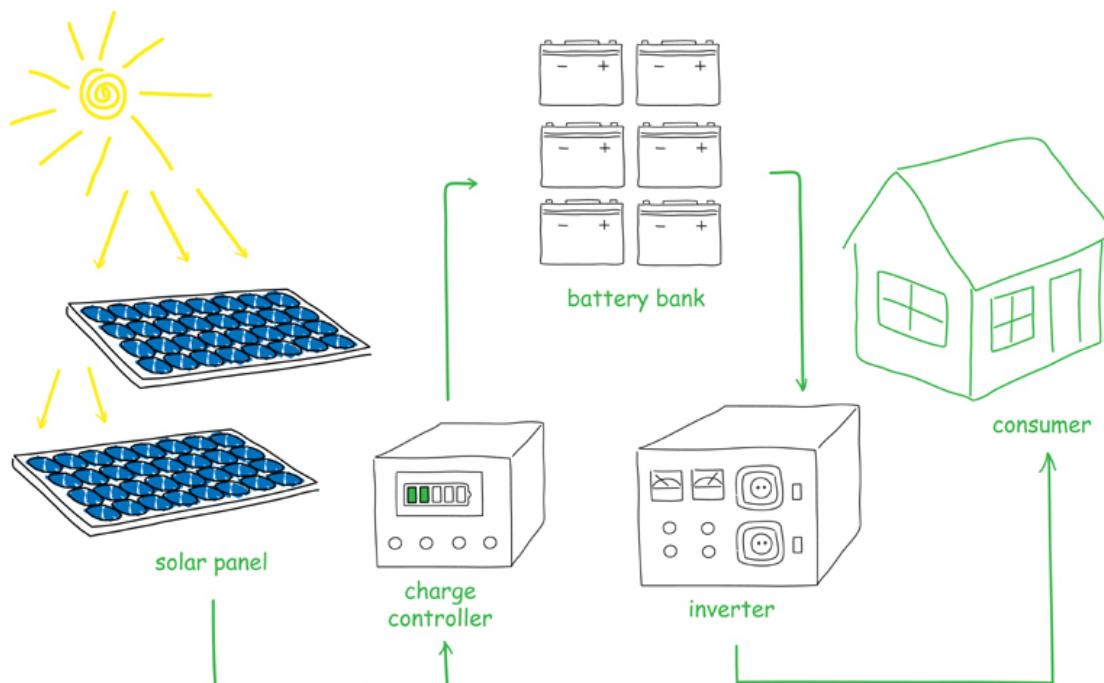


Fig. 2.3.1: Charge controller

Charge controller performs functions such as:

- Charging the battery.
- Giving an indication when battery is fully charged.
- Monitoring the battery voltage and when it is minimum, cutting off the supply to the load switch to remove the load connection.
- Ensuring the load is cut off from the battery supply in case of overload (the load is in a switch-off state).

The following figure shows the functions of a charge controller:

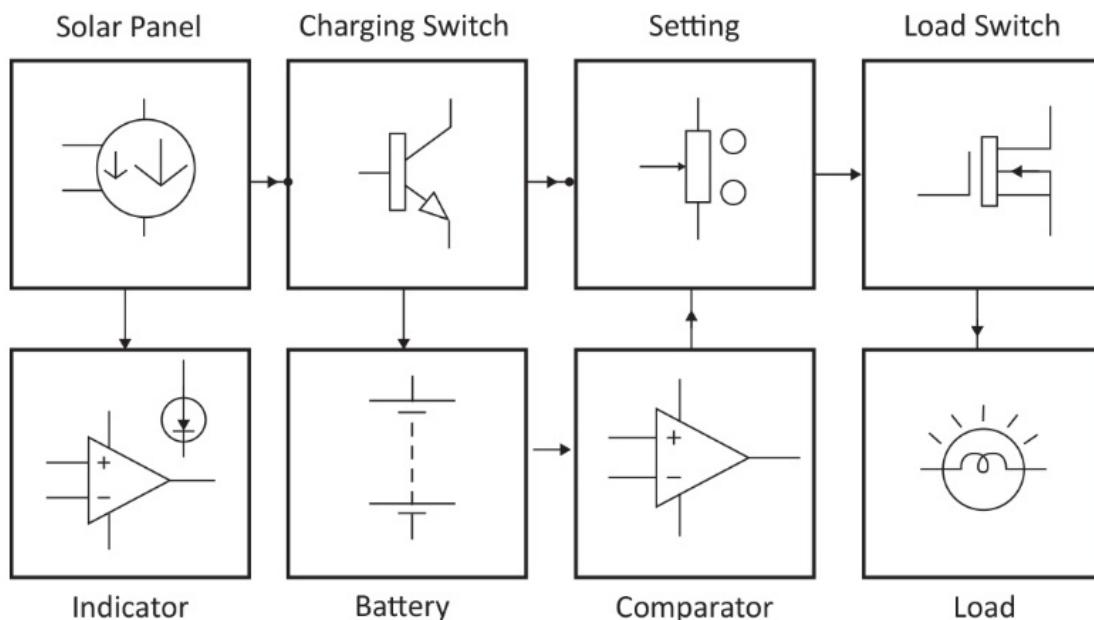


Fig. 2.3.2: Functions of a charge controller

## 2.3.2 Charge Controllers - Types

The main types of charge controllers are mentioned in the following figure:

### Series Charge Controller

- A switch shutting the electricity flow off from the panel to the battery when full charge is attained.
- Switching usually done using magnetic switch known as a relay. Other switching transistors may also be used.

### Parallel Charge Controller

- It is a parallel connection along with panels placed side to side with their output wires.
- The panel wires are short restricting any extra electricity to the battery when a full battery is sensed.

### Discharge Controller

- Restricts appliances from intake of excess electricity from the battery to avoid discharging it.
- It should be connected between the appliances and battery. It works by keeping the battery's voltage under a constant check.
- During a low voltage, it shows a battery is completely drained.

### Combined Charge & Discharge Controllers

- They are put together in a same box and can be distinguished by looking their respective connections.
- If the connections lead to the panels, the controller box consists of a charge controller. If the box connections lead to the appliances, the controller box consist of a discharge controller.

*Fig. 2.3.3: Types of Charge Controllers*

The following image shows a combined charge controller:

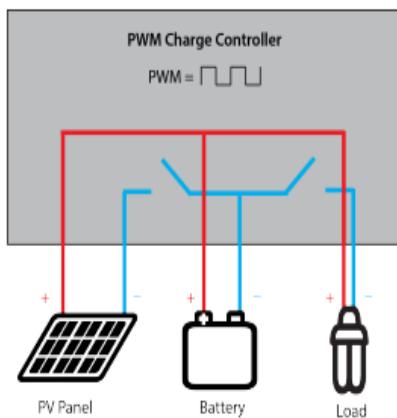


*Fig. 2.3.4: Combined charge controller*

### 2.3.3 Charge Controller Technologies

A basic charge controller ceases to charge a battery when they go beyond a set upper limit of voltage level and begins to recharge when the battery voltage goes back, down that level. With technological advancements in electronics, charge rates can be adjusted as per the battery level allowing maximum charge capacity. The following figure lists the technologies used by the charge controllers:

#### Pulse Width Modulation (PWM) Charge Controller

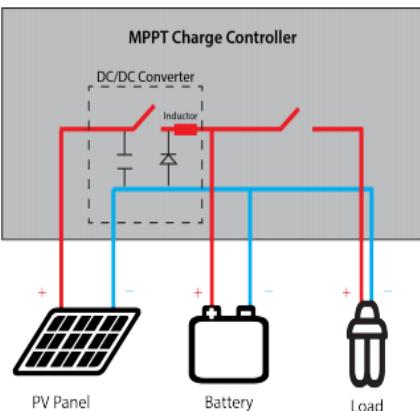


PWM charge controllers function by matching the panel voltage to the voltage of the battery and in the process bring down the output voltage of the panel.

It comes into action when the battery is full. At the time of charging, it allows current as much as the panels can generate to reach the target.

Once the battery reaches the target voltage, the battery is disconnected from the charge controller from the panel ensuring the efficient charging of the battery and protecting it from being overcharged.

#### Maximum Power Point Tracking (MPPT) Charge Controller



MPPT charge controller is based on the latest technology and aims at getting the utmost benefit from the solar panel. It functions as per the panel voltage and transforms the excess voltage of the panel into current. This gives a boost to the solar panel's output.

MPPT charge controllers have an indirect connection with the PV system and the battery bank as it is linked to a DC/DC voltage converter. This converter changes the extra PV voltage into additional current without any loss of power.

MPPT controllers do using an adaptive algorithm which follows the MPP of the PV array and then adjusts the input voltage to manage the efficient amount of power for the system.

Fig. 2.3.5: Charge controller technologies

### 2.3.4 Terminologies Related to Charge Controller

For a charge controller to operate, various voltage and current levels are defined. These levels are listed in the following figure:

|  |   |
|--|---|
| Nominal System Voltage                   | <ul style="list-style-type: none"> <li>Voltage at which charge controller and battery operate in PV system.</li> </ul>  |
| Nominal Load Current                     | <ul style="list-style-type: none"> <li>Maximum load current that charge controller should be able to handle.</li> </ul>   |
| Nominal PV Array Current                 | <ul style="list-style-type: none"> <li>Maximum PV array current that charge controller should be able to handle.</li> <li>A safety factor of 1.25 is used to account for variation in short circuit current at non STC.</li> </ul>  |
| Charge Regulator Set Points              | <ul style="list-style-type: none"> <li>It senses a battery's voltage (or SoC) to decide either to disconnect the source (PV array in this case) to prevent overcharging or to disconnect the load (from the battery output) to prevent deep discharging.</li> <li>Majorly used in cases of unpredictable loads and the batteries for minimizing initial cost (optimized/undersized). There are set algorithm threshold values, decisions upon which are taken.</li> </ul> |
| Voltage Regulation Set Point (VR)        | <ul style="list-style-type: none"> <li>A battery's maximum voltage up to which it holds its charge capacity.</li> <li>At a threshold level, the controller either regulates the current received by the battery or disconnects it from the source.</li> </ul>   |
| Voltage Regulation Hysteresis (VHR)      | <ul style="list-style-type: none"> <li>It is the difference between VR and the voltage at which the controller reconnects the battery to the PV source and starts charging.</li> <li>VRH determines the effectiveness of a controller charging the battery.</li> </ul>  |
| Low Voltage Disconnect (LVD)             | <ul style="list-style-type: none"> <li>Minimum battery's voltage that states its discharge but not deep discharge. It is also referred as DoD of battery (depth of discharge).</li> <li>Battery load is disconnected by charge controller the moment voltage reaches its LVD, to avoid deep discharge.</li> </ul>   |
| Low Voltage Disconnect Hysteresis (LVDH) | <ul style="list-style-type: none"> <li>Difference between battery voltage and LVD value, where load battery terminals are reconnected to the load.</li> <li>Low LVDH will make the load switched on and off more frequently, which can adversely affect the battery hence the LVDH is not very low.</li> </ul>  |

Fig. 2.3.6: Voltage and current levels of a charge controller

The following figure shows the charge regular set points:

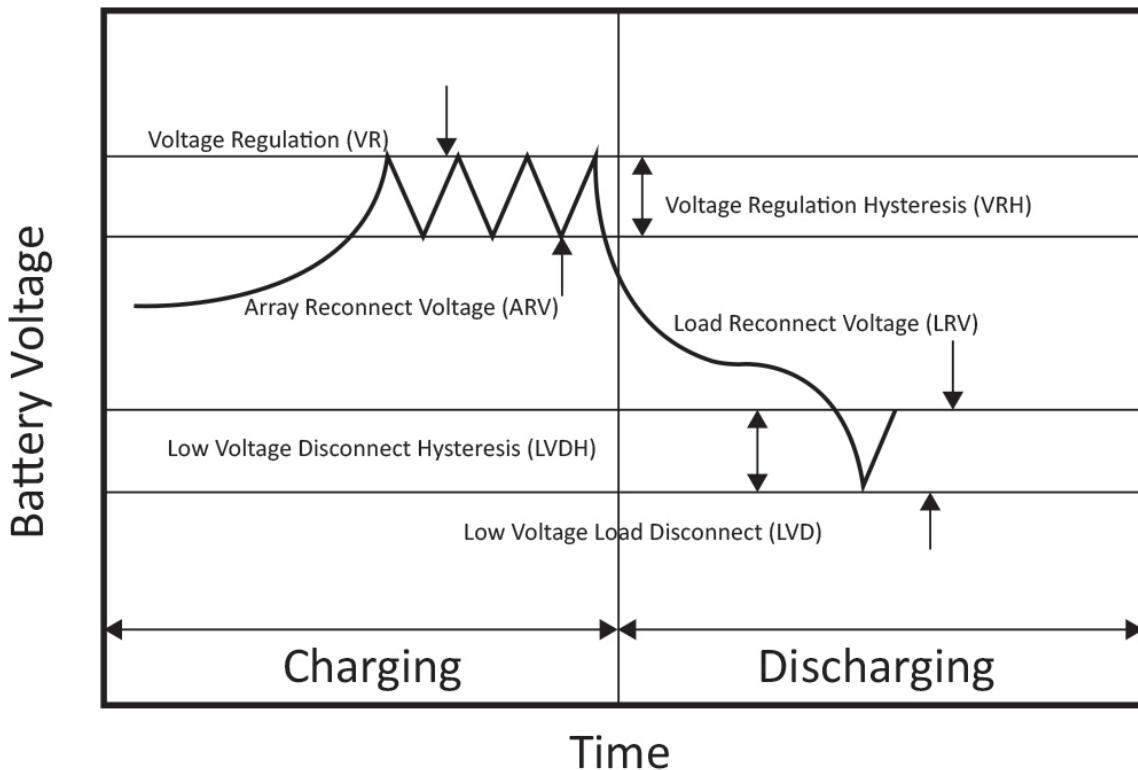


Fig. 2.3.7: Charge regular set points

Charge controllers are available for various rating of nominal system voltage and PV array current. Typical rating of 12V, 6A rated PWM charge controller is shown in the following figure:

|                          |                 |
|--------------------------|-----------------|
| Nominal System Voltage   | 12V             |
| Nominal PV array current | 6A              |
| Nominal load current     | 6A              |
| Regulation voltage       | 14V             |
| Low voltage disconnect   | 11V             |
| Low Voltage reconnect    | 13V             |
| Type of charging         | Series PWM      |
| Temperature              | -20° C to 55° C |
| Self-consumption         | 10mA maximum    |

Fig 2.3.7: Specifications of a PWM charge controller

## Features of Charge Controller

The features of a charge controller are as follows:

- Type of switching and control: Switching may be series type or shunt or parallel type. The control algorithm used by a charge controller may be PWM type or MPPT type.
- Temperature compensation: It alters the charge regulation voltage as per the battery temperature.
  - Raises the regulation voltage when the battery temperature is very low. This improves its capability to charge the battery.
  - Lowers the regulation voltage when the temperature of the battery is high. It helps to reduce the loss of electrolyte and overcharging of the battery.
  - Lead acid battery has the standard temperature compensation coefficient of  $-5\text{mV}/^{\circ}\text{C}$ .

Few charge controllers have the provision of equalization functions, both manual and automatic. Charge regulation voltage is regularly raised for a fixed span of time to equalize the battery cells. Flooded, and vented batteries usually get the equalisation charge.

- Indications for system status and operating information: The set points of the charge controller specify the voltage levels of the controller to perform regulate and control functions. These are important parameters affecting the life of the battery and the system efficiency.

Few charge controllers have battery voltage sense leads to oppose the aftereffect of voltage drop on the charge regulation set points. The following image shows battery voltage sensing of a charge controller:

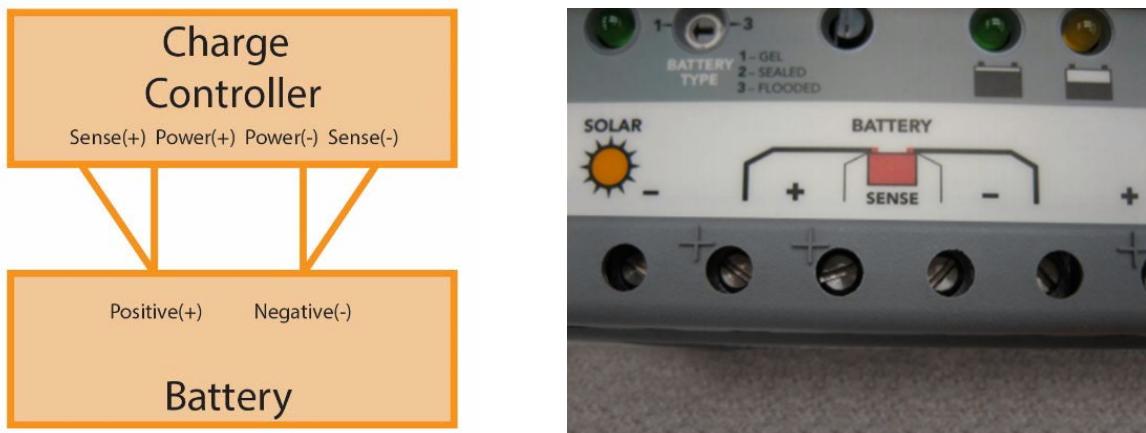


Fig. 2.3.8: Battery voltage sensing of a charge controller

### 2.3.5 Wiring and Maintenance of Controller

Connecting the correct wires to the right terminals is very important. Incorrect wiring of the controller prevents it from working and the battery may be damaged due to this. For wiring and maintenance of the charge controllers, the key points as shown in the following figure need to be followed:

The controller should be wired in the circuit as per the instructions provided by the supplier of the controller in the manual.

- The battery's positive should be connected to battery's positive terminal on the controller followed by a panel's positive terminal being connected to the controller.
- In some cases, a controller has a panel connected before the battery or vice versa in other cases.

The controller should be strongly mounted in a cool place away from sun, safe from rain and close to the battery.

- A controller should be placed where indicators are visible. Problems may be caused due to long wires between the battery and controller as measurement of charge from a distance is difficult.
- A wire should range between 1m-2m between a battery and controller.

Ensure installation of an earthing system and that all installation steps are duly followed.

- Lightening is the major damaging agent of semiconductor switches. A circuit to disperse generated electricity from lightening is included in charge controllers of good-quality.
- Controllers must be equipped with a wire earther properly using an earthing rod (burried) so that electricity as a result of lightening can go down in the ground without causing any harm to the controller.
- A mount or PV panel frame is essentially required in some installations for an earth connection.

Avoid changing controller adjustments.

- The adjustments indicate a full or discharged.
- Without appropriate equipment or techniques, adjustments can't be correct.
- Any change in adjustments without proper equipment/techniques, it may result in a battery's damage or decreased life span.

Ensure a correct wiring.

- Incorrect wiring can cause serious damage to controllers.
- Other factors are water, insects, heat, and animals.
- Carefully add new appliances to ensure a controller handles extra power without damaging itself.
- In case of a serious damage to controller, consider replacing with a good quality controller.

*Fig. 2.3.9: Key points for wiring and maintenance of the charge controllers*

## Activity



Complete the following table to obtain missing quantities:

| Solar Panel Wattage (W) | Solar Panel operating voltage | Battery bank voltage | Battery bank current | Battery bank current +25% | MPPT Ratings |
|-------------------------|-------------------------------|----------------------|----------------------|---------------------------|--------------|
| 1000                    | 24                            | 24                   | 41.67                | 51                        | 24V, 51A     |
| 3000                    | 36                            | 36                   |                      |                           |              |
| 4800                    | 48                            | 36                   |                      |                           |              |

## UNIT 2.4: Inverters

### Unit Objectives

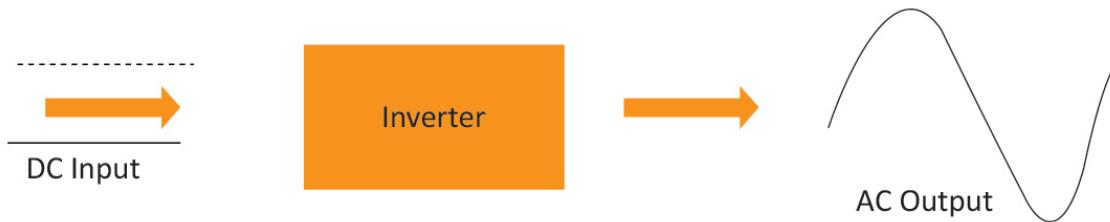


At the end of this unit, you will be able to:

1. List the basic functions of inverters
2. Identify the types of inverters
3. Evaluate the efficiency of inverters

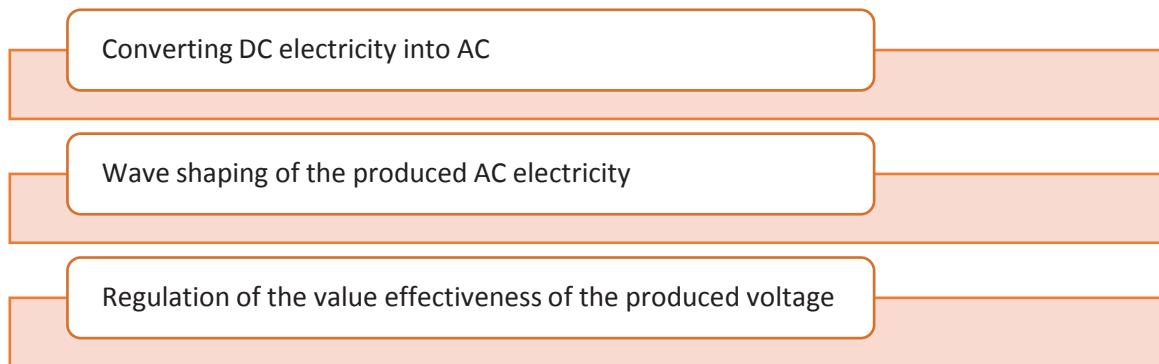
### 2.4.1 Defining Inverter

Most of the appliances use AC power while PV modules produce DC Power. Also, in standalone solar photovoltaic systems the energy stored in batteries is in the form of DC power. Therefore, the transition of DC power to AC power is required before it is used for running appliances. Transition of DC Power into AC power can be obtained using devices called DC to AC converters or DC/AC converters or inverters. The following figure shows the basic workflow of an inverter:



*Fig. 2.4.1: Basic workflow of an inverter*

The inverter's main functions are listed in the following figure:



*Fig. 2.4.2: Basic functions of an inverter*

## Inverters for PV Applications

Inverters operating in a solar PV system, constantly nears MPP (maximum power point). The high-switching-frequency inverters with a 20 kHz or higher frequency, is possible because of switch-mode semiconductor power devices. Low power inverters use power MOSFETs and bipolar transistors whereas, thyristors are utilized in high-power inverters. If run at a frequency up to 50 kHz, IGBT (Insulated-gate bipolar transistor) have the capacity of handling several hundred kW; delivering an AC production wave in the form of pure sinusoidal one, along with a little filter at the output. Thus, the process restricts the large, energy-consuming and expensive power filters.

Inverters, used for PV applications, have the following:

- Reliability
- Efficiency characteristics

Solar inverters have some unique functions modified to work with PV arrays. These include highest power point tracking and anti-islanding safety. Islanding indicates a state wherein a distributed generator (DG) persists powering an area when the grid power is not available from the utility.

Solar micro-inverters are not same as the regular inverters. Each solar panel has a single micro-inverter connected to it. The total efficiency of the system can be enhanced due to this. The collective output from all the micro-inverters is supplied to the electrical grid.

### 2.4.2 Types of Solar Inverters

The solar inverters play as a significant interface between the solar PV and load. Depending on whether battery is used in the PV system or not, the solar inverters can be classified in three categories:

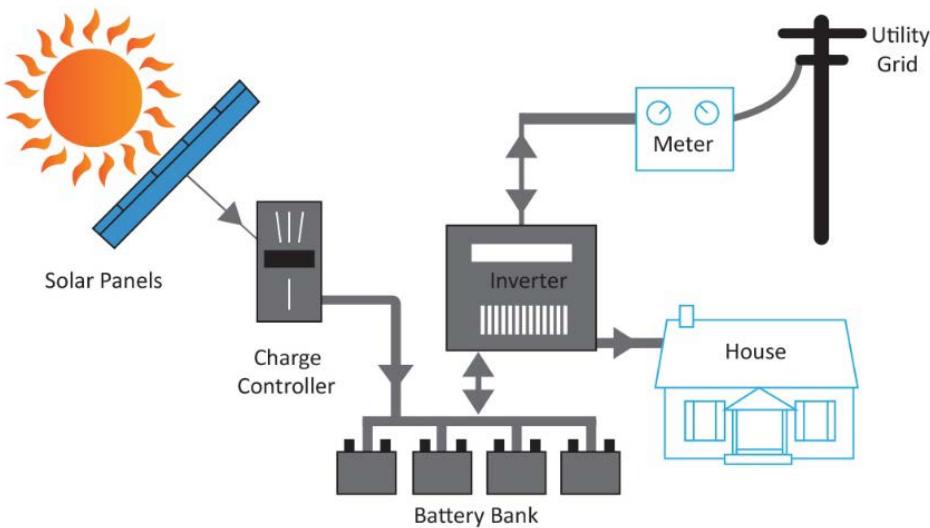
- Standalone Inverters
- Grid Tie Inverters
- Battery Backup Grid-tie Inverters

#### Standalone/Off-Grid Inverters

They are normally used in standalone PV power systems. In standalone system, there is no backup of power for energy storage. Therefore, this type of inverter has battery backup to supply the power to the load in case of non-sunshine hours.

The standalone inverters are called so because there is no need to attach them to the solar panels. They receive DC power from batteries. PV arrays are used to charge the batteries. Some standalone inverters are coupled with the battery chargers to refill the battery. Since the standalone inverters are detached from the utility grid they do not need anti-islanding safety.

The following image represents a block diagram of a standalone inverter:



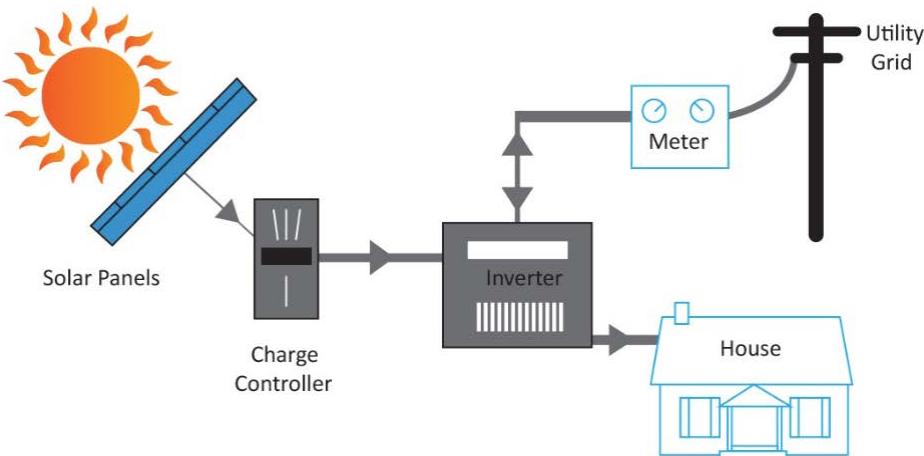
*Fig. 2.4.3: Block diagram of a standalone inverter*

### Grid Tie Inverters

These inverters are connected to grid and do not have battery back-up. They have special circuitry to match inverter output voltage and frequency with that of grid. Grid is used as battery backup when power generated by PV array is insufficient. These inverters also have inbuilt MPPT to extract maximum amount of power from the PV array.

When the sun is shining and PV array is generating more power than usage, then the extra power after meeting the load is supplied to the grid. If PV array power is less than the load requirement, then some power is drawn from the grid to make up the shortage of power.

The grid tie inverters are set up in such a way that they turn off automatically at times of power loss to provide protection from any harm. Thus, at such times these inverters do not supply emergency power. Homes, which are powered by utility grid, should utilize grid tie inverters to get benefit from net metering. Grid tie inverters need anti-islanding protection in their system. The following image represents a block diagram of a grid tied inverter:



*Fig. 2.4.4: Block diagram of a grid tie inverter*

### Battery Backup Grid-tie Inverter

Grid-ties inverters also have battery backup like standalone inverters. The battery backup inverters are designed to draw energy from batteries and regulate that with its on-board charger. They supply the extra energy to the utility grid. These inverters can provide AC power to chosen areas where energy is needed at times of power interruptions. They need to install anti-islanding protection. A battery backup grid-tie inverter is shown in the following image:

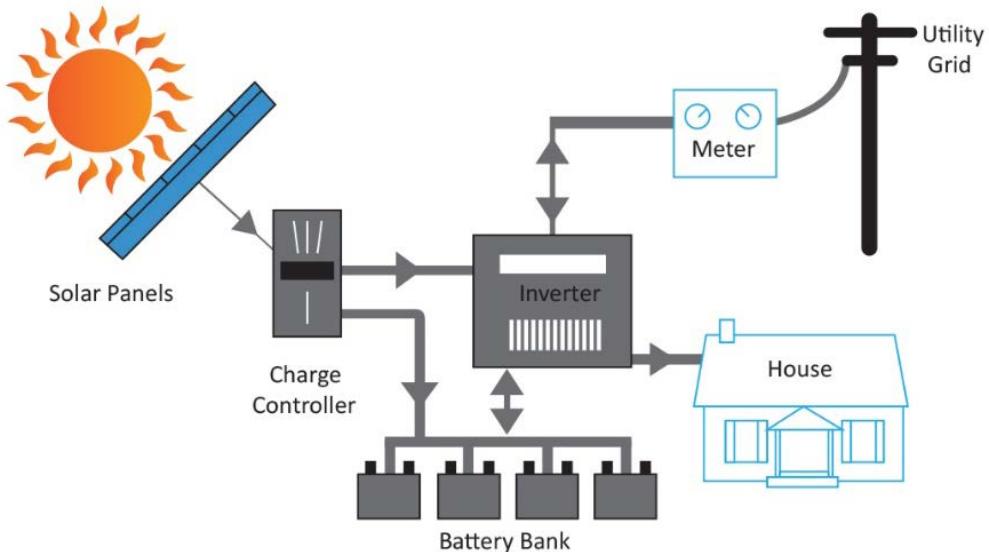


Fig. 2.4.5: Block diagram of a battery backup grid-tie inverter

### 2.4.3 Efficiency of Inverters

The competence of an inverter is typically demarcated by its design operating power. In general, efficiency of the inverters ranges from:

- Partial load at 85% - 95% (typically 10%)
- Full load at 90% to 96%

In a PV system, the size of a grid-connected inverter is calculated using the efficiency characteristics of the inverter as well as its overload capability. Ideal system performance can be achieved by using an inverter that has a rating in the range of 70% -90% as nominal rating of the solar PV array that depends on the performance of inverter and the climate involved.

For grid-tied operation, inverters should:

- Match the necessary equipment considering the quality of output voltage and current waveforms.
- Avoid production of electrical noise that may hinder TV's/Radio's reception.
- Be turned off during a grid's failure ensuring safety of engineers present to repair the grid.

In stand-alone PV systems, battery supplies energy to the inverter. Hence, partial load operation of the inverter can be curtailed by sizing the inverter to match loads.

## Activity



1. Complete the following table for a DC/DC Converter:

| I/P Voltage | I/P Current | I/P Power | O/P Voltage | O/P Current | O/P Power | Power Loss | Efficiency (%) |
|-------------|-------------|-----------|-------------|-------------|-----------|------------|----------------|
| 50          | 3           |           | 40          | 3           |           |            |                |
|             | 3           | 300       |             | 3           | 230       |            |                |

2. Input DC power of an inverter is 300W. The efficiency of the inverter is given 97%. What is the output of AC power?

## UNIT 2.5: Mounting Structures

### Unit Objectives



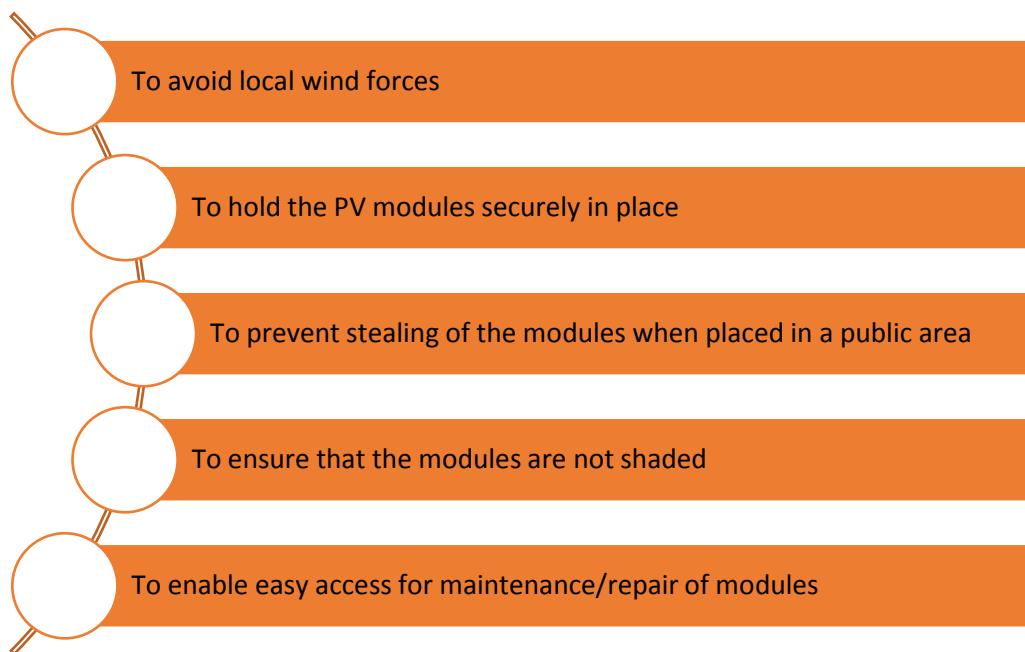
At the end of this unit, you will be able to:

16. Identify the need of mounting structures
17. List different types of mounting systems

PV mounting systems are also known as solar module racking. These are utilized to get the solar panels attached to locations such as surfaces of roofs, exterior of buildings or the ground. Retrofitting of solar panels on roofs or as a section of a building (known as BIPV) can be done with the help of these mounting systems.

### 2.5.1 Importance for Mounting Structures

The importance of mounting structures is listed in the following figure:



*Fig. 2.5.1: Aim of mounting structures*

Special mounting structures that can serve as PV modules as well as building elements are developed for integration in buildings. PV modules on the roofs of houses, in the facades of buildings, warning signage, outdoor lighting and telephone box's roof are some common examples. The structural cost must be low. In most PV applications, the configuration is less profitable due to extra cost borne for placement of PV modules on sun tracking system.

## 2.5.2 Types of Mounting Structures

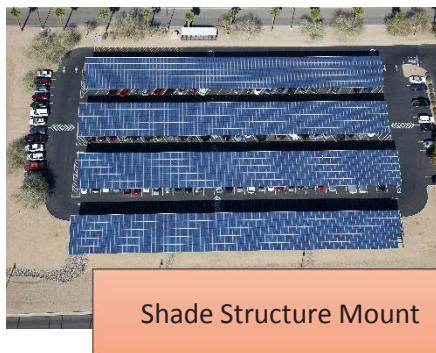
Solar panel mounting structures or systems are made of aluminium, galvanized iron (GI) and mild steel (MS) material. The following image shows the basic solar panel mounting systems:



Ground Mounting



Roof Mounting



Shade Structure Mount



Building Integrated PV (BIPV)

Fig. 2.5.2: Basic solar panel mounting systems

The following table lists some common types of PV array mounting systems:

| Structure                | Description   | Image |
|--------------------------|---|-------|
| Ground-mounted PV arrays | <ul style="list-style-type: none"> <li>They are used for larger PV systems or where the rooftop installations are not practical.</li> <li>They can use racks, poles and other foundations for supporting the arrays.</li> <li>They are usually more vulnerable to damage than rooftop arrays, but the constraints for their orientation and location is less as compared to the rooftop installations.</li> </ul> |       |

| Structure                    | Description   | Image  |
|------------------------------|---|--|
| Integrated mount             | <ul style="list-style-type: none"> <li>They have panels attached directly to rafters and replace roofing materials.</li> <li>They require modules are integrated into the exterior of the building or roofing Sometimes these systems are referred to building integrated PV.</li> </ul>  |    |
| Stand-off mount/Flush mount  | <ul style="list-style-type: none"> <li>They use standoffs attached to the roof for supporting rails on which the PV modules are mounted.</li> <li>They allow sufficient gap to provide air flow as solar panels usually need air flow to give best performance.</li> <li>They are recommended and popular mounts for residential purposes.</li> </ul> |   |
| Standard panel fixture       | <ul style="list-style-type: none"> <li>They allow panels to be fixed in the customer place as it is.</li> <li>There is no requirement of adjustments in these fixtures.</li> </ul>  |  |
| Non- standard panel fixtures | <ul style="list-style-type: none"> <li>They require pictorial representation of customer place where the panel is to be installed.</li> <li>They require the panel fixture be designed separately as per the customer roof model.</li> </ul>  |  |

| Structure                  | Description   | Image |
|----------------------------|---|-------|
| Ballasted mounting systems | <ul style="list-style-type: none"> <li>• They are used in flat roof commercial projects.</li> <li>• They are dependent on the weight of the array, racking system and material such as concrete paver to fix the array to the roof or ground.</li> <li>• They do not require penetration to roof or ground.</li> </ul>  |       |
| Roof top                   | <ul style="list-style-type: none"> <li>• They are very popular for installing solar PV arrays.</li> <li>• They offer less physical protection and limited access to the PV array for safety.</li> <li>• They generally provide better sun exposure.</li> <li>• They do not occupy space on the ground. Hence the ground may be needed for other purposes.</li> <li>• They must be secured structurally and any attachment and penetration must be weather sealed properly.</li> <li>• They should not be blocked from sun by any shades.</li> </ul> |       |

| Structure               | Description   | Image  |
|-------------------------|---|--|
| Direct mount            | <ul style="list-style-type: none"> <li>They allow panels to be attached directly to the roof.</li> <li>They are cheap and easy to install.</li> </ul>   |    |
| Pole mount              | <ul style="list-style-type: none"> <li>They are generally used with manufactured racks that are mounted on the top or attached to the side of a steel pole.</li> <li>They are popular for off-grid residential photovoltaic systems, as the weight of PV array is balanced over the pole, seasonal adjustments can be easily done.</li> <li>They are very common in small applications having one or two modules where the entire system mounted on a single pole.</li> <li>They offer better cooling for the panels as compared to roof mounting.</li> </ul> |   |
| Rack mounting structure | <ul style="list-style-type: none"> <li>They are used for non-tracking system at ground level.</li> <li>They are also used in large commercials or utility scale arrays.</li> </ul>  |  |

| Structure           | Description   | Image |
|---------------------|---|-------|
| Sun-tracker systems | <ul style="list-style-type: none"> <li>• They follow the sun daily.</li> <li>• They are generally mounted on poles and allow the system to receive greater amount of solar energy.</li> <li>• They allow tracking to enhance the summer gain by 30% or more, but in winter the gain is 15% or less.</li> <li>• They allow tracking in two axes to achieve maximum performance.</li> <li>• They can also be of single-axis to provide simplicity and reliability.</li> </ul> |       |
| Shade structure     | <ul style="list-style-type: none"> <li>• They work as patio covers to provide shade.</li> <li>• For example, carports can have solar panels and cover as many parking spots as the project requires. These carports could have the provision of electric vehicle charging stations as an added benefit to the cars parked there.</li> </ul>   |       |

Fig. 2.5.3: PR array mounting systems

## Activity



**Choose the correct alternative.**

1. Which of the following mounting structures does not need any penetration to the roof or ground?  
a. Ballasted Mounting      b. Rack Mounting      c. Pole Mounting
  
2. Which of the following options is a purpose of mounting systems?  
a. Regulating temperature      b. Resisting wind force      c. Protecting PV modules from dust





### 3. Role of a Solar Panel Installation Technician

- Unit 3.1 – Responsibilities of a Solar Panel Installation Technician
- Unit 3.2 – Installation Prerequisites
- Unit 3.3 – Site Analysis
- Unit 3.4 – Installation and Maintenance of Solar Panel



## Key learning Outcomes



At the end of this module, you will be able to:

1. Recognize the roles of a solar panel installation technician
2. Identify prerequisites for installing a solar PV system
3. Construct the design of the solar PV system
4. Analyse the size and calculation of the components
5. Evaluate the location for installation
6. Analyze the customer's requirements
7. Identify the suitable mounting structures
8. Assemble and fix the mounting structure
9. Execute setting up connection between different components of the PV system
10. Perform troubleshooting of PV system

## UNIT 3.1: Responsibilities of a Solar Panel Installation Technician

### Unit Objectives



At the end of this unit, you will be able to:

1. Identify the attributes needed to work as a solar panel installation technician
2. Recognize the roles of a solar panel installation technician
3. Identify the technical responsibilities of a solar panel installation technician

Solar panel installation technician, also known as panel installer, is responsible for installing solar panels at the customers' premises. Essential skills required to install solar panel are:

- Work in a standing position for long hours
- Have physical capacity to deal with the weight of a solar panel
- Be willing to work in an outdoor setting at various locations like fields, roof tops, both urban and rural

Fig. 3.1.1: Attributes of a panel installer

The following image shows solar panel installation technicians installing panels.



Fig. 3.1.2: Solar panel installation technicians

The role of a solar panel installation technician is listed as follows:

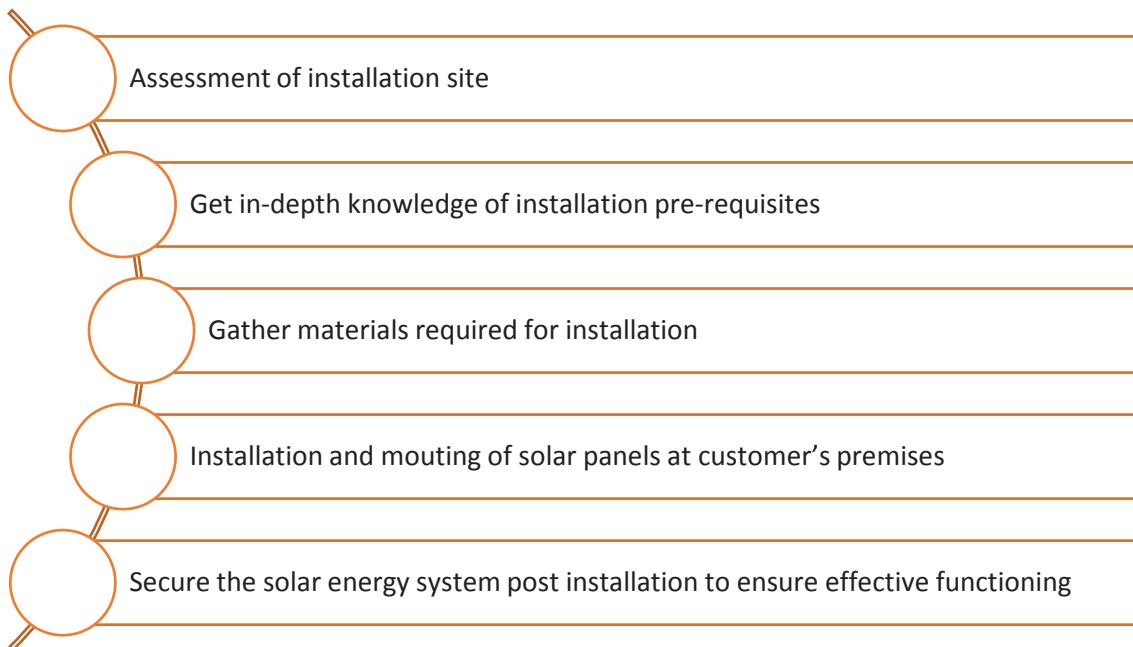


Fig. 3.1.3: Key roles of a panel installer

Apart from the key technical responsibilities of the installation, the solar panel installation technician or the panel installer also needs to:

- Ensure number of modules and panels are as per the voltage requirement.
- Ensure proper handling of panels and other materials.
- Assess precautionary measures to be taken.
- Ensure effective functioning of the system post-installation.
- Manage wastes and workplace safety.
- Deliver quality work as per standards despite constraints.
- Ensure customer satisfaction and get a feedback on standards of work.

## UNIT 3.2: Prerequisites for Solar Panel Installation

### Unit Objectives



At the end of this unit, you will be able to:

1. Identify required tools and equipment
2. Construct the design of the solar PV system
3. Analyse the size and calculation of the components
4. Identify the wiring requirements

### 3.2.1 Tools and Equipment for Solar Panel Installation

For a solar panel installation, there are certain tools required for site assessments and installation. The panel installer must have the knowledge of different tools needed for analyzing site condition, mounting and installing solar panel. To mount solar panels, the panel installer need to gather the required equipment and consumables.

The tools required for site assessment are:

- Tape measure of 50-100 ft.
- Solar Pathfinder that will help in evaluating the solar energy potential of a site)
- Maps for calculating the latitude and magnetic declination of the location
- Digital camera to capture the location for future use.

Some other materials, such as a blanket and cardboard, are also required to keep the PV modules from being live during the installation process. Some tools are required especially for installing and maintaining the battery system. They are listed in the following figure:

|                  |  |
|------------------|--|
| Small flashlight | Used to view the electrolyte level       |
| Baking soda      | Used as a neutralizer for any acid spill |
| Funnel           | Used to fill electrolyte in the battery  |
| Distilled water  | Used as electrolyte for the battery      |

Fig. 3.2.1: Tools required for installing and maintaining the battery system

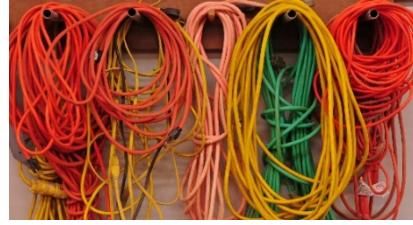
To prepare the location for installing solar panel, some electrical and mechanical tools and equipment are needed.

The following table lists the tools and equipment required for solar panel installation:

| Tool and equipment | Description  | Image  |
|--------------------|--|--|
| Angle finder       | Used to find degree of bend and precision angle  |  A circular magnetic angle finder with a dial and a base, placed on a blue surface. |
| Torpedo level      | Used to measure vertical, horizontal and diagonal planes   |  A yellow and black torpedo-style level with two vials.                              |
| Fish tape          | Used for routing wiring through the walls and electrical conduits  |  A coiled purple fish tape with a handle.  |
| Chalk line         | Used to mark straight lines on flat surfaces, where a hand does not reach  |  A black and orange chalk line reel with a coiled chalk line.                     |
| Cordless drill     | <ul style="list-style-type: none"> <li>Used to drive screws into various substrates without damaging them</li> <li>Are available in hammer drill configuration with a clutch</li> <li>Uses rechargeable batteries</li> </ul>   |  A red and black cordless drill with a drill bit attached.                        |
| Drill bits         | <ul style="list-style-type: none"> <li>Used to remove material for creating different kinds of holes in different materials</li> <li>Are attached to a drill to cut through the work object by rotating it</li> <li>Available in various shapes and sizes</li> </ul> |  A set of various sizes and types of twist drill bits.                             |

| Tool and equipment | Description   | Image  |
|--------------------|---|--|
| Hole saw           | <ul style="list-style-type: none"> <li>Is a saw blade of ring shape</li> <li>Creates a hole in the work object without having to cut up the core</li> </ul>   |   |
| Hole punch         | <ul style="list-style-type: none"> <li>Creates holes in sheets of paper which are used in a binder or folder</li> <li>Used on sheet metal, like aluminium siding or metal air ducts</li> </ul>  |    |
| Torque wrench      | <ul style="list-style-type: none"> <li>Used where the screw and bolt tightening is important</li> <li>Applies a specific torque to a fastener such as a nut or bolt</li> <li>Acts usually as a socket wrench that comes with special internal mechanisms</li> </ul> |   |
| Nut driver         | <ul style="list-style-type: none"> <li>Used to tighten the nuts and bolts</li> <li>Consists of a socket attached to a shaft and cylindrical handle</li> <li>Sizes of 7/16", 1/2", 9/16" are used for PV modules</li> </ul>  |  |
| Wire strippers     | Used to strip the insulation part from electric wires   |  |
| Crimpers           | Used to crimp, which is binding two pieces of metal by deforming one or both of them such that they hold each other   |  |

| Tool and equipment | Description  | Image   |
|--------------------|--|---|
| Needle-nose pliers | <ul style="list-style-type: none"> <li>Used to bend, re-position and snip wire</li> <li>Help in reaching areas where fingers or any other tool/instrument is less likely to reach</li> </ul> |     |
| Lineman's pliers   | <ul style="list-style-type: none"> <li>Used to grip, twist, bend and cut wire and cable</li> <li>Have a gripping joint at their snub nose and cutting edge in their jaws</li> </ul>          |     |
| Slip-joint pliers  | Are pliers with adjustable pivot point or fulcrum which increases the size range of their jaws   |   |
| Wire cutter        | Used for cutting wires. Both small and large wire cutters are needed for PV installation   |  |
| Multimeter         | Used to measure resistance, current and voltage  |  |
| Hacksaw            | Used for cutting metal as well as plastic pipe and plastic conduit   |   |

| Tool and equipment         | Description   | Image   |
|----------------------------|---|---|
| Tape measure               | <ul style="list-style-type: none"> <li>A ruler made of ribbon or cloth, fibre glass or plastic or metal strip</li> <li>Consists of linear-measurement markings</li> <li>Measures long length and around curves or corners</li> <li>Can be easily carried in pocket or toolkit</li> </ul>  |    |
| Heavy duty extension cords | <ul style="list-style-type: none"> <li>Flexible electrical power cables, also known as flex. They are attached to a plug at one end and one/multiple sockets at the other end</li> <li>Used in case of high voltage power supply for heavy work operations like power supply of large drilling machines on construction sites</li> </ul>          |     |
| Caulking gun               | <ul style="list-style-type: none"> <li>Holds a cartridge or tube filled with glue type material and is used to seal gaps/cracks</li> <li>Has caulk made of silicone or latex, and is used to bind a wide range of materials like metal, glass, wood and ceramic</li> <li>Used to seal joints or seams in various structures and piping</li> </ul> |   |
| Fuse Pullers               | Used to insert and remove electrical fuses from housing   |  |
| Clamp meter                | Used to measure the vector sum of the currents, which depends on their phase relationship, flowing in all the conductors passing through the probe  |  |

| Tool and equipment | Description  | Image |
|--------------------|--|-------|
| Reciprocating saw  | <ul style="list-style-type: none"> <li>Used to cut objects with push-and-pull ("reciprocating") motion of the blade</li> <li>Contains a large blade and a handle which allows the saw to be used comfortably on vertical surfaces</li> </ul> |       |
| Conduit bender     | Used in conjunction with a long lever to bend angles in conduit where the electric wires are placed  |       |
| Magnetic wristband | <ul style="list-style-type: none"> <li>Is a band worn on the wrist that has magnetic mechanism to hold the tools on the wrist band while you work.</li> <li>Can hold nails, fasteners, drill bits, small tools and wrenches</li> </ul>       |       |
| C-clamps           | Used to hold a wood or metal work object by turning the screw from the bottom of a frame until it reaches the required state of pressure or release  |       |

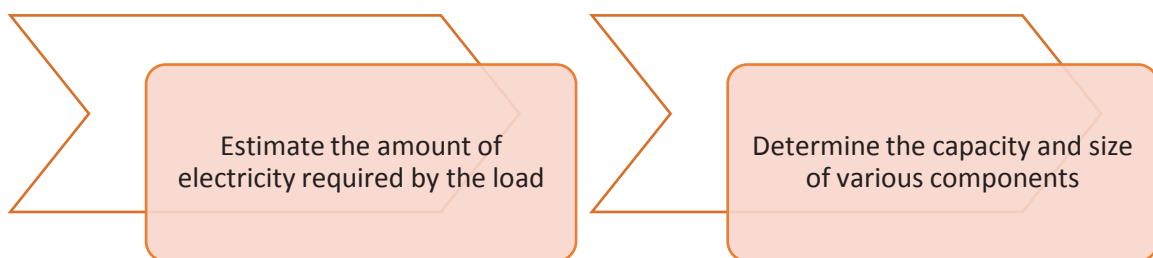
| Tool and equipment | Description   | Image   |
|--------------------|---|---|
| Stud finder        | Used to locate framing studs that are typically behind the final walling surface (usually drywall)  |    |
| Pry bar            | Consists of a metal bar with a single curved end and flattened points, usually with a small fissure on one or both ends for removing nails          |     |
| Refractometer      | Used for the battery system to measure refraction of light through the liquid. The index of refraction is calculated from the material composition. |    |
| Hydrometer         | Used to measure the gravity of a battery's electrolyte  |   |
| Voltmeter          | Used to measure potential difference between two points in the electric circuit   |  |

Fig. 3.2.2: Tools required for solar panel installation

### 3.2.2 Design of the Solar PV System

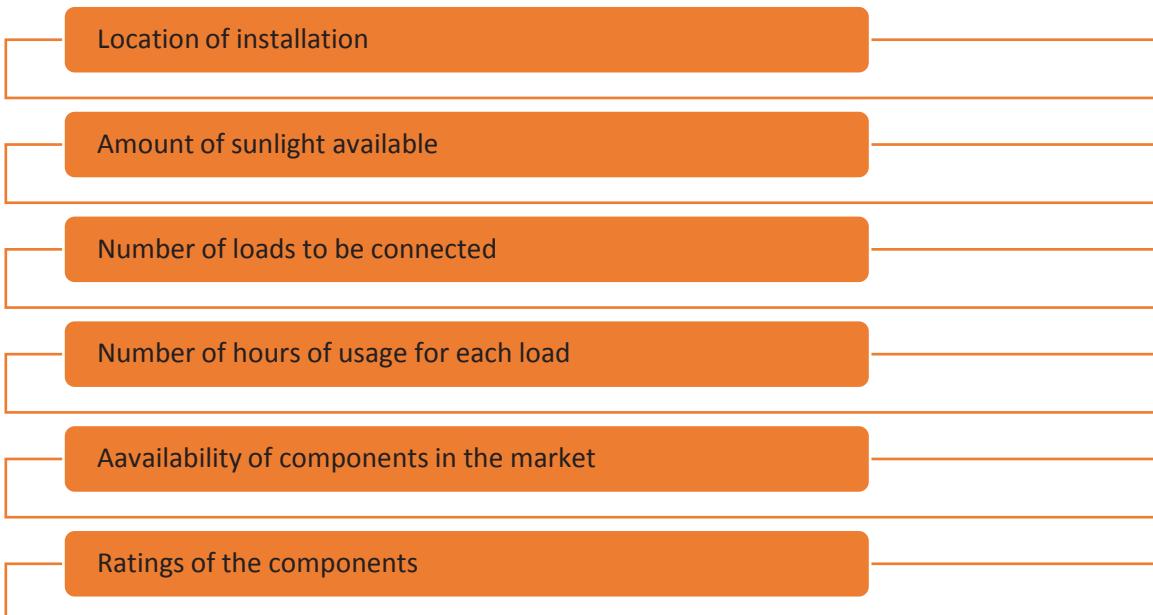
Each household has different electrical equipment leading to different requirements of electricity supply. The installation technician should take care of these varying requirements while designing solar PV systems. Each solar PV system is custom designed to meet the requirement of the customer.

The design of a solar PV system requires calculation of, the values of different components such as solar PV modules, battery, charge controller and inverter, required to make the complete PV system which is capable of supplying electricity to the connected load as required. The following figure lists the steps for designing a PV system:



*Fig. 3.2.3: Steps involved to design of a PV system*

To design a solar PV system, following information is required:



*Fig. 3.2.4: Information needed to design a solar PV system*

The design can be of two types:

- Approximate Design
- Precise Design

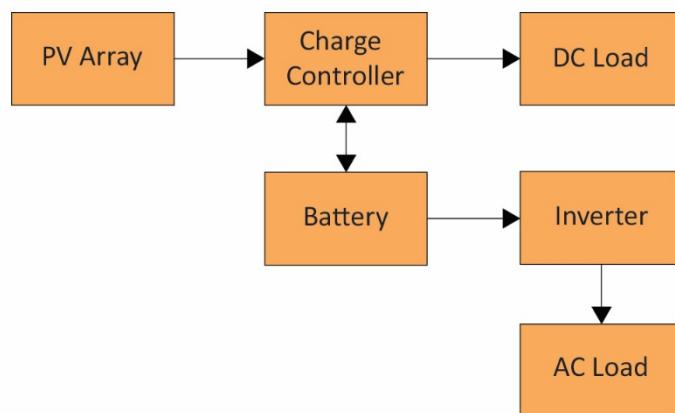
Since many parameters come into play in the design of solar PV systems, most of the time it is acceptable to create an approximate design. As the name suggest, this design may not be 100% correct. The approximate design is useful when your system size is not too large.

However, if the system is in several 10s of kW or 100s of kW, it is advisable to create a precise design where all the parameters that affect the performance of the PV system are considered.

### Approximate Design of a SPV System

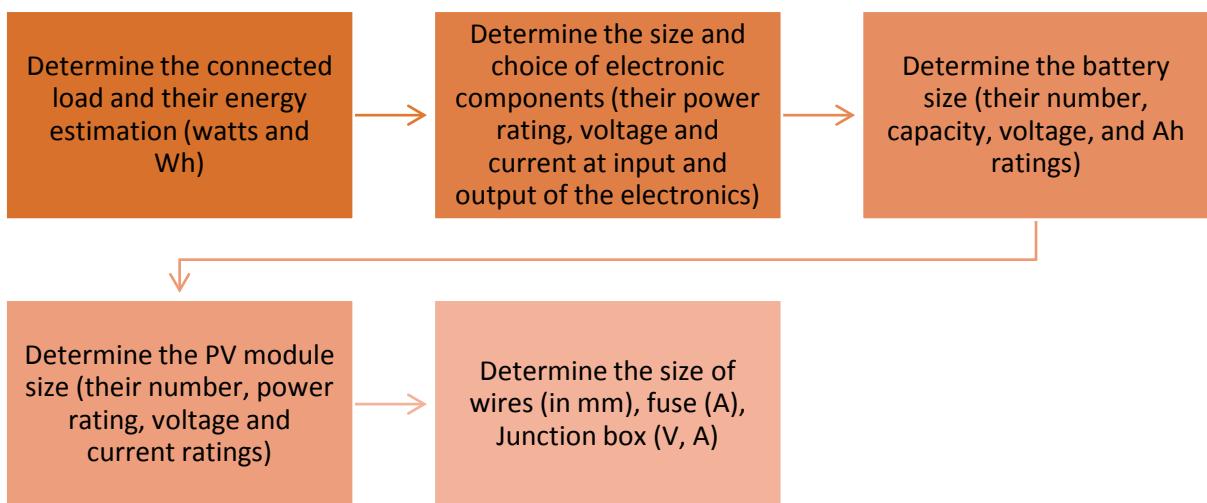
An approximate design is based on certain assumptions and parameters, neglecting the impact of temperature and radiation.

The energy flow diagram is useful in designing a solar PV system. During the sunshine hours, energy flows from the PV source to the battery through electronic circuitry through the power converters units like maximum power point tracking (MPPT) charge controller which is controlled by electronic circuits. When the load is operating, the energy flows from the battery to the load through the electronic circuitry (mainly charge controller, and through inverter in the case of AC loads). The following figure represents solar PV system's energy flow diagram:



*Fig.3.2.5: Energy flow diagram*

The design of a standalone PV system proceeds in the reverse direction of the energy flow. The following figure lists steps for approximate design of solar PV systems:



*Fig. 3.2.6: Steps for approximate design of solar PV systems*

### 3.2.3 Sizing and Calculation of the Components

After estimating the energy requirement of the load, choose the components suitable for the PV system. The determination of capacity of these components depends on the total voltage and current of the loads.

#### Capacity of Inverter:

The inverter should be selected in such a way that it can supply the desired power to the load. Hence, the desired output power of the inverter must be equal to the total connected power of the load. In practice, it is good to choose an inverter with a power capacity higher than the total connected load. The efficiency of the inverter can be calculated as:

$$\text{Efficiency } (\eta) = (\text{Output Power}/\text{Input Power}) \times 100\%$$

The efficiency of the inverter helps in estimating the required input power to the inverter. The following table shows the required capacity for the inverter:

| Load                  | Inverter       |            |  |
|-----------------------|----------------|------------|--|
| Total Wattage of Load | Efficiency (%) | Output (W) | Input (VA)                                     |
| 565                   | 93             | 565        | $(565 \times 100)/93$<br>=607.52 VA<br>=610 VA |

Fig. 3.2.7: Capacity of inverter

#### Selection of Charge Controller

The charge controller is selected as per the required input and output voltage and current of the load and the battery. It should be able to handle the currents and voltages that are likely to be flowing in the system. The following table shows the parameters required for selecting a charge controller:

| Energy (Wh) | Wattage (W) | Voltage (V) | Maximum Current (A) |
|-------------|-------------|-------------|---------------------|
| 3420        | 565         | 12          | 48                  |

Fig. 3.2.8: Charge controller parameters

To pass the maximum current, a charge controller must have sufficient ampere capacity. It is calculated by splitting the panel's peak-watt rate to 12V. For instance, a 100 Wh panel connected to a controller must have a charging capacity of  $8.33A$  ( $100 \div 12$ ).

Majority of appliances require more amperes in order to start rather than keep running. For instance, electrical motors require thrice the amount of ampere to keep running. Hence, a discharge controller should have sufficient ampere capacity that enable passing maximum current load, inclusive of extra current used for starting.

#### Battery Size for PV System

A battery is required since appliances utilize electricity at a wide-range of time and at different rates as compared to the output produced by a panel. To work properly, a system's battery must fall under the category of deep-discharge. At the same time, the battery must have the storage capacity

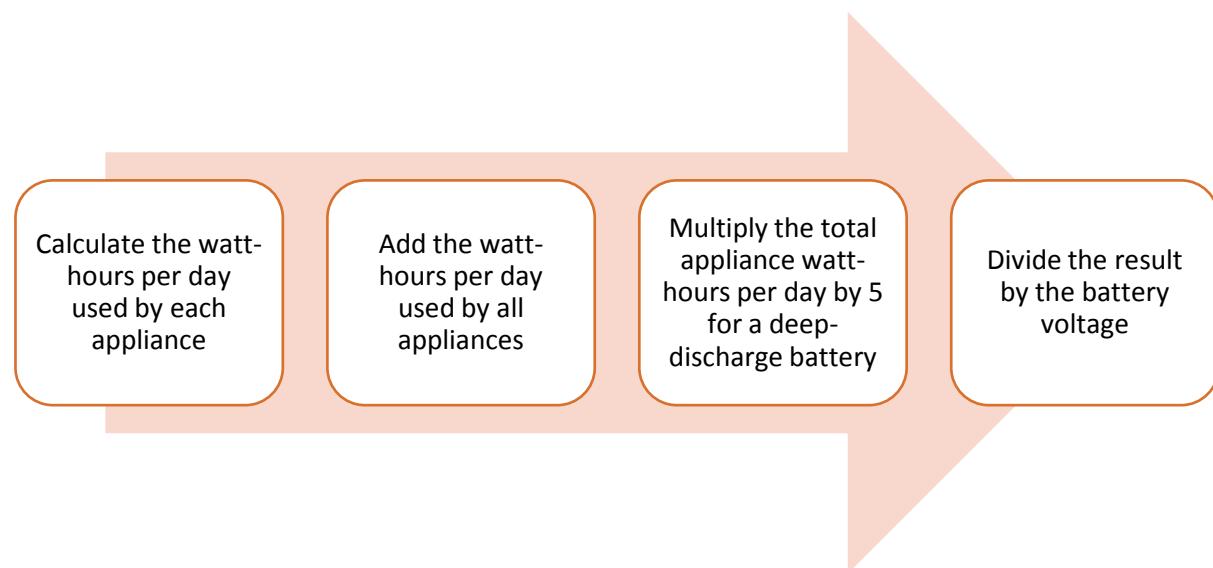
to operate such appliances at all times despite bad weather. To have a battery that lasts long, it must be

charged regularly. A large battery, which has the capacity to operate appliances for five days at a stretch without the need to recharge, must be installed.

Voltage and ampere-hour rate should be known before hand while purchasing a battery. A home based solar PV system should be 12V or 24V. The following points should be considered at the time of buying:

- The watt-hour capacity needed in the battery should be five times the total appliance watt-hours per daytime.
- The inverter and DC-DC converters will have some losses because they will have less than 100% efficiency. Therefore, batteries should be selected in such a way that they should not only supply the power and energy required by the load, but can also supply the loss of energy in inverter and/or DC to DC converters. In other words, the loss occurring at converter must be compensated by the battery.
- The size of the battery must be large enough so that the appliances will use one-fifth of its full charge in one day.

The following figure lists the steps for calculating battery size:



*Fig. 3.2.9: Steps for calculating battery size*

To determine the size and number of batteries needed, the parameters of the batteries to be considered. For example, if the DoD is 50%, only 50% of the total charge stored in the battery can be used. In solar PV system, normally the deep discharge batteries are used with DoD in the range of 50% to 60%.

The following table shows the actual battery capacity calculation:

| Energy  | System Voltage | Battery Capacity | DOD (%) | Actual Battery Capacity |
|---------|----------------|------------------|---------|-------------------------|
| 3420 Wh | 12V            | 3420/12= 285Ah   | 50      | 285/0.5 = 570Ah         |

*Fig. 3.2.10: Battery capacity calculation*

### PV Module Size

The solar PV module must supply enough energy to the battery, so that battery can supply enough energy to the inverter, to supply enough energy to the load as per the requirement.

The following table shows the required energy from solar PV module when the efficiency of the battery is 95%:

| Total Energy (Wh) | Battery Efficiency (%) | Energy from Solar PV Module |
|-------------------|------------------------|-----------------------------|
| 3420              | 95                     | $3420/0.95 = 3600\text{Wh}$ |

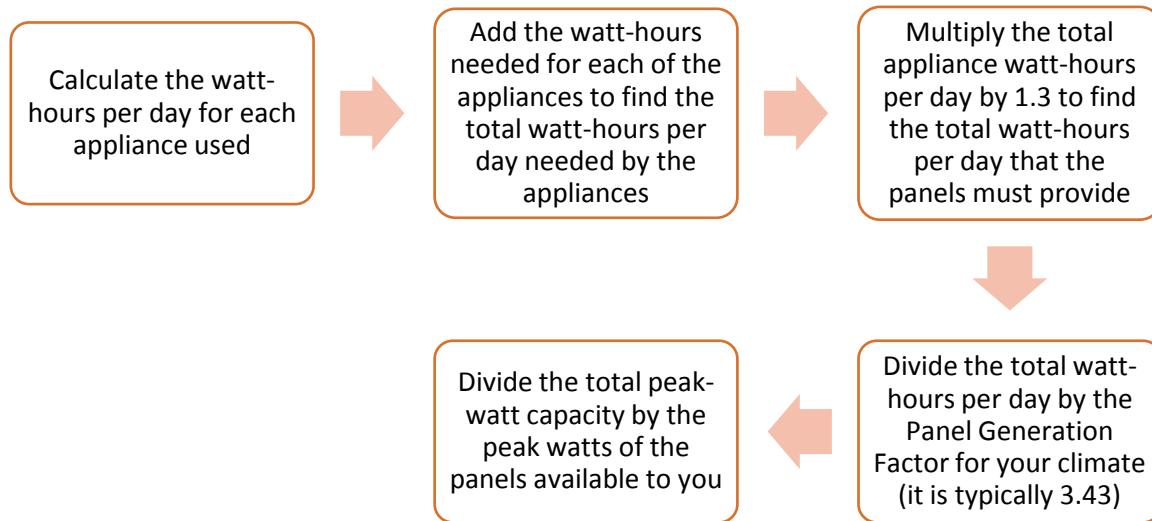
Fig. 3.2.11: Solar PV module energy

To estimate the requirement for the number of PV modules, the availability of solar radiation at the location where PV system is being installed must be considered. Typical daily solar radiation in India varies from 4-7 kWh/m<sup>2</sup>/day. For example, the daily solar radiation at the location where the system will be installed is 4.5kWh/m<sup>2</sup>/day. The estimated solar PV module wattage is shown in the following table:

| Energy from Solar PV Module | No. of Sunshine Hours | Solar PV Module Wattage        |
|-----------------------------|-----------------------|--------------------------------|
| 3600                        | 4.5                   | $3600/4.5 = 800 \text{ Watts}$ |

Fig. 3.2.12: PV module voltage

The following figure lists the steps to calculate the peak-watt capacity required in a system:



### Panel Generation Factor

A small panel of 1Wp shall provide 3.43Wh/day ( $120 \div 35$ ) as 35Wp is the average daily energy produced in tropical climate that produces 12Wh/day. The Panel Generation Factor for the said climate would be 3.43. The Panel Generation Factor varies with climate.

Fig. 3.2.13: Steps to find the peak-watt capacity

### Adjusting the Panel Generation Factor as per Climate

The system's size should fit even the cloudiest season to give its services all through the year. The following guidelines must be adhered to for estimating a panel output of different climates:

|                        |  |
|------------------------|--|
| <b>Climate Class 1</b> | Sunnier than the tropical coastal climate with many days of clear skies and few cloudy periods longer than four days. A desert location may be in this class. For this climate, use a Panel Generation Factor of 3.86. |
| <b>Climate Class 2</b> | A tropical coastal climate with most days partly cloudy. Fully cloudy periods are usually no more than five days long. For this climate, use a Panel Generation Factor of 3.43.  |
| <b>Climate Class 3</b> | Cloudy periods of five to seven days occur regularly but are typically followed by three or more clear days. For this climate, use a Panel Generation Factor of 3.0.   |
| <b>Climate Class 4</b> | Cloudy periods of ten or more days occur regularly and fully clear days are unusual. For this climate, use a Panel Generation Factor of 2.57.  |

*Fig. 3.2.14: Guidelines for estimating the panel output*

### Fuse and Junction Box Selection

Fuses and junction box are components that are also required for PV system installation. Fuses, wires and junction boxes should be chosen for the maximum possible currents and voltages that are likely to occur in the system. Mainly, the parameter used for choosing these products is current. Normally, a standalone system will have a DC side as well as an AC side. Therefore, the maximum voltage and current for both DC and AC sides must be considered. This estimation of maximum current is useful in deciding the appropriate components, fuses, junction boxes and wires.

## 3.2.4 Wiring Requirements

In any electrical system, wires are needed to connect power supply and load together. The choice of wires which includes choice of materials for wires, diameter of wires, and so on, plays an important role. The appropriate choice of wires is even more important in the case of solar PV applications, because a part of the system may be working on DC current and another part on AC current.

The appropriate choice of wires is important because:

- This will reduce the electrical losses in wires. Since solar PV power is expensive, it is important to minimize the power losses in wires as much as possible.
- This will help to avoid shock hazards and fire hazards in PV systems.

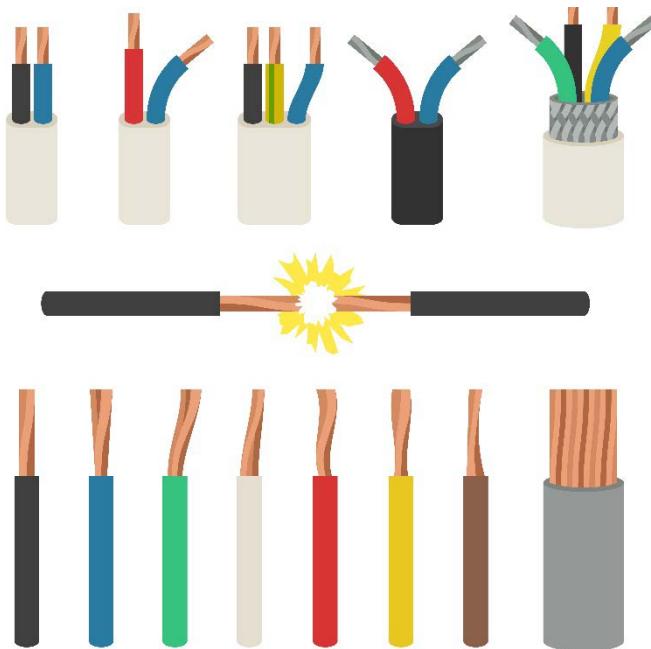
- This will help the system to perform better. If all the components in PV system are chosen sufficiently but appropriate wire is not available, the system may not perform as per the expectations. For example, if large current is flowing in a certain part of your PV system and wire that you have chosen is very thin, there may be lot of power loss in the thin wire, it may heat up and even burn. There may even be fire in the system and the whole system will stop working. In the worst case, the entire PV system may get destroyed.

Electrical wires are made up of metals because metals are the most electrically conductive materials. Wires are mostly made of metals such as silver, copper and aluminum. Copper wire is generally used as it is cheap and available.

Generally, wires are coated with any insulating material like polyvinyl chloride (PVC), nylon, and polyester, to prevent shock hazards and energy loss through unwanted current conduction and avoid short circuit between two wires running together.

When a bunch of wires run side by side wherein the wires may be bonded, twisted or braided together, it is referred as 'cables' or wire cable'.

The following image shows different types of wires:



*Fig. 3.2.16: Different types of wires*

### Voltage Loss in Wires

The voltage desirable to drive electricity in a wire is known as the voltage drop of the wire. It is important to choose appropriate conductor with low resistance to minimize voltage loss in DC wires and cables in PV systems. Wires with low resistance are of large diameter. But large diameter wires mean more material, which means large diameter wires are more expensive than small diameter wires of the same material. There is a trade-off between cost and resistance of wires. Therefore, some cost optimization of wire with respect to their resistance is required.

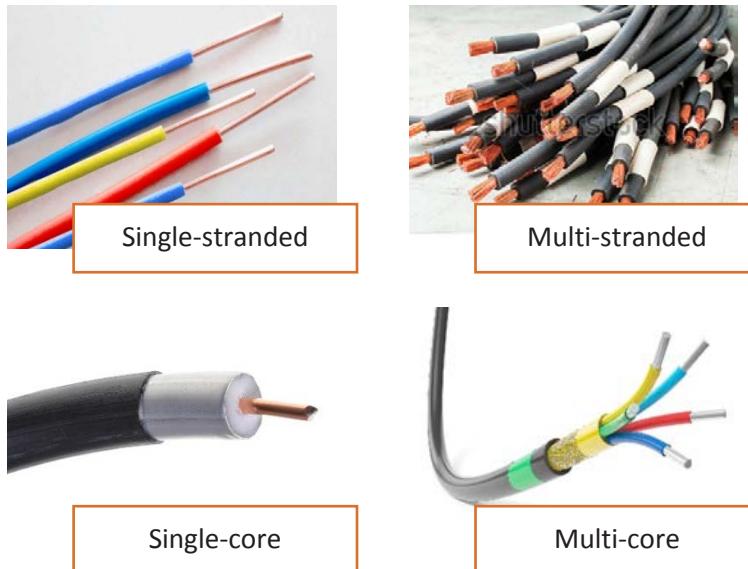
To avoid a greater voltage loss, the wiring rules as listed in the following figure should be considered:

- The length of wire should be as short as possible as per the required purpose.
- The voltage drop-in should not exceed 0.5V and 1V in a 12V system and a 24V system, respectively.
- A wire less than 2.5mm square in length should not be in PV system wiring.

*Fig. 3.2.17: Wiring rules to minimize voltage loss*

### Types of Wires

Wires can be divided into the following four categories, depending on their structures and applications. The following figure shows different categories of wires:



*Fig. 3.2.18: Different categories of wires*

### Solar Cable

A cable utilized for interconnection of solar panels or other electrical components in the generation of photovoltaic power is known as a solar cable.

The features of a solar cable are as follows:

- Designed as UV and weather resistant
- Laid outside and used between large temperature range
- Maximum DC voltage permissible is 1.8kV for single-core cables. DC rating should be Uo1.5kVDC from phase to ground with a temperature range of -40 °C to +90 °C ambient, a 25-year service life against thermal ageing 120 °C on the conductor.

- Should have a double insulation for protection against ground faults and short circuits
- The cable's cut-away needs to be proportionate so that 1% loss during economical operations is restricted.

MC4 extension cable and an electrical extension cord is quite similar. It has a female and male connector at each end, respectively. These cables are available in various lengths from 8 feet to 100 feet. The following image shows a solar cable with connectors:



*Fig. 3.2.19: Solar cable with connectors*

The use of an extension cable is not viable because the distance travelled by the wire in a solar panel set-up of a house or a cabin is normally very long. Therefore, in such cases the panels are connected to a combiner box with the help of an extension cable. This approach allows the use of cheaper wiring in an electrical conduit to cater to long distances; which in turn lead to less cost than MC4 cables.

Consider a 20 feet wire needs to go through the electrical equipment and two modules. A 50 foot extender cable shall suit the situation.

As per the combiner box location, one side of the panel string may have a greater distance than the opposite side.

### Solar Cable Connectors

The following image shows a solar PV cable connector:



*Fig. 3.2.20: A solar PV cable connector*

A PV module is designed with a junction box at the back. An installer attaches wires directly to the junction box when modules are wired together. The recent PV modules have been added with MC connectors that appear from the junction box. The MC connectors are weatherproof, safe and reliable.

The following table lists the connectors:

| Type         | Description   | Image |
|--------------|---|-------|
| Solar line 1 | <ul style="list-style-type: none"> <li>A common connector on modules, it has been available since mid-1990s and presently manufactures too.</li> <li>Rubbery ends of each connector fit the ridges. It is essential that no gaps exist for a good connection.</li> <li>Abbreviated as: MC1 or MC3 (for 3-millimeter connector)</li> </ul>   |       |
| Solar line 2 | <ul style="list-style-type: none"> <li>Built into modules from mid-2000 and are common today</li> <li>Rigid plastic, and on being engaged, it clicks together</li> <li>As per 2008 National Electric Code (NEC), connectors that lock and click must be used when PV modules are installed in accessible locations.</li> <li>Installer has an option of attaching an optional piece to the solar line 2 connectors, which provide a provision to lock. A special tool is required to unlock connectors.</li> <li>Abbreviated as: MC2, MC2L (L for locking) and MC4 (for 4mm connector)</li> </ul> |       |

Fig. 3.2.21: Connectors

### Size of Wires

More volts (electrical pressure) are needed to push a certain amount of amperes (current) across a wire in a smaller wire with less diameter. More panels and batteries should be installed to get a higher voltage, which includes extra cost. In large diameter wires, the voltage required to drive electricity through wires is low whereas the wire's cost is high. The best wire size will compensate the cost of a large wire with a low voltage and the extra panel cost from smaller diameter wires that are relatively cheaper.

More voltage is required to push certain amperes through a longer wire. In order to get an increased voltage, more panels and batteries should be installed, bearing extra cost. Short wires save cost and reduce the scope of power loss.

The following figure lists the steps to find the correct size of wire:

Estimate the appliance's rating of watt/ampere

Draw a rough estimate of the distance between battery and appliance, required by a wire to cover

Allow extra length of wires to be placed around windows or doors or place it in switches

Fig. 3.2.22: Steps for finding the required size of wire

The watt or ampere rating is usually shown on the label, although sometimes it can only be found on specification sheets packed with the appliance. The amperes used by an appliance can also be measured while it is in use with an ammeter.

## Activity



A house has the following DC loads rated at 12 V.

- Three 40W lights
- A 50W fan

All the loads are to be powered simultaneously using two parallel connected modules. Each module has a peak current of 2.5A and short circuit current of 3.5A. Choose the proper Charge Controller.

**Activity**

1. A household has 3 CFL lamp of 12 watt each, used for 6 hours per day, and a fan of 50 watt used for 10 hours per day. Estimate the total daily energy consumed by the households. All the loads use AC power.
2. A household has only DC loads. There are 5 LED lamps of 5 watt each and two DC fans of 30 watt each. There is also a TV that works on DC power and consumes 80 watt. All loads are operated for two hours per day. Estimate the total energy consumed in a day by all the loads.

## UNIT 3.3: Site Analysis

### Unit Objectives



At the end of this unit, you will be able to:

1. Recognize the key tasks involved in site analysis
2. Evaluate the location for installation
3. Analyse the customer's requirements
4. Identify the suitable mounting structures

Site analysis is an initial segment of urban and architectural process of designing, purely dedicated to a study of historical, geographical, legal, climatic and infrastructural background of a particular site. Before installing a solar energy system, site analysis must be carried out to evaluate the feasibility and efficiency of the system.

PV arrays are attached on the rooftops, ground or other structures providing adequate solar access along with protection and support. The conditions on site and its results typically dictate an appropriate approach to use and indicate a location for mounting a system. The following figure lists the key tasks involved in site analysis:

Assessing the prerequisites for solar panel installation

Evaluating the location of installation

Assessing the customer's requirement

Analysing the suitable mounting structures

*Fig. 3.3.1: Key tasks involved in site analysis*

### 3.3.1 Assessing the Prerequisites for Installing Solar Panel

Before starting the installation of solar panels, it must be ensured that the requirements for the installations are available. These requirements may include:

- Tools and equipment needed for the installation
- Cables to be used in the installation
- Structure materials needed for mounting
- Adequate number of proper PV system components
- Construction of the site where solar panels will be mounted.

The finest practices for solar energy system installation require a system optimization for solar energy production along with structural considerations. The following figure lists the elements that need to be optimized in a solar energy system:

**Roof orientation and panel orientation**

- Follow the sun's path in the sky to understand if an object casts a shadow over the solar photovoltaic panels; due to which operating efficiency of the unit will suffer.

**• Roof slope**

- Type of solar mount structures
- Associated safety issues

**• Shading**

- Placement of solar panel with respect to shading from trees, chimneys and vents.

**• Setback requirements**

- Local building rules and regulations
- Issues with regard to installer/maintenance
- Accessibility during an emergency
- Pressure from wind load

**• Type of roof**

- Shape (flat or sloped)
- Material (clay tile, asphaltic shingle, metal, shake)
- Placement and connections of panels

**• Panel array layout**

- Panel layout (landscape or portrait)
- Number of panels required

*Fig. 3.3.2: Elements to be optimized for better installation of solar energy system*

Trusses or rafters must be thoroughly inspected before installing a solar energy system. The spacing, condition and size must be assessed. It is difficult to inspect trusses even though analyzing a rafter's integrity is simple and direct. Truss cannot be repaired or modified without the assistance of a structural engineer. An assembly of pieces of wood connected along with steel plates forming a combined structural member is known as a truss. A truss resembles a common beam which supports load in an open space. The major variance in both is that every piece of a truss in tension, resists force, whereas a solid beam flexes when stressed. The construction must be strong enough to hold the panel for a long period, may be 20-25 years.

### 3.3.2 Evaluating the Location of Installation

Location for the solar energy system is one of the most important consideration. Whether the installing of the solar panel will be fruitful is dependent on the location. Earthquake loads and wind loads must be considered where applicable. The solar panel must be installed in a way that:

- The panels get sunlight for the maximum period
- The panels are kept out of any shade throughout the year
- The system can avoid obstruction such as trees, buildings and antennas, or soiling such as leaves and bird droppings because every small and partial shading of the module will cause a reduced system output. The presence of water and snow in the installation should also be considered as it can also affect the solar panels and the mounting structures.
- The sunlight falls perpendicularly on the panels so that they can absorb the maximum energy.

The following image shows solar panels in a snowy region:



*Fig. 3.3.3: Solar panels in a snowy region*

For example, the module should be facing true south in northern latitudes and true north in southern latitudes for best power production.

### 3.3.3 Assessing the Customer's Requirement

The panel installer should enquire customers about the purpose of the installation. Assessing their requirements and their preferences, the installer should suggest a type of PV systems that the customers may opt for. The customers must be informed of the following:

- The estimated cost for the installation
- The materials required for the installation
- Any civil construction that must be undertaken for the installation of the panels so that the panels get maximum solar energy.
- Remove all factors that restrain the sunlight to reach solar unit, for example trim branches or unnecessary item.
- Time required for the total process of installing the system

The types of load that will be attached to the PV system must also be assessed. It will help to identify the requirements of installation. The equipment, lights and appliances, power-driven using a PV solar system comprise PV system's electric loads. Loads that are energy-efficient give economic efficiency to an overall system. The following table lists the power consumption of some commonly used appliances:

| DC                        | Wattage | AC                         | Wattage   |
|---------------------------|---------|----------------------------|-----------|
| Fluorescent light         | 5-15    | Fluorescent light          | 7-25      |
| Stereo player             | 40      | Stereo player              | 100       |
| Television (25cm, colour) | 45      | Computer                   | 50        |
| Refrigerator              | 50-70   | Television (48 cm, colour) | 60-85     |
| Ceiling Fan               | 20      | Refrigerator (100 L)       | 90-150    |
|                           |         | Cooler                     | 200-300   |
|                           |         | Microwave oven             | 450-750   |
|                           |         | Power drill                | 450-1000  |
|                           |         | Toaster                    | 900-1100  |
|                           |         | Coffee Maker               | 850-1500  |
|                           |         | Air Conditioner            | 3000-4000 |

Fig. 3.3.4: Commonly used appliances

### 3.3.4 Analyzing Suitable Mounting Structures

The location, civil constructions and other requirements decide the suitability of a mounting structure. Ground mount structures are preferred for larger systems. Sometimes rooftop mount structures are preferred so that the ground can be used for other purposes.

A PV array's layout may have a substantial effect on operating temperatures and natural cooling such as:

- Considering passive cooling of the modules, there are chances of a horizontal layout having some benefit over vertical layout.
- A landscape unit allows more uniform cooling as air tends to be under a module for a shorter time frame before it escapes.
- A mounting placed 3 inches atop a roof is considered coolest.

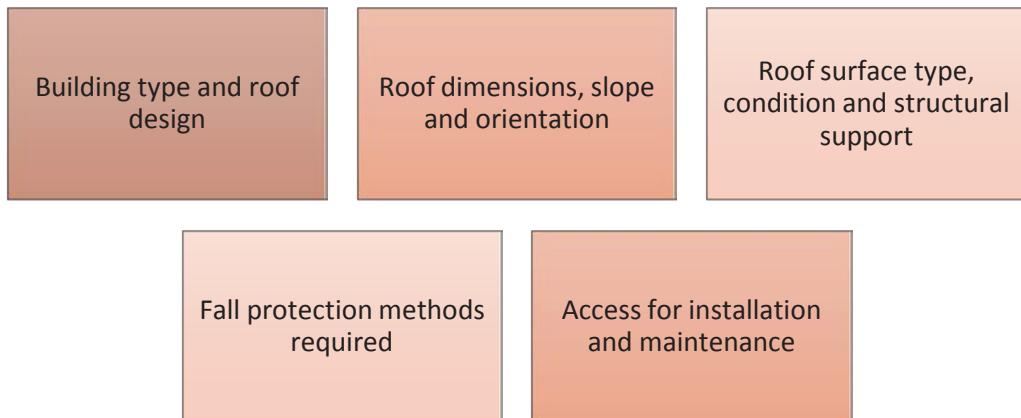
Mounting PV arrays on rooftop areas are restricted by the following factors:

- Necessary space for service and installation
- Fire cod's ventilation and pathway
- Setbacks by wind load
- Required space for other tools/equipment

Sloped roofs need fall protection systems or personal fall arrest systems for maintenance workers and installers. Photovoltaic arrays may be:

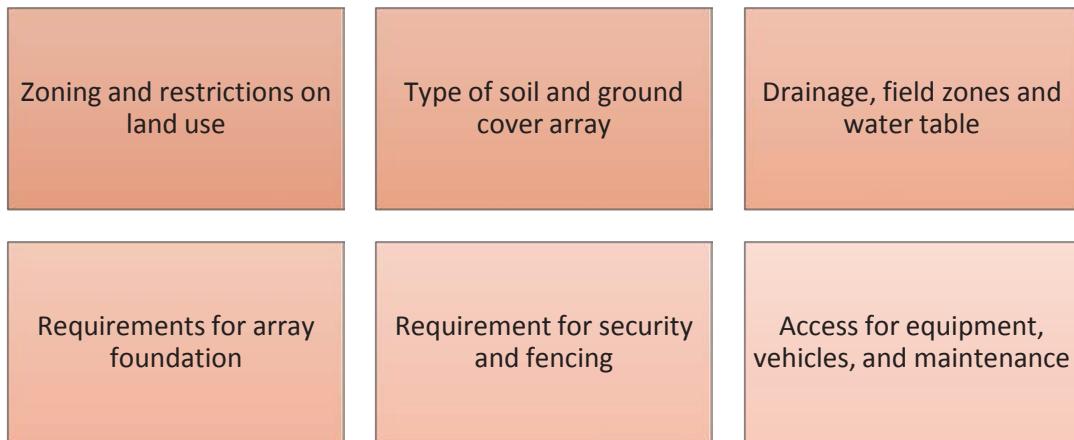
- Roof mounted on a sloping or a flat roof
- Ground free standing

Suitability of installation of a PV system's roof construction should be ensured. The following figure lists some major aspects to evaluate while conducting a site survey for roof-mounted PV arrays:



*Fig. 3.3.5: Some key items to evaluate during a site survey for roof-mounted PV arrays*

The following figure lists some key inspection points for the site survey for ground mounted PV array:



*Fig. 3.3.6: Some key items to evaluate during a site survey for ground-mounted PV arrays*

**Activity**

Create a checklist for prerequisites of panel installation.

## Activity

Look at the devices on the table. Note their wattage ratings labelled on them. Calculate the energy consumed if they run for 8 hours.

### Components:

- CFL (20W)
- Phone charger (4W)
- Laptop (50W)
- Lamp (60W)

## UNIT 3.4: Installation and Maintenance of Solar Panel

### Unit Objectives



At the end of this unit, you will be able to:

1. Identify the steps of solar panel installation
2. Assemble and fix the mounting structure
3. Execute setting up connection between different components of the PV system
4. Perform the troubleshooting of a PV system

Installation is a process in which the different components are connected in a systematic order to make a perfect working solar PV system to meet predefined demands. Based on the requirements of the customer, different types and different number of components are used in a PV system.

Solar modules require to be installed firmly on metallic structures to get it permanently fixed. The mounting structures depend on the size and application of the system. For example:

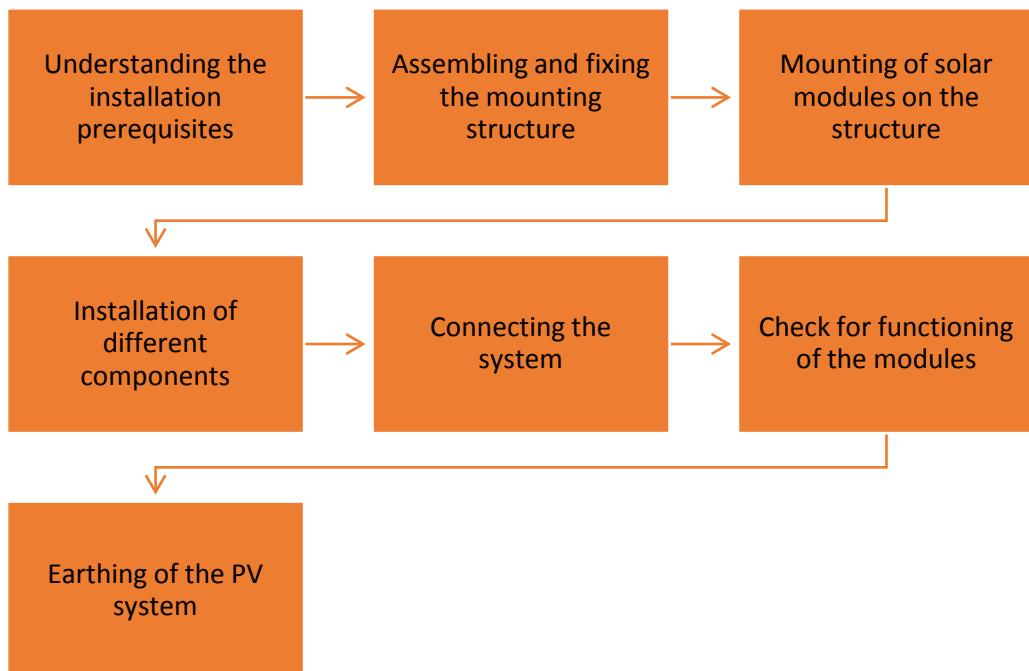
- For smaller systems, such as solar home systems, mounting structures used are simple enough.
- Pole mounting module structures are used for solar streetlights, solar pumps and solar-powered signal lighting,
- For bigger systems, such as solar power plants, larger array mounting structures are used.

Before starting the installation procedure, the panel installer needs to measure the value of the parameters of the panels that include:

- Short circuit current
- Open circuit voltage
- Maximum Current
- Maximum Voltage
- Maximum power (at STC) or Peak Power Output

### 3.4.1 Installation of Solar Panel

The following figure lists the steps of solar panel installation:



*Fig. 3.4.1: Steps for installing solar panel*

### 3.4.2 Understanding Installation Prerequisites

The PV technician must understand the prerequisites of the panel installation. He/she needs to:

- understand the requirement of the customer
- ensure availability of required equipment during installation
- certify the module is defect-free prior to installation
- undertake specified measures like corrosion resistance, fire resistance during module's installation

### 3.4.3 Assembling and Fixing the Mounting Structure

To mount the panels, the installer should determine the mounting method – whether it will be ground mount or roof mount. While mounting the solar modules, the installer should consider certain guidelines to ensure the maximum output from the solar modules.

The following figure lists the guidelines to ensure maximum output:

- 
- Orient modules towards south for maximum sunlight absorption
  - Produce more power under full sunlight at a low temperature
  - Track the sun to increase the amount of an array's power

*Fig. 3.4.2: Some guidelines for ensuring maximum output*

Due to the movement of the earth, there is a difference of angle at which the earth's surface receives the sun's rays over a year. At any particular place on earth, this variation in angle in one year may be up to 45 degrees. The following figure lists the facts that should be considered while installing solar panels:

Solar panels should be installed at an angle of '(LATITUDE of the place + 10) degree' from horizontal

Solar panels should be installed facing the south in northern hemisphere and north in southern hemisphere

Any obstruction (such as a tree or a building) should be avoided in the east, west or south of the place of installation

The support for the solar panel needs to be a robust one and should not be accessible to general public

It should be so installed that rainwater, bird dropping, leaves etc., do not accumulate and the top surface can be cleaned easily

The tilt of PV array and space between the rows of the arrays must be calculated to receive maximum light and to avoid shadow

*Fig. 3.4.3: Facts to be considered while installing solar panels*

## Precautions for Installing Structure and Mounting of PV Modules

In a PV system, depending on the requirement, the numbers of modules connected in a parallel and serial combination result in PV array. The array is kept in a sequence according to the number of modules in series and parallel, and accordingly, the structure for the array is designed and mounted on that structure. Following precautions must be taken:

- Mechanical structures should be designed keeping in mind the wind load data of the site where the solar photovoltaic system is being installed so that it can withstand that much wind load. There are standard norms that are followed to design a structure for the given wind load.
- The appropriate material should be used for mounting structure. Normally, the PV modules are supposed to last for 25 years; therefore, the PV structure should also be lasting for 25 years. Galvanized iron or aluminum steel structure can be used. Precaution must be taken to use the appropriate thickness of galvanization.
- Stainless steel bolts should be used to avoid any rusting during the lifetime of the system.
- All the connection should be tightly made to avoid any shorts and sparking.
- Different rated PV modules should not be connected in series and parallel combination.

### 3.4.4 Installation of PV System Components

After fixing the mounting structures as per the customer requirements, the PV technician needs to install the solar panels and other components such as battery, inverter and controllers.

#### Installation of PV Modules

PV modules come in a well-packaged form. To have safe a installation, the technician needs to find an appropriate place so that the dust settling on these components may be avoided.

The installer must:

- Carefully unpack the solar panel.
- Carefully handle the panels without damaging any panel.
- Mount the modules in either horizontal or vertical orientation above the fixture along with mounting rails with the help of bolts and nuts. In a vertical installation, the junction box's module clamp should point downward. The support module mounting structure, nuts and bolts, and clamps should adhere to all customary norms.
- Ensure that there is enough space between the two modules bearing in mind the linear thermal expansion of the module frames.
- Provide suitable ventilation for cooling under a module and to allow any condensation or moisture to dissipate.

The roof installation of solar module may affect the fire proofing of the house construction. The following figure lists some probable solutions for fire proofing:

Leave enough space between the modules so that fire fighting personnel can access the place in case of fire.

Place a fireman's switch around the PV module in the DC current line. Solar modules can be mounted on the rails using pre-drilled mounting holes which are located at the back of module frame

*Fig. 3.4.4: Some probable solutions for fire proofing*

#### Precautions for Installing PV Modules

The following figure lists some precautions that are required to be taken by the installer during the installation:

Monitor module Voc and Isc and check that they are within specified limits before installing the module.

The installation of modules should be done in dry weather condition using dry tools to avoid risk of electric shock.

Use mounting system recommended by manufacturer. Use predrilled mounting holes. Additional holes drilled in the frame may void the warranty.

Modules should not be stepped on during installation. No heavy or sharp edge items should be placed on them to avoid damage to the glass cover.

Ensure accessibility of the roof structure after modules are installed for maintenance. Preassembled & prewired modules may be used for roof areas difficult to access.

The corners and edges of frameless modules are particularly sensitive and are subjected to high level of breakage risk during installation.

When installing multiple modules on a support structure, lay out all modules before fastening to ensure they are aligned, leaving gaps between them.

Use an opaque material to cover the module during installation to avoid generation of any current.

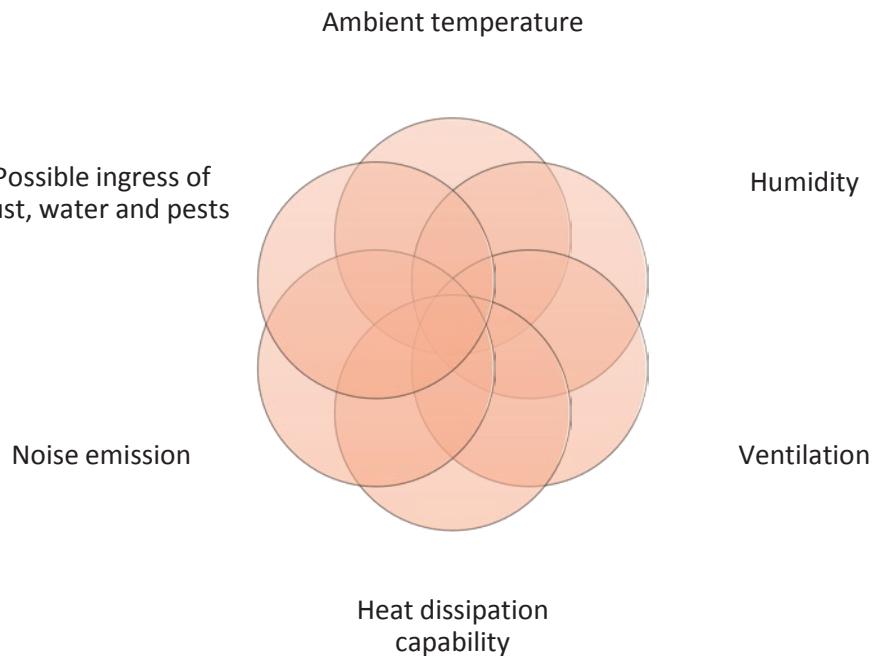
Do not disassemble or disturb a module's part.

*Fig. 3.4.5: Precautions for installing PV modules*

### Installation of Inverter

While installing the inverter, the PV installation technician must ensure that:

- The inverters are installed in a location where faultless operation is guaranteed. The following figure lists some factors that are to be considered:

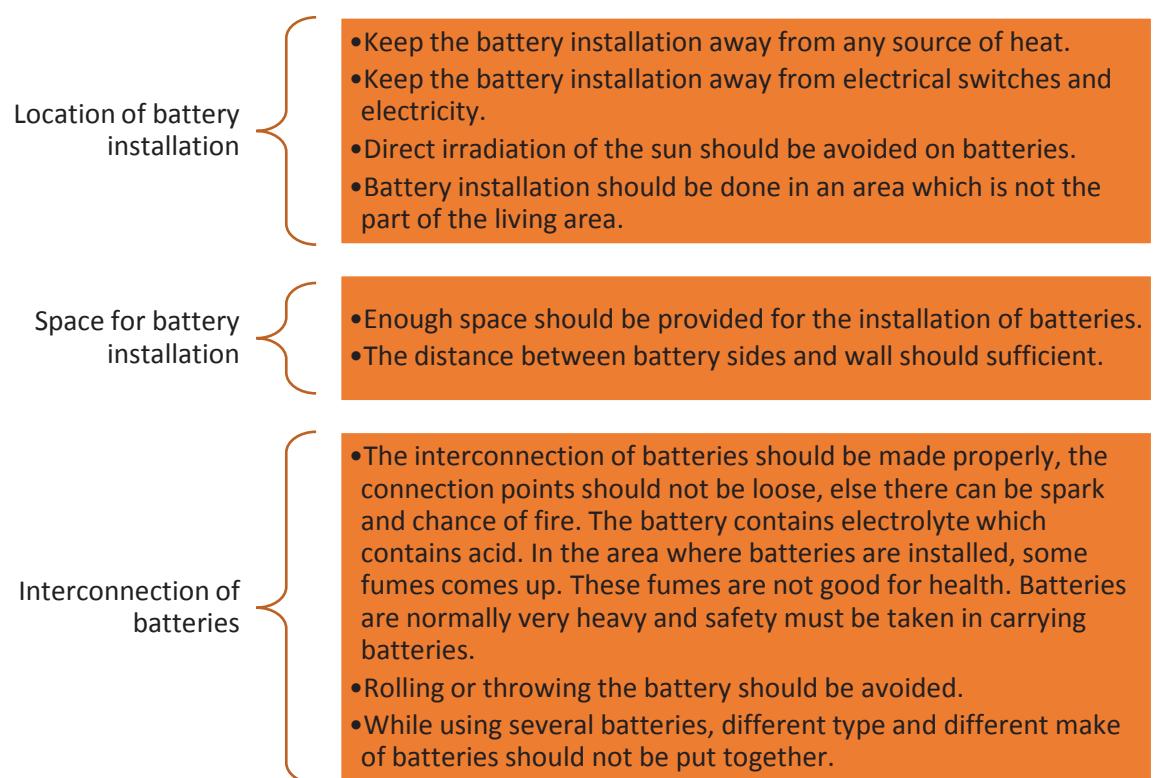


*Fig. 3.4.6: Factors for installation of inverters*

- The inverters must be easily accessible with sufficient space around them, for maintenance and servicing.
- The inverter mounted on the ground or a wall should be at a height convenient for reading its display.
- The inverter for large power application is mounted on ground and is securely bolted to the concrete floor.
- The inverter for small power application is mounted on a wall and is securely bolted to the wall.
- Ensure adequate open space is provided around ventilation panels for heat dissipation.

## Installation of Battery

The panel installer must consider the factors listed in the following figure for the installation of the battery:



*Fig. 3.4.7: Factors for installation of the battery*

## Installation of DC and AC Power Distribution Boxes

The installer should ensure:

- The DC and AC distribution boxes are located near the inverter.
- The array output wires from the combiner box are routed to the DC distribution box along the shortest route.
- The installation of wiring to the DC or the AC isolator switch and surge protection devices is ground fault and short circuit proof.
- For DC voltages > 50V, the two pole DC isolator switch has at least 5mm gap between the contacts to enable safe and reliable isolation.
- The plate of the DC isolator clearly states the DC voltage level of operation.
- The inverter input should be isolated when connecting to the DC distribution box and inverter output should be isolated when connecting to the AC distribution box.
- The AC distribution box may be combined with the load distribution box. If separate, it should be located near the load distribution box.
- The DC PV energy meter is installed inside the DC distribution box and the AC PV energy meter is installed inside the AC distribution box.
- The DC and the AC distribution box enclosures are connected to the ground.

### 3.4.5 Connecting the System

Cables are used to connect multiple PV modules in combination to generate the desired voltage and current. For carrying out the interconnection the panel installer must:

- Check the maximum system voltage as per the installation and follow adjustment measures accordingly to match output requirement.
- Use recommended cable to generate maximum voltage.
- Use recommended material of solar cable and plugs for electrical connection.
- Ensure that junction box is covered.

For cabling, the following rules listed in the following figure must be followed:

- Required length of cable shall be cut and terminals to be crimped.
- Wire size shall be increased as the length of the cable increases.
- All exposed wiring must be in conduits/capping-casing. DC and AC cables should be installed in separate conduits or enclosures and labelled.
- Wiring through roofing must be water proof. Cables should be laid in shadow areas where possible and they should not impede rain water run-off.
- Where the wiring is through flammable materials, like thatched roof, they must be in a metal conduit.
- For roof mounted installations, fix cables to the roof supports using suitable fastenings.
- Cables, fasteners and cable ties should be weather resistant.
- Cables should stay away from lightning conductors.
- Avoid sharp edges and mechanical damage to cable insulation.
- Use proper recommended tools and follow cable termination guidelines.
- Cable termination should be either crimped or soldered to suit terminal design.

*Fig. 3.4.8: Rules for cabling*

#### Interconnection of Components

The panel installer needs to connect the PV modules with other components such as junction box, controller and battery, and then check the functioning of the modules.

### Interconnection of Junction Box and PV Module

The installer must follow the following steps for connecting the junction box to the PV module:



1. Open the junction box of the module



2. Take cable with correct polarity



3. Connect the module cable



4. Close the junction box

Fig. 3.4.9: Steps for connecting the junction box to the PV module

Install spare fuse to avoid any short circuits as per company policy

### Interconnection of Charge Controller and PV Module

For interconnections between solar modules and charge controllers, some general installation guidelines must be followed:

- Minimum wire length must be used to avoid DC voltage drop.
- No wires are loosely connected.
- Different size of conductor for series and parallel connections and from junction box to the battery must be used to avoid the system's voltage from dropping.

The following figure lists the steps of interconnection of a charge controller and a PV module:

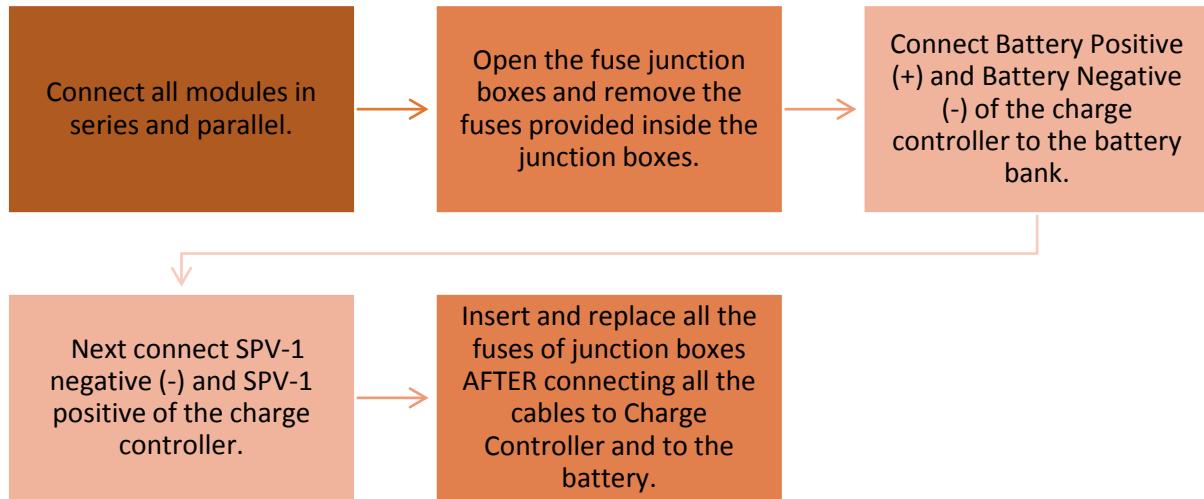


Fig. 3.4.10: Steps to interconnect charge controller and PV module

- Battery connections must be given first to charge controller. The charge controller will be damaged if the solar PV Array is connected first and then the battery bank.
- Switch OFF MCB of Charge Controller before any connection.
- Switch ON MCB of the Charge Controller when all the connections are thoroughly checked and fuses are replaced in the junction boxes.
- Do not short negative terminals of the system.
- All the positive (+) and negative (-) wires will run separately from the junction boxes.

### Precautions for Interconnecting the Components

The panel installer must:

- Ensure that modules with similar MPP currents are interconnected in a series string to avoid losses due to mismatching of modules.
- Interconnect module connectors under open circuit.
- For modules without connectors, use suitable clamp terminals, strain relief and waterproof cable feed-through when connecting cables into the module junction box. Ensure that the junction box cover is sealed and watertight.
- Not disconnect module connectors under load.
- Before disconnecting module connectors, turn off the inverter and trip the DC circuit breaker to isolate load. The module connectors can be disconnected under open circuit voltage.
- Measure string open circuit voltage before connecting in parallel with other strings.
- Ensure that the measurement of string I/V characteristics ensures that string MPP voltages and currents are matched within specified limits.

- Ensure that the string open circuit voltages are matched within specified limits.
- Ensure that fuses, blocking diodes and DC surge/lightning protection devices are installed and wired inside the combiner box.
- When connecting DC main cable into the combiner box, ensure that combiner box is isolated from PV string/array to avoid high risk of arc because of DC power input.
- Ensure ease of access for interconnections and maintenance of string/array combiner boxes while installing the boxes.
- When connecting DC main cable into inverter DC input, ensure that the inverter DC input is isolated using a DC circuit breaker.

### 3.4.6 Checking for Functioning of the Modules

A panel installer needs to check the functioning of the PV modules after setting up the connections between the system components and the panels. He/she needs to:

- Visually check the system after installation is complete
  - Check that all modules and system components are secured by bolts.
  - Check that all wiring connections are properly made as per diagrams and instructions.
  - Ensure all essential parts are grounded properly. Ensure all disconnects and circuit breakers are turned off and all fuses have been removed out of their holders.
  - Check the polarity of all PV strings and PV array, both at combiner boxes and at inverters.
  - Check open circuit voltages of all PV strings and PV array. The string open circuit voltages should be within specified tolerance.
- Ration the voltage through the circuit where shorting link is to be installed.
  - Only if this voltage is zero, install shorting link across the PV output's load side circuit while disconnect is open.
  - Do not insert a fuse/disconnect breakers towards the battery/inverter during these steps.
  - Then attach a PV string fuse in the first-string fuse holder.
  - Shut associated disconnect.
  - Measure the short circuit current, then open the disconnect.
  - Move the fuse to each circuit string and re-do the procedure. Every time, measure the current. The string short circuit currents should be as per the specified tolerance.
  - Remove the shorting link and open the disconnect on PV output circuit.
- Check that all the source string fuses are installed.
  - Estimate the PV array's open circuit voltage.
  - Ensure that the open circuit voltage is close to the lowest individual string open circuit voltage, measured and within specified tolerance.
- If the ground fault protection device trips in any of the above tests, ensure there is only one grounding point and follow troubleshooting procedure to find ground fault.
- Connect the inverter, PV array and the utility source by closing output disconnects/circuit breakers prior to the input disconnect/circuit breakers.
  - The inverter will remain off for some time with its input voltage close to a PV array open circuit voltage and an AC output current of zero.

- When the inverter begins delivering power to load/grid, the inverter output AC current as well as the DC input voltage and current will reach maximum power values.
- Monitor inverter output current using clamp-on current probe. Record inverter output AC Current, voltage and frequency. These should be within specified limits.
- Monitor inverter DC input voltage and current. Ensure they are within maximum power specification.

### 3.4.7 Earthing of the PV system

The panel installer must ensure the proper earthing of the PV system to protect the system from lightning. The following figure lists the reasons for earthing or grounding:

Equipment and system grounding is required to provide earth as a common reference point for various voltages, to restrict voltages because of lightning/accidental contact/line surges with lines having a high voltage and to provide current path for operation of over-current protection devices.

Equipment grounding maintains protection from shock which are a result of ground fault. It is an obligation in all PV systems.

*Fig. 3.4.11: Reasons for grounding the PV system*

The grounding consists of the grounding electrode, the grounded conductor and the grounding conductor.

The following figure lists the rules for grounding of PV system:

The grounded conductor is grounded at one point via the grounding electrode and the grounding conductors connect all equipment enclosures to the grounding electrode via the grounded conductor.

The equipment chassis is connected to grounding electrode via grounding conductor.

The PV array, the combiner box, the inverter, the DC and the AC distribution boxes require grounding.

The grounding conductor must not be fused or switched.

Array support structure should have equipotential bonding and grounding arrangements for safe conduction of capacitive discharge currents to ground.

All grid-connected PV systems have DC voltage well over 50V and require system ground. DC system grounding is done by connection of a negative conductor on ground at a single point.

The single point ground is located near the PV array for battery system protection from voltage surges.

AC system can use the same grounding electrode.

If two separate electrodes are used for DC and AC systems, they need to be bound together.

Jumpers can be installed for system and equipment grounding conductors to maintain ground continuity if one of the equipment is removed from the system.

Ground fault detector and interrupter (GFDI) is used to isolate grounded negative conductor from ground under ground fault condition.

GFDI also isolates undergrounded positive conductor. Most grid-tied inverters provide inbuilt fault protection for ground. If not, an external fault protection for ground is required.

Fig. 3.4.12: Some rules for grounding of PV system

### 3.4.8 Maintenance of PV System

Maintenance refers to fixing any sort of mechanical, plumbing or electrical work so that the component or equipment or system does not go out of order or break.

Maintenance can be of many different types. The following figure lists two basic type of maintenance:

| Unscheduled Maintenance  | Scheduled Maintenance   |
|--|---|
| <ul style="list-style-type: none"> <li>• Performed when there is a sudden fault or damage to the system or its components</li> <li>• Involves repair or replacement of components of the system</li> </ul> | <ul style="list-style-type: none"> <li>• Performed as a routine check up to maintain the components of a system so that the system and its components are in proper working condition</li> <li>• Done periodically</li> </ul> |

Fig. 3.4.13: Scheduled and unscheduled maintenance

The PV system and its components require less maintenance as compared to other power systems, although a few periodic maintenance tasks should be performed on the PV system components.

While performing maintenance for PV components it is must to refer to the component specification sheet or the catalogue provided by the supplier, so that the installer is:

- properly familiar with the component
- aware of the necessary precautions to be taken while maintaining the component.

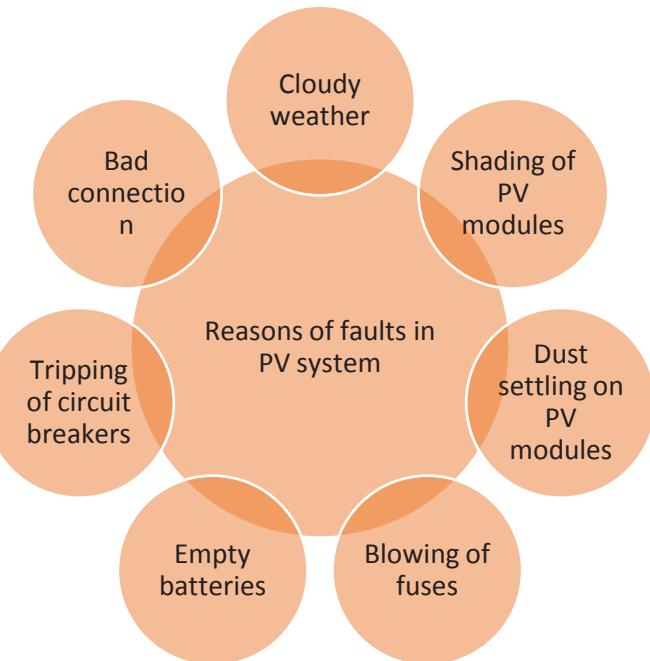
The associated components of a PV system, such as batteries and charge controller, need to be maintained:

- Once a fortnight the surface of the panels should be wiped clean with a wet rag to remove dust, fallen leaves, bird dropping, etc.
- Only water is to be used and no other cleaning agent.
- With solar panel secondary battery maintenance becomes minimum. Still general periodical maintenance of battery should be carried out in the usual manner and as per the maintenance manual.

### 3.4.9 Troubleshooting of PV System Components

A variety of problem solving and troubleshooting techniques are applied for repair of failed systems, processes or products. It is a reasonable, methodical search for the cause of a problem/issues for the purpose of a resolution and so that the module/process/system can be made functional again. Proper working of the PV system would be possible if during the initial phase of installation, a high quality and a proper designed system is installed, and, if regular maintenance of the system and its components, is done.

The following figure lists the probable reasons of fault in a PV system:



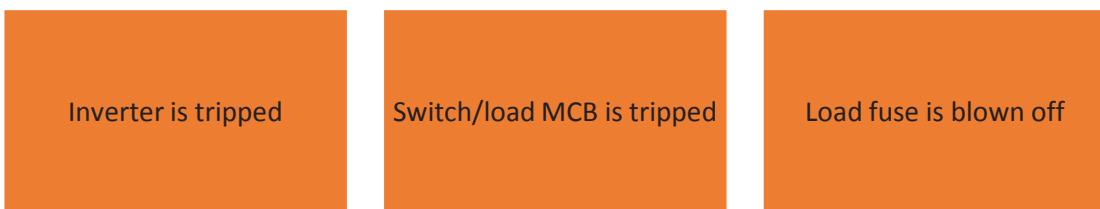
*Fig. 3.4.14: Probable reasons of faults in the PV system*

Basic troubleshooting starts with visual inspection of different components. A PV technician should be able to:

- Check the PV array for partial shading or dirt.
- Check all fuses and the circuit breaker.
- Check the junction boxes, the distribution boxes and wiring for loose connections and/or corrosion.
- Check the PV modules and batteries for proper series-parallel configurations.
- Check system wiring using multimeter for proper polarity and continuity.
- Check the meters installed in the system for proper voltage and current readings.

The solar PV power source is a reliable source of electrical energy. However, there may be rare instances when the solar PV power source is not able to drive the connected equipment. The diagnosis of the problem in such situations starts with the battery. A panel installer must:

- Check the voltage of the battery bank.
  - If the voltage of the battery bank is correct as indicated in the charge controller, the problem may be due to:



*Fig. 3.4.15: Checking the battery to resolve the issue*

- If none of the above faults is observed then analyze the exact gravity of electrolyte present in the battery's secondary cells. There may be two cases that are listed in the following figure:

Specific gravity is above the level as specified in the maintenance manual.

- Battery is in order and the problem would be either with the charge controller or the load.
- Disconnect the load from charge controller and connect it directly to the battery.
- If the equipment operates, the defect may be with the charge controller.
- Disconnect the charge controller and check as per troubleshooting instructions given in the manual supplied with it.
- If the problem is not solved, inform the manufacturer/supplier.

Specific gravity of the electrolyte is below the specified level and red LED is glowing.

- Loads may be drawing more current from the battery than required.
- In such case, battery is bound to get discharged, even if SPV Panel is functioning properly.
- This would result in frequent tripping of the load.
- To avoid this, get the load equipment checked and replace any defective components.
- The SPV Panel may not be producing required power for which the Power Source has been designed.
- Check for any loose connection/breakage of wire in SPV module interconnections.
- If there is no such loose connection, clean the SPV Modules with soft cloth.
- Whenever there is bright sunshine, measure the voltage and current of each module after disconnecting the wire.
- If any of the SPV modules gives low voltage/current output during bright sunlight inform the manufacturer/Supplier with module serial number along with the measurement taken, for necessary investigations.
- Failure of blocking diode
- If it is failed in short circuit mode, voltage across its terminal will be zero in place of 0.7 V while charging current flows through it.
- When it fails in open circuit mode, the current will not flow through the diode.
- The diode may be checked as per standard method of checking of diode by removing from the circuit.

Fig. 3.4.16: Steps to diagnose the problem

### 3.4.10 Troubleshooting faults in a PV System

The following table lists some fault symptoms along with their possible reasons:

| Symptom   | Probable cause  | Action   |
|---|---|--|
| No output                                       | <ul style="list-style-type: none"> <li>• Break of conductor</li> <li>• Corrosion of cable</li> <li>• Loose or improper connection</li> </ul>                                      | <ul style="list-style-type: none"> <li>• Replace cable</li> <li>• Check polarity and connection of wires</li> <li>• Ensure wires are non-corrosive</li> </ul>  |
|   | <ul style="list-style-type: none"> <li>• Defective connector</li> <li>• Loose connection</li> <li>• Corrosion of connector</li> <li>• Improper fixing of the connector</li> </ul> | <ul style="list-style-type: none"> <li>• Replace the connector</li> <li>• Adjust the connector properly</li> </ul>   |
|   | • Damaged junction box  | <ul style="list-style-type: none"> <li>• Send for servicing to the factory</li> </ul>  |
|   | • Charge controller fails   | <ul style="list-style-type: none"> <li>• Replace the charge controller</li> </ul>  |
|   | • Some internal problem   | <ul style="list-style-type: none"> <li>• Send to factory for exchange in warranty period</li> </ul>  |
| Output voltage okay, but no output current      | <ul style="list-style-type: none"> <li>• Internal damage of cell</li> <li>• Interconnection problem</li> </ul>  | <ul style="list-style-type: none"> <li>• Return to factory within the warranty period</li> </ul>   |
| No charging indication on the Charge controller | <ul style="list-style-type: none"> <li>• Shading of the SPV module</li> <li>• Dirt on panels</li> </ul>   | <ul style="list-style-type: none"> <li>• Remove the shades or change the location of the module and ensure maximum sunlight falls on the module.</li> <li>• Clear the particles on the module</li> </ul> |
|   | • Broken module   | <ul style="list-style-type: none"> <li>• Replace</li> </ul>  |
|   | • Electronic failure of charge controller   | <ul style="list-style-type: none"> <li>• Replace</li> </ul>  |
|   | <ul style="list-style-type: none"> <li>• Break of conductor</li> <li>• Corrosion of cable</li> <li>• Loose or improper connection</li> </ul>                                      | <ul style="list-style-type: none"> <li>• Replace cable</li> <li>• Verify the wire connections are tight, corrosion free and of correct polarity.</li> </ul>  |

Fig. 3.4.17 (a): Troubleshooting in PV system

| Symptom                            | Probable cause  | Action  |
|------------------------------------|---|---|
| Output voltage for less duration   | <ul style="list-style-type: none"> <li>• Shading of the SPV module</li> <li>• Dirt on panels</li> <li>• Improper installation</li> </ul>  | <ul style="list-style-type: none"> <li>• Remove the shades or change the location of the module and ensure maximum sunlight falls on the module.</li> <li>• Place the module in such a way that direct sunlight falls on the module for more hours.</li> <li>• Clear the particles on the module</li> </ul> |
|                                    | <ul style="list-style-type: none"> <li>• Broken module</li> </ul>   | <ul style="list-style-type: none"> <li>• Replace</li> </ul>   |
|                                    | <ul style="list-style-type: none"> <li>• Electronic failure of charge controller</li> </ul>   | <ul style="list-style-type: none"> <li>• Replace</li> </ul>   |
|                                    | <ul style="list-style-type: none"> <li>• Conductor has broken</li> <li>• Corrosion of cable</li> <li>• Loose or improper connection</li> </ul>                                  | <ul style="list-style-type: none"> <li>• Replace cable</li> <li>• Verify that the wire connections are tight, corrosion free and of correct polarity.</li> </ul>  |
|                                    | <ul style="list-style-type: none"> <li>• Insufficiently charged battery</li> <li>• Acid leak from battery</li> <li>• Low capacity</li> <li>• Battery terminal broken</li> </ul> | <ul style="list-style-type: none"> <li>• Charge the battery to full charge condition and check the output duration.</li> <li>• Replace battery</li> </ul>   |
| No voltage across blocking diode   | <ul style="list-style-type: none"> <li>• Diode failed in short circuit mode</li> </ul>  | <ul style="list-style-type: none"> <li>• Replace diode</li> </ul>   |
| Voltage high across blocking diode | <ul style="list-style-type: none"> <li>• Diode failed in open circuit mode</li> </ul>   | <ul style="list-style-type: none"> <li>• Replace diode</li> </ul>   |

Fig. 3.4.17 (b: Troubleshooting in PV system

## Activity



Create a maintenance schedule checklist for a PV system.

## Practical



**There is a sudden shut down and loss of energy in a PV system. Troubleshoot the problem.**

**Tools:**

- Clamp meter
- Screw drivers (or 11-in-1)
- Notepad
- Pencil
- Spare GFDI fuses
- Multimeter

**Practical**

**Measure the current of the PV module with a clamp accessory.**

**Tool:**

- Digital Multimeter (DMM)
- Current Output Clamp
- Voltage Output Clamp

## Practical



Wire and install a 1-kilowatt standalone PV system.

**Components:**

- 1/2" galvanized electrical conduit
- Copper grounding wire
- Concrete
- 4 x 4 posts
- 40-amp charge controller
- 24-volt 110-watt PV panels (8)
- 1/2" copper rod
- Electrical cable
- 12-volt, 255-amp sealed batteries (4)
- 5500-watt power inverter
- Nylon rope
- Angle brackets
- Angle finder
- Fuse combiner box
- Solar breaker
- Circuit breaker

**Practical**

The output of the PV system is low. Troubleshoot the problem.

**Components:**

- PV system with low output
- Faulty PV module
- 381 voltmeter
- 381 clamp meter
- DC ammeter

## Practical



Perform the maintenance activities of a PV system.

**Component:**

- Piece of cloth
- Electrolyte (ionized distilled water)
- Grease
- Torque wrench
- Baking powder solution
- Water
- PV system battery with corroded terminal

**Practical**

**Battery state of charge (SOC) is constantly below 1.5V. Troubleshoot the issue.**

**Components:**

- Faulty battery
- Wrench
- Distilled water
- Multimeter

## Practical



Perform a test for the earthing and lightning protection.

**Components:**

- Ohmmeter
- DC voltmeter

**Practical**

**Set up a cable connection for PV modules and other components in the PV system.**

**Components:**

- MC4 connector
- Cable trench or tray
- Flat head screw driver
- Class 2 SPD
- Cable
- 3 core, 5 core cables
- Wire stripper
- Spare fuse

## Practical



Install roof attachment for a flat roof mounting systems.

**Components:**

- Rails
- Clamps
- Purlins (supports boards or rafters, rests on principals, horizontal beam running lengthwise with the roof)
- PV modules
- Bolts

**Practical**

**Install roof attachment for a slope roof mounting systems.**

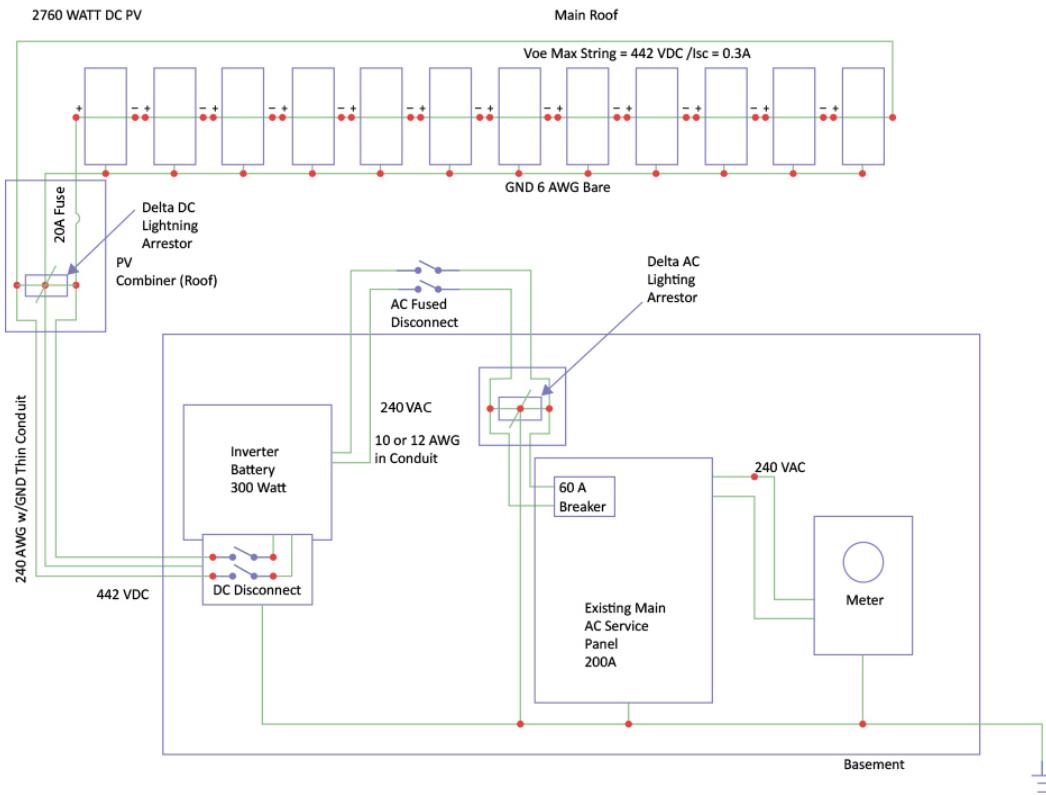
**Components**

- Hooks
- Screws
- Drill
- Hanger bolt
- Array structure
- Corrosion protection
- Weather protection
- Flange (strengthens or attaches a work piece to maintain position on a rail, is a projecting flat rim, collar, or rib structure on a work piece)
- Rubber seal
- PV modules
- Bolts and nuts

## Practical



Install a commercial grid-tied PV system as per the specification given in the diagram.





## 4. Soft Skills and Work Ethics

- Unit 4.1 – Effective Communication and Coordination at Work
- Unit 4.2 – Working Effectively and Maintaining Discipline at Work
- Unit 4.3 – Maintaining Social Diversity at Work



## Key Learning Outcomes



By the end of this unit, participants will be able to:

1. State the importance of work ethics and workplace etiquette
2. State the importance of effective communication and interpersonal skills
3. Explain ways to maintain discipline in the workplace
4. Discuss the common reasons for interpersonal conflict and ways of managing them effectively.

## UNIT 4.1: Effective Communication and Coordination at Work

### Unit Objectives



By the end of this unit, participants will be able to:

1. Work effectively at the workplace.
2. Demonstrate practices related to gender and PwD sensitization.

#### 4.1.1 Importance of Work Ethics and Workplace Etiquette

Workplace ethics are a set of moral and legal guidelines that organizations follow. These guidelines influence the way customers and employees interact with an organization. Workplace ethics essentially guide how an organization serves its clients and treats its employees.

For example, if a company seeks to fulfil the promises it makes, it may develop processes and set up a robust support system to address this policy and build customer/client loyalty. To achieve this goal, the company may implement specific incentive programs for employees to encourage them to produce high-quality work and ensure the organization fulfils the promises it makes to its clients/ customers.

Many organizations, often the large ones, set detailed ethical codes to guide their operations and control how the organizational processes impact the stakeholders. These ethics usually help organizations maintain certain standards of responsibility, accountability, professionalism and among others, as they navigate through different challenges and day-to-day circumstances. By following these guidelines, organizations often experience several benefits that improve the lives of stakeholders, such as customers, employees, leaders, etc.

##### Examples of Common Workplace Ethics



Fig. 4.1.1 Examples of Common Workplace Ethics

Workplace ethics are essential for a successful organization with a satisfied and loyal team. High ethical standards help in ensuring all stakeholders, such as customers, investors, employees, and other individuals involved in the workplace operations, feel the organization is safeguarding their interests. By creating and implementing ethical guidelines, organizations can keep the best interests of their employees in mind while maintaining a positive influence on those they impact through their processes. As a result, employees maintain the organization's best interests by being ethical in their daily work duties. For example, fairly-treated employees of an organization who understand the organization's commitments to environmental sustainability are usually less likely to behave in a manner that causes harm to the environment. Thus, they help maintain a positive public image of the organization. It means that workplace ethics help in maintaining reciprocal relationships that benefit organizations at large and the individuals associated with and influenced by the organizational policies.

### **Benefits of Workplace Ethics**

There are various benefits of implementing workplace ethics. When organizations hold themselves to high ethical standards, leaders, stakeholders, and the general public can experience significant improvements. Following are some of the key benefits of employing ethics in the workplace:



*Fig. 4.1.2 Benefits of Workplace Ethics*

## 4.1.2 Interpersonal Communication

Interpersonal communication is a process that involves sharing ideas and emotions with another person, both - verbally and non-verbally. It is essential to interact effectively with others in both personal and professional lives. In professional life or the workplace, strong interpersonal skills play a crucial role in achieving effective collaboration with colleagues.

### Interpersonal Skills

Interpersonal skills, in other terms, are known as people skills, which are used to communicate and interact with others effectively. These are soft skills one uses to communicate with others and understand them. One uses these skills in daily life while interacting with people

#### Examples of Interpersonal Skills



*Fig 4.1.3 Examples of Interpersonal Skills*

Numerous interpersonal skills involve communication. Communication can be verbal, such as persuasion or tone of voice — or non-verbal, such as listening and body language.

### Importance of Interpersonal Skills

Interpersonal skills are essential for communicating and collaborating with groups and individuals in both personal and professional life. People with strong interpersonal skills often are able to build good relationships and also tend to work well with others. Most people often enjoy working with co-workers who have good interpersonal skills.

Among other benefits of good interpersonal skills is the ability to solve problems and make the best decisions. One can use the ability to understand others and good interpersonal communication skills to find the best solution or make the best decisions in the interest of everyone involved. Strong interpersonal skills help individuals work well in teams and collaborate effectively. Usually, people who possess good interpersonal skills also tend to be good leaders, owing to their ability to communicate well with others and motivate the people around them.

Interpersonal communication is the key to working in a team environment and working collectively to achieve shared goals. Following are the interpersonal communication skills:

### **Verbal Communication**

The ability to speak clearly, appropriately and confidently can help one communicate effectively with others. It is vital to select the appropriate vocabulary and tone for the target audience.

For example – one should speak formally and professionally in the work environment, while informal language is acceptable in an intimate environment with close friends and family. Also, one should avoid using complex or technical language while communicating with an audience that may not be familiar with it. Using simple language in a courteous tone helps achieve better communication, irrespective of the audience.

### **Active Listening**

Active listening is defined as the ability to pay complete or undivided attention to someone when they speak and understand what they are saying. It is important for effective communication because without understanding what the speaker is saying, it becomes difficult to carry forward a conversation. One should ensure to use appropriate verbal and non-verbal responses, e.g. eye contact, nodding, or smiling, to show interest in what the speaker says. Active listening is also about paying attention to the speaker's body language and visual cues. Asking and answering questions is one of the best ways to demonstrate an interest in conversing with the other person.

Active listening is critical for communicating effectively without ambiguity. It helps one understand the information or instructions being shared. It may also encourage co-workers to share their ideas, which ultimately helps achieve collaboration.

### **Body Language**

One's expression, posture, and gestures are as important as verbal communication. One should practice open body language to encourage positivity and trust while communicating. Open body language includes - maintaining eye contact, nodding, smiling and being comfortable. On the other hand, one should avoid closed body language, e.g. crossed arms, shifting eyes and restless behaviour.

### **Empathy**

Empathy is the ability to understand the emotions, ideas and needs of others from their point of view. Empathy is also known as emotional intelligence. Empathetic people are good at being aware of others' emotions and compassionate when communicating with them. Being empathetic in the workplace can be good to boost the morale of employees and improve productivity. By showing empathy, one can gain the trust and respect of others.

### **Conflict Resolution**

One can use interpersonal communication skills to help resolve disagreements and conflicts in the workplace. This involves the application of negotiation and persuasion skills to resolve arguments between conflicting parties. It is also important to evaluate and understand both sides of the argument by listening closely to everyone involved and finding an amicable solution acceptable to all.

Good conflict resolution skills can help one contribute to creating a collaborative and positive work environment. With the ability to resolve conflicts, one can earn the trust and respect of co-workers. These are essential communication skills that are vital for success at work:

## Teamwork

Employees who communicate and work well in a team often have better chances of achieving success and common goals. Being a team player can help one avoid conflicts and improve productivity. One can do this by offering to help co-workers when required and asking for their feedback and ideas. When team members give their opinions or advice, one should positively receive and react to the opinions/advice. One should be optimistic and encouraging when working in groups.

## Improving Interpersonal Skills

One can develop interpersonal skills by practising good communication and setting goals for improvement. One should consider the following tips to improve their interpersonal skills:

- One should ask for feedback from co-workers, managers, family or friends to figure out what needs improvement concerning their interpersonal skills.
- One can identify the areas of interpersonal communication to strengthen by watching others.
- One can learn and improve interpersonal skills by observing co-workers, company leaders and professionals who possess good interpersonal skills. This includes watching and listening to them to note how they communicate and the body language used by them. It is vital to note their speed of speaking, tone of voice, and the way they engage with others. One should practice and apply such traits in their own interactions and relationships.
- One should learn to control their emotions. If stressed or upset, one should wait until being calm to have a conversation. One is more likely to communicate effectively and confidently when not under stress.
- One can reflect on their personal and professional conversations to identify the scope of improvement and learn how to handle conversations better or communicate more clearly. It helps to consider whether one could have reacted differently in a particular situation or used specific words or positive body language more effectively. It is also vital to note the successful and positive interactions to understand why they are successful.
- One should practice interpersonal skills by putting oneself in positions where one can build relationships and use interpersonal skills. For example, one can join groups that have organized meetings or social events. These could be industry-specific groups or groups with members who share an interest or hobby.
- Paying attention to family, friends and co-workers and making efforts to interact with them helps a lot. One should complement their family, friends and co-workers on their good ideas, hard work and achievements. Trying to understand someone's interests and showing interest in knowing them can help one build strong interpersonal skills. Offering to help someone, especially in difficult situations, helps build stronger and positive workplace relationships.
- One should avoid distractions, such as a mobile phone, while interacting with someone. Giving someone full attention while avoiding distractions helps achieve a clear exchange of ideas. By listening with focus, one can understand and respond effectively.

- One can attend appropriate courses on interpersonal skills or sign up for workshops at work to improve interpersonal skills. One can find many resources online also, such as online videos.
- For personal mentoring, one can approach a trusted family member, friend, co-worker, or current/former employer. A person one looks up to with respect and admires is often a good choice to be selected as a mentor. One can even hire a professional career or communication coach.

Interpersonal communication skills often help one boost their morale, be more productive in the workplace, complete team projects smoothly and build positive and strong relationships with co-workers.

# Notes



## UNIT 4.2: Working Effectively and Maintaining Discipline at Work

### Unit Objectives



**By the end of this unit, participants will be able to:**

- Discuss the importance of following organizational guidelines for dress code, time schedules, language usage and other behavioural aspects
- Explain the importance of working as per the workflow of the organization to receive instructions and report problems
- Explain the importance of conveying information/instructions as per defined protocols to the authorised persons/team members
- Explain the common workplace guidelines and legal requirements on non-disclosure and confidentiality of business-sensitive information
- Describe the process of reporting grievances and unethical conduct such as data breaches, sexual harassment at the workplace, etc.
- Discuss ways of dealing with heightened emotions of self and others.

### 4.2.1 Discipline at Work

Discipline is essential for organizational success. It helps improve productivity, reduce conflict and prevent misconduct in the workplace. It is important to have rules concerning workplace discipline and ensure that all employees comply with them. In the absence of discipline, a workplace may experience conflicts, bullying, unethical behaviour and poor employee performance. An efficient workplace disciplinary process helps create transparency in the organization. Benefits of disciplinary standards:

**All employees follow the same rules which helps establish uniformity and equality in the workplace**

**Managers and supervisors have defined guidelines on what action to take while initiating disciplinary action**

**With well-defined and enforced disciplinary rules, an organization can avoid various safety, security, reputational risks**

*Fig 4.2.1 Benefits of Disciplinary Standards*

Maintaining an organized and cohesive workforce requires maintaining discipline in both personal and professional behaviour. It is important to follow the appropriate measures to keep employees in line without affecting their morale.

### Defining Discipline

The first and crucial step in maintaining workplace discipline is to define what is meant by discipline. It helps to evaluate common discipline problems and devise guidelines for handling them effectively.

Among a number of areas, discipline usually covers:

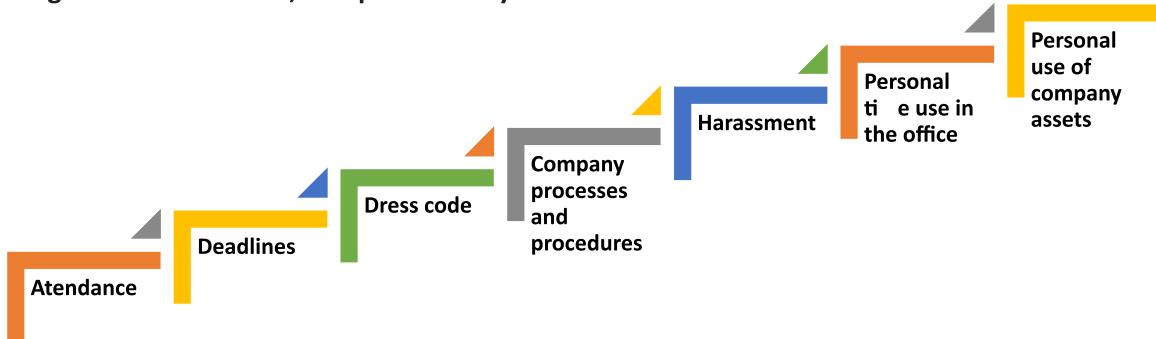


Fig 4.2.2 Examples of Workplace Discipline

According to demography and local issues, it may also include substance use and related issues.

It is vital for a workplace to have an employee handbook or company policy guide, to serve as a rulebook for employees to follow. The employee handbook/ company policy guide should be reviewed and updated periodically according to any issues or areas, or concerns identified concerning workplace discipline. Such manuals should also cover all the laws and regulations governing workplace behaviour.

Defining and documenting workplace rules aids in their implementation, ensuring little or no ambiguity. All employees in a workplace should also have easy access to the workplace guidelines so that they can refer to them to get clarity whenever required. To maintain discipline at work, it is also critical to ensure uniform application of workplace guidelines to all employees without exception.

## 4.2.2 Employee Code of Conduct

The employee code of conduct manual serves as a guide for employees to inform them regarding the behaviour expected from them at work. It helps create a good work environment with consistent behaviour from employees. The manual should list examples of acceptable and not acceptable behaviours at work. The code of conduct should be discussed with employees so that they have the clarifications required.

For example, an organization may create guidelines concerning the conduct with clients to ensure no contact is made with them except for business purposes, also prescribing the use of appropriate means of communication.

Employees should have a clear understanding concerning their job responsibilities and the behaviour expected from them with all stakeholders, e.g. company personnel, clients and associated third parties. It is critical to have documented guidelines for employees to follow concerning all aspects of work. It should also document the disciplinary action to be followed in case of non-compliance, e.g. verbal and

then written warning, temporary suspension or eventual termination of service in case of repeated non-compliance with the employee code of conduct. Employees should know what the company rules are and what will happen if they break the rules. However, disciplinary action should be initiated only when reasonably required to avoid its misuse for employee harassment.

There should also be an effective mechanism for employees to raise their concerns/ grievances and have them addressed while maintaining privacy, as required, e.g. raising concerns regarding the behaviour of a co-worker.

The employee code of conduct manual must be duly reviewed and approved by the concerned stakeholders, such as the Human Resources (HR) department and company executives.

### 4.2.3 Interpersonal Conflicts

Interpersonal conflict is any type of conflict between two or more people. These are found in both - personal and professional relationships - among friends, family, and co-workers. In the workplace, interpersonal conflict is often observed when a person or group of people interfere with another person's attempts at completing assignments and achieving goals. It is critical to resolve conflicts in the workplace to boost the morale of employees, repair working relationships among them, and improve customer satisfaction.

#### Reasons for Workplace Conflicts

Workplace conflicts are often observed when two or more people have different points of view. This can happen between managers, co-workers, or clients and customers. In general, interpersonal conflicts are caused by a lack of communication or unclear communication.

Some of the leading reasons for workplace conflicts are:

- Difference in values
- Personality clashes
- Poor communication

Example of poor communication – if a manager reassigns a task to another employee without communicating with the employee to whom it was originally assigned, interpersonal conflict can arise among them. This may potentially make the first employee, i.e. who was originally assigned the task, feel slighted and mistrusted by the manager. It may even cause animosity in the first employee toward the employee who has now been assigned the task.

## Types of Interpersonal Conflict

Following are the four types of interpersonal conflicts:

a. **Policy-related interpersonal conflict**

When a conflict relates to a decision or situation that involves both parties, it can be called a policy-related interpersonal conflict. Example – two people or groups working on the same project, trying to adopt different approaches. To resolve policy-related interpersonal conflicts, the parties involved should try to look for a win-win situation or make a compromise. This is especially critical to resolve trivial issues so that work is not affected and common goals are achieved.

b. **Pseudo-conflicts**

Pseudo-conflict arises when two people or groups want different things and cannot reach an agreement. Pseudo-conflicts usually involve trivial disagreements that tend to hide the root of the issue.

c. **Ego-related interpersonal conflicts**

In ego conflicts, losing the argument may hurt or damage a person's pride. Sometimes ego conflicts arise when a number of small conflicts pile up on being left unresolved. To resolve ego-related conflicts, it's best to find the root of the issue and work towards a resolution.

d. **Value-related interpersonal conflicts**

Sometimes conflicts may occur between people when they have different value systems. Such conflicts can be difficult to identify initially, making the people involved think the other party is being disagreeable or stubborn, wherein they just have different values. Some co-workers may highly value their personal/ family time after office that they may be unreachable to clients during non-office hours, while others may place a high value on client satisfaction and may still be available for clients during non-office hours. Conflict may arise among such people when they may be required to coordinate to help a client during after-office hours. Value-related interpersonal conflicts are often difficult to settle since neither party likes to compromise.

## Resolving Interpersonal Conflicts

Conflicts are usually likely in the workplace; they can, however, be prevented. Often resolving interpersonal conflicts through open communication helps build a stronger relationship, paving the way for effective coordination and success. Some ways to resolve interpersonal conflict:

- **Communication** - A great way to resolve interpersonal conflicts is for the opposing parties to listen to one another's opinions and understand their viewpoints. Meeting in person and keeping the conversation goal-oriented is important. One can have effective communication by following some measures, e.g. staying on the topic, listening actively, being mindful of the body language, maintaining eye contact, etc.

- **Active Listening** - One should patiently listen to what the other person is saying without interrupting or talking over them. It helps one display empathy and get to the root of the issue. Asking questions to seek clarification when required helps in clear communication and conveys to the other person that one is listening to them. Practising active listening is a great way to improve one's communication skills.
- **Displaying Empathy** - Listening attentively and identifying the anxieties/ issues of co-workers is a great way to show empathy and concern. It is essential to understand their feelings and actions to encourage honesty and avoid future conflict.
- **Not Holding Grudges** - With different types of people and personalities in a workplace, it is common for co-workers to have conflicts. It is best to accept the difference in opinions and move on. Being forgiving and letting go of grudges allows one to focus on the positive side of things and perform better at work.

Work-related interpersonal conflicts can be complicated because different people have different leadership styles, personality characteristics, job responsibilities and ways in which they interact. One should learn to look above interpersonal conflicts, resolving them to ensure work goals and environment are not affected.

#### 4.2.4 Importance of Following Organizational Guidelines

Policies and procedures or organizational guidelines are essential for any organization. These provide a road map for the operations of the organization. These are also critical in ensuring compliance with the applicable laws and regulations by guiding the decision-making process and business operations.

Organizational guidelines help bring uniformity to the operations of an organization, which helps reduce the risk of unwanted and unexpected events. These determine how employees are supposed to behave at work, which ultimately helps the business achieve its objectives efficiently.

However, organizational guidelines are ineffective and fail to serve their purpose if they are not followed. Many people don't like the idea of following and abiding by specific guidelines. Such people should be made to understand the benefits of following the organizational guidelines. Some of the key benefits are given below:

With well-defined organizational guidelines in place, no individual can act arbitrarily, irrespective of their position in the organization. All individuals will know the pros and cons of taking certain actions and what to expect in case of unacceptable behaviour. Benefits of following organizational guidelines:

- Consistent processes and structures - Organization guidelines help maintain consistency in operations, avoiding any disorder. When all employees follow the organizational guidelines, an organization can run smoothly. These ensure that people in different job roles operate as they are supposed to, knowing what they are responsible for, what is expected of them, and what they can expect from their supervisors and co-workers. With clarity in mind, they can do their jobs with confidence and excellence. With every person working the way intended, it's easy to minimise errors.

With all the staff following organizational guidelines, the organization has a better scope of using time and resources more effectively and efficiently. This allows the organization to grow and achieve its objectives.

- **Better quality service** - By following organizational guidelines, employees perform their duties correctly as per the defined job responsibilities. It helps enhance the quality of the organization's products and services, helping improve the organization's reputation. Working with a reputable organization, employees can take pride in their work and know they are contributing to the reputation.
- **A safer workplace** - When all employees follow organizational guidelines, it becomes easy to minimise workplace incidents and accidents. It reduces the liabilities associated with risks for the organization and limits the interruptions in operations. Employees also feel comfortable and safe in the workplace, knowing their co-workers are ensuring safety at work by following the applicable guidelines.

Different organizations may have different guidelines on dress code, time schedules, language usage, etc. For example – certain organizations in a client-dealing business requiring employees to meet clients personally follow a strict dress code asking their employees to wear formal business attire. Similarly, organizations operating in specific regions may require their employees to use the dominant regional language of the particular region to build rapport with customers and serve them better. Certain organizations, such as banks, often give preference to candidates with knowledge of the regional language during hiring.

Working hours may also differ from one organization to another, with some requiring employees to work extra compared to others. One should follow the organizational guidelines concerning all the aspects of the employment to ensure a cohesive work environment.

## 4.2.5 Workflow

Workflow is the order of steps from the beginning to the end of a task or work process. In other words, it is the way a particular type of work is organised or the order of stages in a particular work process.

Workflows can help simplify and automate repeatable business tasks, helping improve efficiency and minimise the room for errors. With workflows in place, managers can make quick and smart decisions while employees can collaborate more productively.

Other than the order that workflows create in a business, these have several other benefits, such as:

- Identifying Redundancies - Mapping out work processes in a workflow allows one to get a clear, top-level view of a business. It allows one to identify and remove redundant or unproductive processes.

Workflow gives greater insights into business processes. Utilizing such useful insights, one can improve work processes and the bottom line of the business. In many businesses, there are many unnecessary and redundant tasks that take place daily. Once an organization has insight into its processes while preparing workflow, it can determine which activities are really necessary.

Identifying and eliminating redundant tasks creates value for a business. With redundant tasks and processes eliminated, an organization can focus on what's important to the business.

- Increase in Accountability and Reduction in Micromanagement - Micromanagement often causes problems in a business setting as most employees don't like being micromanaged, and even many managers don't like the practice. Micromanagement is often identified as one of the reasons why people quit their job.

However, the need for micromanagement can be minimized by clearly mapping out the workflow. This way, every individual in a team knows what tasks need to be completed and by when and who is responsible for completing them. This makes employees more accountable also.

With clearly defined workflow processes, managers don't have to spend much time micromanaging their employees, who don't have to approach the manager to know what the further steps are. Following a workflow, employees know what is going on and what needs to be done. This, in turn, may help increase the job satisfaction of everyone involved while improving the relationships between management and employees.

- Improved Communication - Communication at work is critical because it affects all aspects of an organization. There are instances when the main conflict in an organization originates from miscommunication, e.g. the management and employees disagreeing on an aspect, despite pursuing the same objectives. Poor communication is a common workplace issue that is often not dealt with.
- This highlights why workflow is important. Workplace communication dramatically can increase with the visibility of processes and accountability. It helps make the daily operations smoother overall.

- Better Customer Service - Customers or clients are central to a business. Therefore, it is imperative to find and improve ways to improve customer experience. Relying on outdated manual systems may cause customer requests or complaints to be overlooked, with dissatisfied customers taking their business elsewhere. However, following a well-researched and defined workflow can help improve the quality of customer service.

By automating workflows and processes, an organization can also reduce the likelihood of human error. This also helps improve the quality of products or services over time, resulting in a better customer experience.

#### 4.2.6 Following Instructions and Reporting Problems

All organizations follow a hierarchy, with most employees reporting to a manager or supervisor. For organizational success, it is vital for employees to follow the instructions of their manager or supervisor. They should ensure they perform their duties as per the given instructions to help achieve the common objectives of the organization and deliver quality service or products. This consequently helps maintain the reputation of the organization.

It is also important to be vigilant and identify problems at work or with the organizational work processes. One should deal with the identified within their limits of authority and report out of authority problems to the manager/ supervisor or the concerned person for a prompt resolution to minimise the impact on customers/clients and business.

#### 4.2.7 Information or Data Sharing

Information or data is critical to all organizations. Depending on the nature of its business, an organization may hold different types of data, e.g. personal data of customers or client data concerning their business operations and contacts. It is vital to effective measures for the appropriate handling of different types of data, ensuring its protection from unauthorized access and consequent misuse.

One should access certain data only if authorised to do so. The same is applicable when sharing data which must be shared only with the people authorised to receive it to use it for a specific purpose as per their job role and organizational guidelines. For example – one should be extra cautious while sharing business data with any third parties to ensure they get access only to the limited data they need as per any agreements with them. It is also critical to monitor how the recipient of the data uses it, which should strictly be as per the organizational guidelines. It is a best practice to share appropriate instructions with the recipient of data to ensure they are aware of the purpose with which data is being shared with them and how they are supposed to use and handle it. Any misuse of data must be identified and reported promptly to the appropriate person to minimise any damage arising out of data misuse.

These days most organizations require their employees and business partners or associated third parties to sign and accept the relevant agreement on the non-disclosure of business-sensitive information. In simple terms, business-sensitive information is confidential information. It is proprietary business information collected or created during the course of conducting business, including information about the business, e.g. proposed investments, intellectual property, trade secrets, or plans for a merger and information related to its clients. Business-sensitive information may sometimes also include information regarding a business's competitors in an industry.

The release of business-sensitive information to competitors or the general public poses a risk to a business. For example, information regarding plans for a merger could be harmful to a business if a competitor gets access to it.

#### 4.2.8 Reporting Issues at Work

Most organizations have defined guidelines on appropriate reporting processes to be followed for reporting different types of issues. For example – one can report any grievances or dissatisfaction concerning co-workers to their manager/supervisor, e.g. data breaches or unethical conduct. If the concern is not addressed, then the employee should follow the organizational guidelines and hierarchy for the escalation of such issues that are not addressed appropriately.

For example – any concern related to sexual harassment at the workplace should be escalated to the concerned spokesperson, such as Human Resources (HR) representative, and if not satisfied with the action taken, it should be reported to the senior management for their consideration and prompt action.

#### 4.2.9 Dealing with Heightened Emotions

Humans are emotional beings. There may be occasions when one is overwhelmed by emotions and is unable to suppress them. However, there may be situations when one must manage emotions well, particularly at work.

Stress in one's personal and professional life may often cause emotional outbursts at work. Managing one's emotions well, particularly the negative ones, is often seen as a measure of one's professionalism. Anger, dislike, frustration, worry, and unhappiness are the most common negative emotions experienced at work.

##### Ways to manage negative emotions at work:

- **Compartmentalisation** – It's about not confining emotions to different aspects of one's life. For example, not letting negative emotions from personal life affect work-life and vice versa. One should try to leave personal matters and issues at home. One should train their mind to let go of personal matters before reaching work. Similarly, one can compartmentalise work-related stresses so that negative emotions from work don't affect one's personal life.

- **Deep breathing and relaxation** – Deep breathing helps with anxiety, worry, frustration and anger. One should take deep breaths, slowly count to ten - inhaling and exhaling until one calms down. One can also take a walk to calm down or listen to relaxing music. Talking to someone and sharing concerns also helps one calm down.
- **The 10-second rule** - This is particularly helpful in controlling anger and frustration. When one feels their temper rising, they should count to 10 to calm down and recompose. If possible, one should move away to allow temper to come down.
- **Clarify** - It is always good to clarify before reacting, as it may be a simple case of misunderstanding or miscommunication.
- **Physical activity** - Instead of losing temper, one should plan to exercise, such as running or going to the gym, to let the anger out. Exercise is also a great way to enhance mood and release any physical tension in the body.
- **Practising restraint** - One should avoid replying or making a decision when angry, not allowing anger or unhappiness to cloud one's judgement. It may be best to pause any communication while one is angry, e.g. not communicating over email when angry or upset.
- **Knowing one's triggers** - It helps when one is able to recognise what upsets or angers them. This way, one can prepare to remain calm and plan their reaction should a situation occur. One may even be able to anticipate the other party's reaction.
- **Be respectful** - One should treat their colleagues the same way one would like to be treated. If the other person is rude, one need not reciprocate. It is possible to stay gracious, firm and assertive without being aggressive. Sometimes, rude people back away when they don't get a reaction from the person they are arguing with.
- **Apologise for any emotional outburst** – Sometimes, one can get overwhelmed by emotions, reacting with an emotional outburst. In such a case, one should accept responsibility and apologise immediately to the affected persons without being defensive.
- **Doing away with negative emotions** - It is recommended to let go of anger, frustration and unhappiness at the end of every workday. Harbouring negative emotions affects one emotionally, affecting their job performance also. Engaging in enjoyable activities after work is a good stress reliever.

# Notes



## UNIT 4.3: Maintaining Social Diversity at Work

### Unit Objectives



By the end of this unit, participants will be able to:

1. Explain the concept and importance of gender sensitivity and equality.
2. Discuss ways to create sensitivity for different genders and Persons with Disabilities (PWD).

#### 4.3.1 Gender Sensitivity

Gender sensitivity is the act of being sensitive towards people and their thoughts regarding gender. It ensures that people know the accurate meaning of gender equality, and one's gender should not be given priority over their capabilities.



Fig 4.3.1 Gender Equality

Women are an important source of labour in many sectors, yet they have limited access to resources and benefits. Women should receive the same benefits and access to resources as men. A business can improve its productivity and quality of work by providing better support and opportunities to women.

#### Important Terms

- **Gender Sensitivity** - Gender sensitivity is the act of being sensitive to the ways people think about gender.
- **Gender Equality** - It means persons of any gender enjoy equal opportunities, responsibilities, and rights in all areas of life.
- **Gender Discrimination** – It means treating an individual unequally or disadvantageously based on their gender, e.g. paying different wages to men and women for similar or equal job positions.

### Strategies for Enhancing Gender Equity

To enhance gender equity, one should:

- Follow gender-neutral practices at all levels at work.
- Participate together in decision-making.
- Help in promoting women's participation in different forums.
- Assist women in getting exposure to relevant skills and practices.
- Assist women in capacity building by mentoring, coaching or motivating them, as appropriate.
- Assist in the formation and operation of women support groups.
- Assist in the implementation of women-centric programmes.
- Combine technical training with reproductive health and nutrition for coffee farming households.
- Assist in making a work environment that is healthy, safe, and free from discrimination.

### Bridging Gender Differences

Men and women react and communicate very differently. Thus, there are some work differences as both genders have their style and method of handling a situation.

Although, understanding and maturity vary from person to person, even between these genders, based on their knowledge, education, experience, culture, age, and upbringing, as well as how one's brain functions over a thought or problem.

**In order to bridge the gap, one should:**

- Not categorize all men and women in one way.
- Be aware of the verbal and non-verbal styles of communication of every gender to avoid any miscommunication and work better.
- Be aware of partial behaviour and avoid it.
- Encourage co-workers of different genders to make room by providing space to others.

### Ways to reduce Gender Discrimination

- Effective steps against sexual harassment by the concerned authorities and general public.
- Gender stereotypes are how society expects people to act based on their gender. This can only be reduced by adopting appropriate behaviour and the right attitude.
- Objectification of females must be abolished.

### Ways to Promote Gender Sensitivity in the Workplace

Practices that promote gender diversity should be adopted and promoted.

- All genders should receive equal responsibilities, rights, and privileges.
- All genders should have equal pay for similar or the same job roles/ positions.
- Strict and effective workplace harassment policies should be developed and implemented.
- An open-minded and stress-free work environment should be available to all the employees, irrespective of their gender.
- Women should be encouraged to go ahead in every field of work and assume leadership roles.
- Follow appropriate measures for women's empowerment.
- Men should be taught to be sensitive to women and mindful of their rights.

### 4.3.2 PwD Sensitivity

Some individuals are born with a disability, while others may become disabled due to an accident, illness or as they get old. People with Disabilities (PWD) may have one or more areas in which their functioning is affected. A disability can affect hearing, sight, communication, breathing, understanding, mobility, balance, and concentration or may include the loss of a limb. A disability may contribute to how a person feels and affect their mental health

#### Important Terms

**·Persons with Disabilities (PWD)** – Persons with Disabilities means a person suffering from not less than 40% of any disability as certified by a medical authority.

#### ·Types of Disability:

- a. Blindness – Visually impaired
- b. Low Vision
- c. Leprosy Cured
- d. Hearing impairment
- e. Locomotor disability
- f. Mental retardation
- g. Mental illness

#### PwD Sensitivity

PwD sensitivity promotes empathy, etiquette and equal participation of individuals and organizations while working with individuals with a disability, e.g. sensory, physical or intellectual.

### Ways to be PwD Sensitive

#### To be sensitive to PwD, one should:

- Be respectful to all Persons with Disabilities (PwD) and communicate in a way that reflects PwD sensitivity.
- Always be supportive and kind towards a PwD with their daily chores.
- Be ready to assist a PwD to help them avail of any benefit/ livelihood opportunity/ training or any kind that helps them grow.
- Encourage and try to make things easier and accessible to PwD so that they can work without or with minimum help.
- Protest where feasible and report any wrong act/behaviour against any PwD to the appropriate authority.
- Learn and follow the laws, acts, and policies relevant to PwD.

### Appropriate Verbal Communication

As part of appropriate verbal communication with all genders and PwD, one should:

- Talk to all genders and PwD respectfully, maintaining a normal tone of voice with appropriate politeness. It is important to ensure one's tone of voice does not have hints of sarcasm, anger, or unwelcome affection.
- Avoid being too self-conscious concerning the words to use while also ensuring not to use words that imply one's superiority over the other.
- Make no difference between a PwD and their caretaker. Treat PwD like adults and talk to them directly.
- Ask a PwD if they need any assistance instead of assuming they need it and offering assistance spontaneously.

### Appropriate Non-verbal Communication

Non-verbal communication is essentially the way someone communicates through their body language. These include:

- **Facial expressions** - The human face is quite expressive, capable of conveying many emotions without using words. Facial expressions must usually be maintained neutral and should change according to the situation, e.g. smile as a gesture of greeting.
- **Body posture and movement** - One should be mindful of how to sit, stand, walk, or hold their head. For example - one should sit and walk straight in a composed manner. The way one moves and carries self, communicates a lot to others. This type of non-verbal communication includes one's posture, bearing, stance, and subtle movements.

- **Gestures** - One should be very careful with their gestures, e.g. waving, pointing, beckoning, or using one's hands while speaking. One should use appropriate and positive gestures to maintain respect for the other person while being aware that a gesture may have different meanings in different cultures.
- **Eye contact** - Eye contact is particularly significant in non-verbal communication. The way someone looks at someone else may communicate many things, such as interest, hostility, affection or attraction. Eye contact is vital for maintaining the flow of conversation and for understanding the other person's interest and response. One should maintain appropriate eye contact, ensuring not to stare or look over the shoulders. To maintain respect, one should sit or stand at the other person's eye level to make eye contact.
- **Touch** - Touch is a very sensitive type of non-verbal communication. Examples are - handshakes, hugs, pat on the back or head, gripping the arm, etc. A firm handshake indicates interest, while a weak handshake indicates the opposite. One should be extra cautious not to touch others inappropriately and avoid touching them inadvertently by maintaining a safe distance.

### Rights of PwD

PwD have the right to respect and human dignity. Irrespective of the nature and seriousness of their disabilities, PwD have the same fundamental rights as others, such as:

- Disabled persons have the same civil and political rights as other people
- Disabled persons are entitled to the measures designed to enable them to become as self-dependent as possible
- Disabled persons have the right to economic and social security
- Disabled persons have the right to live with their families or foster parents and participate in all social and creative activities.
- Disabled persons are protected against all exploitation and treatment of discriminatory and abusive nature.

### Making Workplace PwD Friendly

- One should not make PwD feel uncomfortable by giving too little or too much attention
- One should use a normal tone while communicating with a PwD and treat them as all others keeping in mind their limitations and type of disability
- Any help should be provided only when asked for by a PwD
- One should help in ensuring the health and well-being of PwD.

### Expected Employer Behaviour

Some of the common behavioural traits that employees expect from their employers are:

- Cooperation: No work is successful without cooperation from the employer's side. Cooperation helps to understand the job role better and complete it within the given timeline.
- Polite language: Polite language is always welcomed at work. This is a basic aspect that everybody expects.
- Positive Attitude: Employers with a positive attitude can supervise the work of the employees and act as a helping hand to accomplish the given task. A person with a positive attitude looks at the best qualities in others and helps them gain success.
- Unbiased behaviour: Employers should always remain fair towards all their employees. One should not adopt practices to favour one employee while neglecting or ignoring the other. This might create animosity among co-workers.
- Decent behaviour: The employer should never improperly present oneself before the employee. One should always respect each other's presence and behave accordingly. The employer should not speak or act in a manner that may make the employee feel uneasy, insulted, and insecure.

## Exercise

1. List down three examples of workplace ethics.
2. List down three examples of interpersonal skills.
3. Identify two reasons for workplace conflicts.
4. Identify two ways of resolving interpersonal conflicts
5. List down two ways of dealing with heightened emotions at work.
6. List down two types of non-verbal communication.

# Notes





Skilling India in Electronics

## 5. Basic Health and Safety Practices

Unit 5.1 - Workplace Hazards

Unit 5.2 - Fire Safety

Unit 5.3 - First Aid

Unit 5.4 - Waste Management



**ELE/N1002**

## Key Learning Outcomes



By the end of this module, participants will be able to:

1. Discuss job-site hazards, risks and accidents
2. Explain the organizational safety procedures for maintaining electrical safety, handling tools and hazardous materials
3. Describe how to interpret warning signs while accessing sensitive work areas
4. Explain the importance of good housekeeping
5. Describe the importance of maintaining appropriate postures while lifting heavy objects
6. List the types of fire and fire extinguishers
7. Describe the concept of waste management and methods of disposing of hazardous waste
8. List the common sources of pollution and ways to minimize them
9. Elaborate on electronic waste disposal procedures
10. Explain how to administer appropriate first aid to victims in case of bleeding, burns, choking, electric shock, poisoning and also administer first aid to victims in case of a heart attack or cardiac arrest due to electric shock

## UNIT 5.1: Workplace Hazards

### Unit Objectives



By the end of this unit, participants will be able to:

- Discuss job-site hazards, risks and accidents
- Explain the organizational safety procedures for maintaining electrical safety, handling tools and hazardous materials
- Describe how to interpret warning signs while accessing sensitive work areas
- Explain the importance of good housekeeping
- Describe the importance of maintaining appropriate postures while lifting heavy objects
- Explain safe handling of tools and Personal Protective Equipment to be used.

#### 5.1.1 Workplace Safety

Workplace safety is important to be established for creating a safe and secure working for the workers. The workplace has to be administered as per the rules of the Occupational Safety and Health Administration (OSHA). It refers to monitoring the working environment and all hazardous factors that impact employees' safety, health, and well-being. It is important to provide a safe working environment to the employees to increase their productivity, wellness, skills, etc.

The benefits of workplace safety are:

- Employee retention increases if they are provided with a safe working environment.
- Failure to follow OSHA's laws and guidelines can result in significant legal and financial consequences.
- A safe environment enables employees to stay invested in their work and increases productivity.
- Employer branding and company reputation can both benefit from a safe working environment.

#### 5.1.2 Workplace Hazards

##### 5.1.2. Workplace Hazards

A workplace is a situation that has the potential to cause harm or injury to the workers and damage the tools or property of the workplace. Hazards exist in every workplace and can come from a variety of sources. Finding and removing them is an important component of making a safe workplace.

##### Common Workplace Hazards

The common workplace hazards are:

- Biological: The threats caused by biological agents like viruses, bacteria, animals, plants, insects and also humans, are known as biological hazards.

- **Chemical:** Chemical hazard is the hazard of inhaling various chemicals, liquids and solvents. Skin irritation, respiratory system irritation, blindness, corrosion, and explosions are all possible health and physical consequences of these dangers.
- **Mechanical:** Mechanical Hazards comprise the injuries that can be caused by the moving parts of machinery, plant or equipment.
- **Psychological:** Psychological hazards are occupational hazards caused by stress, harassment, and violence.
- **Physical:** The threats that can cause physical damage to people is called physical hazard. These include unsafe conditions that can cause injury, illness and death.
- **Ergonomic:** Ergonomic Hazards are the hazards of the workplace caused due to awkward posture, forceful motion, stationary position, direct pressure, vibration, extreme temperature, noise, work stress, etc.

### Workplace Hazards Analysis

A workplace hazard analysis is a method of identifying risks before they occur by focusing on occupational tasks. It focuses on the worker's relationship with the task, the tools, and the work environment. After identifying the hazards of the workplace, organisations shall try to eliminate or minimize them to an acceptable level of risk.

### Control Measures of Workplace Hazards

Control measures are actions that can be taken to reduce the risk of being exposed to the hazard. Elimination, Substitution, Engineering Controls, Administrative Controls, and Personal Protective Equipment are the five general categories of control measures.

- **Elimination:** The most successful control technique is to eliminate a specific hazard or hazardous work procedure or prevent it from entering the workplace.
- **Substitution:** Substitution is the process of replacing something harmful with something less hazardous. While substituting the hazard may not eliminate all of the risks associated with the process or activity, it will reduce the overall harm or health impacts.
- **Engineering Controls:** Engineered controls protect workers by eliminating hazardous situations or creating a barrier between the worker and the hazard, or removing the hazard from the person.
- **Administrative Controls:** To reduce exposure to hazards, administrative controls limit the length of time spent working on a hazardous task that might be used in combination with other measures of control.
- **Personal Protective Equipment:** Personal protective equipment protects users from health and safety hazards at work. It includes items like safety helmets, gloves, eye protection, etc.

### 5.1.3 Risk for a Drone Technician

A drone technician may require to repair the propeller, motor and its mount, battery, mainboards, processor, booms, avionics, camera, sensors, chassis, wiring and landing gear. A technician may face some risks while repairing the drones' equipment.

- The technician is susceptible to being physically harmed by propellers.
- Direct contact with exposed electrical circuits can injure the person.
- If the skin gets in touch with the heat generated from electric arcs, it burns the internal tissues.
- Major electrical injuries can occur due to poorly installed electrical equipment, faulty wiring, overloaded or overheated outlets, use of extension cables, incorrect use of replacement fuses, use of equipment with wet hands, etc.

### 5.1.4 Workplace Warning Signs

A Hazard sign is defined as 'information or instruction about health and safety at work on a signboard, an illuminated sign or sound signal, a verbal communication or hand signal.'

There are four different types of safety signs:

- Prohibition / Danger Alarm Signs
- Mandatory Signs
- Warning Signs
- And Emergency

**1. Prohibition Signs:** A "prohibition sign" is a safety sign that prohibits behaviour that is likely to endanger one's health or safety. The colour red is necessary for these health and safety signs. Only what or who is forbidden should be displayed on a restriction sign.



Fig. 5.1.1. Prohibition Warning Signs

## 2. Mandatory Signs:

Mandatory signs give clear directions that must be followed. The icons are white circles that have been reversed out of a blue circle. On a white background, the text is black.



*Fig. 5.1.2. Mandatory Signs*

## 3. Warning Signs

Warning signs are the safety information communication signs. They are shown as a 'yellow colour triangle'.



*Fig. 5.1.3. Warning Signs*

#### 4. Emergency Signs

The location or routes to emergency facilities are indicated by emergency signs. These signs have a green backdrop with a white emblem or writing. These signs convey basic information and frequently refer to housekeeping, company procedures, or logistics.



Fig. 5.1.4. Emergency Signs

### 5.1.5 Cleanliness in the Workplace

Workplace cleanliness maintenance creates a healthy, efficient and productive environment for the employees. Cleanliness at the workplace is hindered by some elements like cluttered desks, leftover food, waste paper, etc. A tidy workplace is said to improve employee professionalism and enthusiasm while also encouraging a healthy working environment.

#### Benefits of cleanliness in the workplace:

1. Productivity: Cleanliness in the workplace can bring a sense of belonging to the employees, also motivating and boosting the morale of the employees. This results in increasing their productivity.
2. Employee Well-being: Employee well-being can be improved by providing a clean work environment. Employees use fewer sick days in a workplace where litter and waste are properly disposed of, and surfaces are cleaned regularly, resulting in increased overall productivity.
3. Positive Impression: Cleanliness and orderliness in the workplace provide a positive impression on both employees and visitors.
4. Cost saving: By maintaining acceptable levels of cleanliness in the workplace, businesses can save money on cleaning bills and renovations, which may become necessary if the premises are not properly kept.

### Reasons for Cleaning the Workplace

- Cleaning of dry floors, mostly to prevent workplace slips and falls.
- Disinfectants stop bacteria in their tracks, preventing the spread of infections and illness.
- Proper air filtration decreases hazardous substance exposures such as dust and fumes.
- Light fixture cleaning improves lighting efficiency.
- Using environmentally friendly cleaning chemicals that are safer for both personnel and the environment.
- Work environments are kept clean by properly disposing of garbage and recyclable items.

### 5.1.6 Lifting and Handling of Heavy Loads

Musculoskeletal Injuries (MSIs), such as sprains and strains, can occur while lifting, handling, or carrying objects at work. When bending, twisting, uncomfortable postures and lifting heavy objects are involved, the risk of injury increases. Ergonomic controls can help to lower the risk of injury and potentially prevent it.

Types of injuries caused while lifting heavy objects:

- Cuts and abrasions are caused by rough surfaces.
- Crushing of feet or hands.
- Strain to muscles and joints

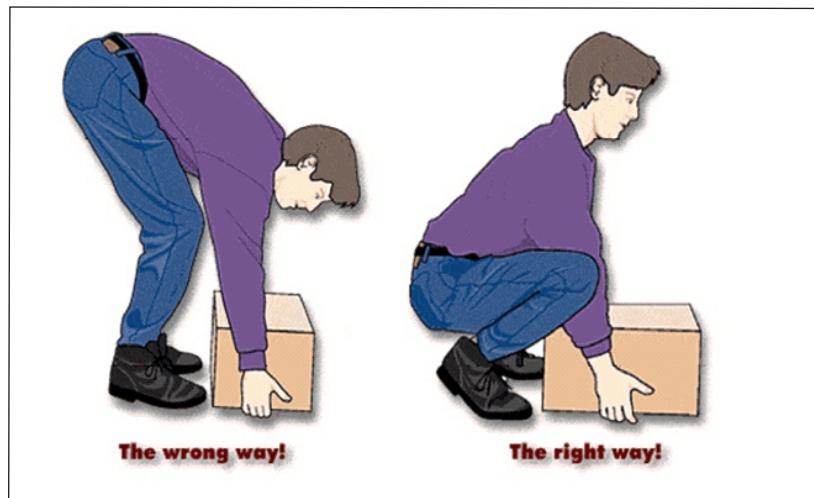


Fig. 5.1.5. Lifting loads technique

### Preparing to lift

A load that appears light enough to bear at first will grow increasingly heavier as one carries it further. The person carrying the weight should be able to see over or around it at all times.

The amount of weight a person can lift, depends on their age, physique, and health

It also depends on whether or not the person is used to lifting and moving hefty objects.

### Common Causes of Back Injuries

The Most Common Causes of Back Injuries are:

- 1) Inadequate Training:** The individual raising the load receives no sufficient training or guidance.
- 2) Lack of awareness of technique:** The most common cause of back pain is incorrect twisting and posture, which causes back strain.
- 3) Load size:** The load size to consider before lifting. If the burden is too much for one's capacity or handling, their back may be strained and damaged.
- 4) Physical Strength:** Depending on their muscle power, various persons have varied physical strengths. One must be aware of their limitations.
- 5) Teamwork:** The operation of a workplace is all about working together. When opposed to a single person lifting a load, two people can lift it more easily and without difficulty. If one of two people isn't lifting it properly, the other or both of them will suffer back injuries as a result of the extra strain.

### Techniques for Lifting Heavy Objects

| Technique  | Demonstration  |
|--|--|
| <p>1. Ensure one has a wide base of support before lifting the heavy object. Ensure one's feet are shoulder-width apart, and one foot is slightly ahead of the other at all times. This will help one maintain a good balance during the lifting of heavy objects. This is known as the Karate Stance.</p> |  |
| <p>2. Squat down as near to the object as possible when one is ready to lift it, bending at the hips and knees with the buttocks out. If the object is really heavy, one may wish to place one leg on the floor and the other bent at a straight angle in front of them.</p>                               |  |

3. Maintain proper posture as one begin to lift upward. To do so, one should keep their back straight, chest out, and shoulders back while gazing straight ahead.



4. By straightening one's hips and knees, slowly elevate the thing (not the back). As one rises, they should extend their legs and exhale. Lift the heavy object without twisting the body or bending forward.



5. Do not lift bending forward.



6. Hold the load close to the body.



|   |   |
|---|---|
| 7. Never lift heavy objects above the shoulder                                  |   |
| 8. Use the feet (not the body) to change direction, taking slow, small steps.   |   |
| 9. Set down the heavy object carefully, squatting with the knees and hips only. |  |

**Table 5.1.1 Techniques for lifting heavy objects**

<sup>3</sup>Source:<https://www.braceability.com/blogs/articles/7-prop-heavy-lifttechniques>

## 5.1.7 Safe Handling of Tools

Workers should be trained on how to use tools safely. When tools are misplaced or handled incorrectly by workers, they can be dangerous. The following are some suggestions from the National Safety Council for safe tool handling when they are not in use:

- Never carry tools up or down a ladder in a way that makes it difficult to grip them. Instead of being carried by the worker, tools should be lifted up and down using a bucket or strong bag.
- Tools should never be tossed but should be properly passed from one employee to the next. Pointed tools should be passed with the handles facing the receiver or in their carrier.
- When turning and moving around the workplace, workers carrying large tools or equipment on their shoulders should pay particular attention to clearances.
- Pointed tools such as chisels and screwdrivers should never be kept in a worker's pocket. They can be carried in a toolbox, pointing down in a tool belt or pocket tool bag, or in hand with the tip always held away from the body.
- Tools should always be stored while not in use. People below are put in danger when tools are left sitting around on an elevated structure, such as a scaffold. In situations when there is a lot of vibration, this risk increases.

## 5.1.8 Personal Protective Equipment

Personal protective equipment, or "PPE," is equipment worn to reduce exposure to risks that might result in significant occupational injuries or illnesses. Chemical, radiological, physical, electrical, mechanical, and other job dangers may cause these injuries and diseases.

PPE used for protection from the following injuries are:

| Injury Protecton              | Protecton  | PPE   |
|-------------------------------|--|---|
| Head Injury Protecton         | Falling or flying objects, stationary objects, or contact with electrical wires can cause impact, penetration, and electrical injuries. Hard hats can protect one's head from these injuries. A common electrician's hard hat is shown in the figure below. This hard hat is made of nonconductive plastic and comes with a set of safety goggles. |     |
| Foot and Leg Injury Protecton | In addition to foot protection and safety shoes, leggings (e.g., leather) can guard against risks such as falling or rolling objects, sharp objects, wet and slippery surfaces, molten metals, hot surfaces, and electrical hazards.   |  |
| Eye and Face Injury Protecton | Spectacles, goggles, special helmets or shields, and spectacles with side shields and face shields can protect against the hazards of flying fragments, large chips, hot sparks, radiation, and splashes from molten metals. They also offer protection from particles, sand, dirt, mists, dust, and glare.  |   |

|                                |  |  |
|--------------------------------|--|--|
| Protector against Hearing Loss | Hearing protection can be obtained by wearing earplugs or earmuffs. High noise levels can result in permanent hearing loss or damage, as well as physical and mental stress. Self-forming earplugs composed of foam, waxed cotton, or fibreglass wool usually fit well. Workers should be fitted for moulded or prefabricated earplugs by a specialist.  |    |
| Hand Injury Protector          | Hand protection will aid workers who are exposed to dangerous substances by skin absorption, serious wounds, or thermal burns. Gloves are a frequent protective clothing item. When working on electrified circuits, electricians frequently use leather gloves with rubber inserts. When stripping cable with a sharp blade, Kevlar gloves are used to prevent cuts.                            |   |
| Whole Body Protector           | Workers must protect their entire bodies from risks such as heat and radiation. Rubber, leather, synthetics, and plastic are among the materials used in whole-body PPE, in addition to fire-retardant wool and cotton. Maintenance staff who operate with high-power sources such as transformer installations and motor-control centres are frequently obliged to wear fire-resistant clothes. |  |

Table 5.1.2. Personal protective equipment

## Notes



## UNIT 5.2: Fire Safety

### Unit Objectives



By the end of this unit, participants will be able to:

1. List the types of fire and fire extinguishers.

#### 5.2.1 Fire Safety

Fire safety is a set of actions aimed at reducing the amount of damage caused by fire. Fire safety procedures include both those that are used to prevent an uncontrolled fire from starting and those that are used to minimise the spread and impact of a fire after it has started. Developing and implementing fire safety measures in the workplace is not only mandated by law but is also essential for the protection of everyone who may be present in the building during a fire emergency.

The basic Fire Safety Responsibilities are:

- To identify risks on the premises, a fire risk assessment must be carried out.
- Ascertain that fire safety measures are properly installed.
- Prepare for unexpected events.
- Fire safety instructions and training should be provided to the employees.

#### 5.2.2 Respond to a Workplace Fire

- Workplace fire drills should be conducted on a regular basis.
- If one has a manual alarm, they should raise it.
- Close the doors and leave the fire-stricken area as soon as possible. Ensure that the evacuation is quick and painless.
- Turn off dangerous machines and don't stop to get personal items.
- Assemble at a central location. Ascertain that the assembly point is easily accessible to the employees.
- If one's clothing catches fire, one shouldn't rush about it. They should stop and descend on the ground and roll to smother the flames if their clothes catch fire.

## 5.2.3 Fire Extinguisher

Fire extinguishers are portable devices used to put out small flames or minimise their damage until fire-fighters arrive. These are maintained on hand in locations such as fire stations, buildings, workplaces, public transit, and so on. The types and quantity of extinguishers that are legally necessary for a given region are determined by the applicable safety standards.

Types of fire extinguishers are:

**There are five main types of fire extinguishers:**

1. Water.
2. Powder.
3. Foam.
4. Carbon Dioxide (CO<sub>2</sub>).
5. Wet chemical.

**1. Water:** Water fire extinguishers are one of the most common commercial and residential fire extinguishers on the market. They're meant to be used on class-A flames.



**2. Powder:** The L2 powder fire extinguisher is the most commonly recommended fire extinguisher in the Class D Specialist Powder category, and is designed to put out burning lithium metal fires.



**3. Foam:** Foam extinguishers are identified by a cream rectangle with the word "foam" printed on it. They're mostly water-based, but they also contain a foaming component that provides a quick knock-down and blanketing effect on flames. It suffocates the flames and seals the vapours, preventing re-ignition.



**4. Carbon Dioxide (CO<sub>2</sub>):** Class B and electrical fires are extinguished with carbon dioxide extinguishers, which suffocate the flames by removing oxygen from the air. They are particularly beneficial for workplaces and workshops where electrical fires may occur since, unlike conventional extinguishers, they do not leave any toxins behind and hence minimise equipment damage.



- 5. Wet Chemical:** Wet chemical extinguishers are designed to put out fires that are classified as class F. They are successful because they can put out extremely high-temperature fires, such as those caused by cooking oils and fats.



## Notes



## UNIT 5.3: First Aid

### Unit Objectives



By the end of this unit, participants will be able to:

1. Explain how to administer appropriate first aid to victims in case of bleeding, burns, choking, electric shock, poisoning
2. Explain how to administer first aid to victims in case of a heart attack or cardiac arrest due to electric shock.

#### 5.3.1 First Aid

First aid is the treatment or care given to someone who has sustained an injury or disease until more advanced care can be obtained or the person recovers.

The aim of first aid is to:

- Preserve life
- Prevent the worsening of a sickness or injury
- If at all possible, relieve pain
- Encourage recovery
- Keep the unconscious safe.

First aid can help to lessen the severity of an injury or disease, and in some situations, it can even save a person's life.

#### 5.3.2 Need for First Aid at the Workplace

- In the workplace, first aid refers to providing immediate care and life support to persons who have been injured or become unwell at work.
- Many times, first aid can help to lessen the severity of an accident or disease.
- It can also help an injured or sick person relax. In life-or-death situations, prompt and appropriate first aid can make all the difference.

### 5.3.2 Need for First Aid at the Workplace

In the workplace, first aid refers to providing immediate care and life support to persons who have been injured or become unwell at work.

Many times, first aid can help to lessen the severity of an accident or disease.

It can also help an injured or sick person relax. In life-or-death situations, prompt and appropriate first aid can make all the difference.

### 5.3.3 Treating Minor Cuts and Scapes

**Steps to keep cuts clean and prevent infectionsand scars:**

- **Wash Hands:** Wash hands first with soap and water to avoid introducing bacteria into the cut and causing an infection. One should use the hand sanitiser if one is on the go.
- **Stop the bleeding:** Using a gauze pad or a clean towel, apply pressure to the wound. For a few minutes, keep the pressure on.
- **Clean Wounds:** Once the bleeding has stopped, clean the wound by rinsing it under cool running water or using a saline wound wash. Use soap and a moist washcloth to clean the area around the wound. Soap should not be used on the cut since it may irritate the skin. Also, avoid using hydrogen peroxide or iodine, as these may aggravate the wound.
- **Remove Dirt:** Remove any dirt or debris from the area. Pick out any dirt, gravel, glass, or other material in the cut with a pair of tweezers cleaned with alcohol.

### 5.3.4 Heart Attack

When the blood flow carrying oxygen to the heart is blocked, a heart attack occurs. The heart muscle runs out of oxygen and starts to die.

Symptoms of a heart attack can vary from person to person. They may be mild or severe. Women, older adults, and people with diabetes are more likely to have subtle or unusual symptoms.

**Symptoms in adults may include:**

- Changes in mental status, especially in older adults.
- Chest pain that feels like pressure, squeezing, or fullness. The pain is most often in the centre of the chest. It may also be felt in the jaw, shoulder, arms, back, and stomach. It can last for more than a few minutes or come and go.
- Cold sweat.
- Light-headedness.
- Nausea (more common in women).
- Indigestion.

- Vomiting.
- Numbness, aching or tingling in the arm (usually the left arm, but the right arm may be affected alone, or along with the left).
- Shortness of breath
- Weakness or fatigue, especially in older adults and in women.

### First Aid for Heart Attack

If one thinks someone is experiencing a heart attack, they should:

- Have the person sit down, rest, and try to keep calm.
- Loosen any tight clothing.
- Ask if the person takes any chest pain medicine, such as nitro-glycerine for a known heart condition, and help them take it.
- If the pain does not go away promptly with rest or within 3 minutes of taking nitro-glycerine, call for emergency medical help.
- If the person is unconscious and unresponsive, call 911 or the local emergency number, then begin CPR.
- If an infant or child is unconscious and unresponsive, perform 1 minute of CPR, then call 911 or the local emergency number.

# Notes



## UNIT 5.4: Waste Management

### Unit Objectives



By the end of this unit, participants will be able to:

1. Describe the concept of waste management and methods of disposing of hazardous waste.
2. List the common sources of pollution and ways to minimize them.
3. Elaborate on electronic waste disposal procedures.

#### 5.4.1. Waste Management and Methods of Waste Disposal

The collection, disposal, monitoring, and processing of waste materials is known as waste management. These wastes affect living beings' health and the environment. For reducing their effects, they have to be managed properly. The waste is usually in solid, liquid or gaseous form.

The importance of waste management is:

Waste management is important because it decreases waste's impact on the environment, health, and other factors. It can also assist in the reuse or recycling of resources like paper, cans, and glass. The disposal of solid, liquid, gaseous, or dangerous substances is the example of waste management.

When it comes to trash management, there are numerous factors to consider, including waste disposal, recycling, waste avoidance and reduction, and garbage transportation. Treatment of solid and liquid wastes is part of the waste management process. It also provides a number of recycling options for goods that aren't classified as garbage during the process.

#### 5.4.2 Methods of Waste Management

Non-biodegradable and toxic wastes, such as radioactive remains, can cause irreversible damage to the environment and human health if they are not properly disposed of. Waste disposal has long been a source of worry, with population increase and industrialisation being the primary causes. Here are a few garbage disposal options.

1. **Landfills:** The most common way of trash disposal today is to throw daily waste/garbage into landfills. This garbage disposal method relies on burying the material in the ground.
2. **Recycling:** Recycling is the process of transforming waste items into new products in order to reduce energy consumption and the use of fresh raw materials. Recycling reduces energy consumption, landfill volume, air and water pollution, greenhouse gas emissions, and the preservation of natural resources for future use.

3. **Composting:** Composting is a simple and natural bio-degradation process that converts organic wastes, such as plant remnants, garden garbage, and kitchen waste, into nutrient-rich food for plants.
4. **Incineration:** Incineration is the process of combusting garbage. The waste material is cooked to extremely high temperatures and turned into materials such as heat, gas, steam, and ash using this technology.

### 5.4.3 Recyclable, Non-Recyclable and Hazardous Waste

1. **Recyclable Waste:** The waste which can be reused or recycled further is known as recyclable waste.
2. **Non-recyclable Waste:** The waste which cannot be reused or recycled is known as non-recyclable waste. Polythene bags are a great example of non-recyclable waste.
3. **Hazardous Waste:** The waste which can create serious harm to the people and the environment is known as hazardous waste.

### 5.4.4 Sources of Pollution

Pollution is defined as the harm caused by the presence of a material or substances in places where they would not normally be found or at levels greater than normal. Polluting substances might be in the form of a solid, a liquid, or a gas.

- **Point source of pollution:** Pollution from a point source enters a water body at a precise location and can usually be identified. Effluent discharges from sewage treatment plants and industrial sites, power plants, landfill sites, fish farms, and oil leakage via a pipeline from industrial sites are all potential point sources of contamination.
- Point source pollution is often easy to prevent since it is feasible to identify where it originates, and once identified, individuals responsible for the pollution can take rapid corrective action or invest in longer-term treatment and control facilities.
- **Diffuse source of pollution:** As a result of land-use activities such as urban development, amenity, farming, and forestry, diffuse pollution occurs when pollutants are widely used and diffused over a large region. These activities could have occurred recently or in the past. It might be difficult to pinpoint specific sources of pollution and, as a result, take rapid action to prevent it because prevention often necessitates significant changes in land use and management methods.

#### **Pollution Prevention**

Pollution prevention entails acting at the source of pollutants to prevent or minimise their production. It saves natural resources, like water, by using materials and energy more efficiently.

**Pollution prevention includes any practice that:**

- Reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal;
- Reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants (these practices are known as "source reduction");
- Improved efficiency in the use of raw materials, energy, water, or other resources, or Conservation is a method of safeguarding natural resources.
- Improvements in housekeeping, maintenance, training, or inventory management; equipment or technology adjustments; process or method modifications; product reformulation or redesign; raw material substitution; or improvements in housekeeping, maintenance, training, or inventory control.

### 5.4.5 Electronic Waste

Lead, cadmium, beryllium, mercury, and brominated flame retardants are found in every piece of electronic waste. When gadgets and devices are disposed of illegally, these hazardous compounds are more likely to contaminate the earth, pollute the air, and leak into water bodies.

When e-waste is dumped in a landfill, it tends to leach trace metals as water runs through it. The contaminated landfill water then reaches natural groundwater with elevated toxic levels, which can be dangerous if it reaches any drinking water bodies. Despite having an environmentally benign approach, recycling generally results in international shipment and dumping of the gadgets in pits.

**Some eco-friendly ways of disposing of e-waste are:**

- Giving back the e-waste to the electronic companies and drop-off points
- Following guidelines issued by the government
- Selling or donating the outdated technology-based equipment
- Giving e-waste to a certified e-waste recycler

## Exercise

1. Name all five types of fire extinguishers.
2. Explain PPE in brief.
3. List the common workplace hazards.
4. Fill in the blanks:
  - i. A "\_\_\_\_\_ sign" is a safety sign that prohibits behaviour that is likely to endanger one's health or safety.
  - ii. \_\_\_\_\_ entails acting at the source of pollutants to prevent or minimise their production.
  - iii. \_\_\_\_\_ is the treatment or care given to someone who has sustained an injury or disease until more advanced care can be obtained or the person recovers.
  - iv. The threats caused by biological agents like viruses, bacteria, animals, plants, insects and also humans, are known as \_\_\_\_\_.
  - v. The workplace has to be administered as per the rules of the \_\_\_\_\_.

# Notes







## 6. Employability & Entrepreneurship Skills

Unit 6.1 – Personal Strengths & Value Systems

Unit 6.2 – Digital Literacy: A Recap

Unit 6.3 – Money Matters

Unit 6.4 – Preparing for Employment & Self-Employment

Unit 6.5 – Understanding Entrepreneurship

Unit 5.6 – Preparing to be an Entrepreneur



## Key Learning Outcomes



**At the end of this module, you will be able to:**

1. Explain the meaning of health
2. List common health issues
3. Discuss tips to prevent common health issues
4. Explain the meaning of hygiene
5. Discuss the purpose of Swacch Bharat Abhiyan
6. Explain the meaning of habit
7. Discuss ways to set up a safe work environment
8. Discuss critical safety habits to be followed by employees
9. Explain the importance of self-analysis
10. Discuss motivation with the help of Maslow's Hierarchy of Needs
11. Discuss the meaning of achievement motivation
12. List the characteristics of entrepreneurs with achievement motivation
13. List the different factors that motivate you
14. Discuss the role of attitude in self-analysis
15. Discuss how to maintain a positive attitude
16. List your strengths and weaknesses
17. Discuss the qualities of honest people
18. Describe the importance of honesty in entrepreneurs
19. Discuss the elements of a strong work ethic
20. Discuss how to foster a good work ethic
21. List the characteristics of highly creative people
22. List the characteristics of highly innovative people
23. Discuss the benefits of time management
24. List the traits of effective time managers
25. Describe effective time management technique
26. Discuss the importance of anger management
27. Describe anger management strategies
28. Discuss tips for anger management
29. Discuss the causes of stress
30. Discuss the symptoms of stress
31. Discuss tips for stress management
32. Identify the basic parts of a computer
33. Identify the basic parts of a keyboard
34. Recall basic computer terminology
35. Recall the functions of basic computer keys
36. Discuss the main applications of MS Office
37. Discuss the benefits of Microsoft Outlook
38. Discuss the different types of e-commerce
39. List the benefits of e-commerce for retailers and customers
40. Discuss how the Digital India campaign will help boost e-commerce in India
41. Describe how you will sell a product or service on an e-commerce platform
42. Discuss the importance of saving money

43. Discuss the benefits of saving money
44. Discuss the main types of bank accounts
45. Describe the process of opening a bank account
46. Differentiate between fixed and variable costs
47. Describe the main types of investment options
48. Describe the different types of insurance products
49. Describe the different types of taxes
50. Discuss the uses of online banking
51. Discuss the main types of electronic funds transfers
52. Discuss the steps to prepare for an interview
53. Discuss the steps to create an effective Resume
54. Discuss the most frequently asked interview questions
55. Discuss how to answer the most frequently asked interview questions
56. Discuss basic workplace terminology
57. Discuss the concept of entrepreneurship
58. Discuss the importance of entrepreneurship
59. Describe the characteristics of an entrepreneur
60. Describe the different types of enterprises
61. List the qualities of an effective leader
62. Discuss the benefits of effective leadership
63. List the traits of an effective team
64. Discuss the importance of listening effectively
65. Discuss how to listen effectively
66. Discuss the importance of speaking effectively
67. Discuss how to speak effectively
68. Discuss how to solve problems
69. List important problem solving traits
70. Discuss ways to assess problem solving skills
71. Discuss the importance of negotiation
72. Discuss how to negotiate
73. Discuss how to identify new business opportunities
74. Discuss how to identify business opportunities within your business
75. Explain the meaning of entrepreneur
76. Describe the different types of entrepreneurs
77. List the characteristics of entrepreneurs
78. Recall entrepreneur success stories
79. Discuss the entrepreneurial process
80. Describe the entrepreneurship ecosystem
81. Discuss the purpose of the Make in India campaign
82. Discuss key schemes to promote entrepreneurs
83. Discuss the relationship between entrepreneurship and risk appetite
84. Discuss the relationship between entrepreneurship and resilience
85. Describe the characteristics of a resilient entrepreneur
86. Discuss how to deal with failure
87. Discuss how market research is carried out

88. Describe the 4 Ps of marketing
89. Discuss the importance of idea generation
90. Recall basic business terminology
91. Discuss the need for CRM
92. Discuss the benefits of CRM
93. Discuss the need for networking
94. Discuss the benefits of networking
95. Discuss the importance of setting goals
96. Differentiate between short-term, medium-term and long-term goals
97. Discuss how to write a business plan
98. Explain the financial planning process
99. Discuss ways to manage your risk
100. Describe the procedure and formalities for applying for bank finance
101. Discuss how to manage your own enterprise
102. List important questions that every entrepreneur should ask before starting an enterprise

## UNIT 6.1: Personal Strengths & Value Systems

### Unit Objectives



At the end of this unit, participant will be able to:

1. Explain the meaning of health
2. List common health issues
3. Discuss tips to prevent common health issues
4. Explain the meaning of hygiene
5. Discuss the purpose of Swacch Bharat Abhiyan
6. Explain the meaning of habit
7. Discuss ways to set up a safe work environment
8. Discuss critical safety habits to be followed by employees
9. Explain the importance of self-analysis
10. Discuss motivation with the help of Maslow's Hierarchy of Needs
11. Discuss the meaning of achievement motivation
12. List the characteristics of entrepreneurs with achievement motivation
13. List the different factors that motivate you
14. Discuss the role of attitude in self-analysis
15. Discuss how to maintain a positive attitude
16. List your strengths and weaknesses
17. Discuss the qualities of honest people
18. Describe the importance of honesty in entrepreneurs
19. Discuss the elements of a strong work ethic
20. Discuss how to foster a good work ethic
21. List the characteristics of highly creative people
22. List the characteristics of highly innovative people
23. Discuss the benefits of time management
24. List the traits of effective time managers
25. Describe effective time management technique
26. Discuss the importance of anger management
27. Describe anger management strategies
28. Discuss tips for anger management
29. Discuss the causes of stress
30. Discuss the symptoms of stress
31. Discuss tips for stress management

### 6.1.1 Health, Habits, Hygiene: What is Health?

As per the World Health Organization (WHO), health is a “State of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity.” This means being healthy does not simply mean not being unhealthy – it also means you need

to be at peace emotionally, and feel fit physically. For example, you cannot say you are healthy simply because you do not have any physical ailments like a cold or cough. You also need to think about whether you are feeling calm, relaxed and happy.

### **Common Health Issues**

Some common health issues are:

- Allergies
- Asthma
- Skin Disorders
- Depression and Anxiety
- Diabetes
- Cough, Cold, Sore Throat
- Difficulty Sleeping
- Obesity

### **Prevent Health Issues**

Taking measures to prevent ill health is always better than curing a disease or sickness. You can stay healthy by:

- Eating healthy foods like fruits, vegetables and nuts
- Cutting back on unhealthy and sugary foods
- Drinking enough water everyday
- Not smoking or drinking alcohol
- Exercising for at least 30 minutes a day, 4-5 times a week
- Taking vaccinations when required
- Practicing yoga exercises and meditation

### **How many of these health standards do you follow? Tick the ones that apply to you.**

1. Get minimum 7-8 hours of sleep every night.
2. Avoid checking email first thing in the morning and right before you go to bed at night.
3. Don't skip meals – eat regular meals at correct meal times.
4. Read a little bit every single day.
5. Eat more home cooked food than junk food.
6. Stand more than you sit.
7. Drink a glass of water first thing in the morning and have at least 8 glasses of water through the day.

8. Go to the doctor and dentist for regular check-ups.
9. Exercise for 30 minutes at least 5 days a week.
10. Avoid consuming lots of aerated beverages.

### What is Hygiene?

As per the World Health Organization (WHO), “Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases.” In other words, hygiene means ensuring that you do whatever is required to keep your surroundings clean, so that you reduce the chances of spreading germs and diseases.

For instance, think about the kitchen in your home. Good hygiene means ensuring that the kitchen is always spick and span, the food is put away, dishes are washed and dustbins are not overflowing with garbage. Doing all this will reduce the chances of attracting pests like rats or cockroaches, and prevent the growth of fungus and other bacteria, which could spread disease.

### How many of these health standards do you follow? Tick the ones that apply to you.

1. Have a bath or shower every day with soap – and wash your hair with shampoo 2-3 times a week.
2. Wear a fresh pair of clean undergarments every day.
3. Brush your teeth in the morning and before going to bed.
4. Cut your fingernails and toenails regularly.
5. Wash your hands with soap after going to the toilet.
6. Use an anti-perspirant deodorant on your underarms if you sweat a lot.
7. Wash your hands with soap before cooking or eating.
8. Stay home when you are sick, so other people don't catch what you have.
9. Wash dirty clothes with laundry soap before wearing them again.
10. Cover your nose with a tissue/your hand when coughing or sneezing.

See how healthy and hygienic you are, by giving yourself 1 point for every ticked statement! Then take a look at what your score means.

### Your Score

**0-7/20:** You need to work a lot harder to stay fit and fine! Make it a point to practice good habits daily and see how much better you feel!

**7-14/20:** Not bad, but there is scope for improvement! Try and add a few more good habits to your daily routine.

**14-20/20:** Great job! Keep up the good work! Your body and mind thank you!

We have already discussed the importance of following good hygiene and health practices for ourselves. But, it is not enough for us to be healthy and hygienic. We must also extend this standard to our homes, our immediate surroundings and to our country as a whole.

### **Swachh Bharat Abhiyan**

The ‘Swachh Bharat Abhiyan’ (Clean India Mission) launched by Prime Minister Shri Narendra Modi on 2<sup>nd</sup> October 2014, believes in doing exactly this. The aim of this mission is to clean the streets and roads of India and raise the overall level of cleanliness. Currently this mission covers 4,041 cities and towns across the country. Millions of our people have taken the pledge for a clean India. You should take the pledge too, and do everything possible to keep our country clean!

### **What are Habits?**

A habit is a behaviour that is repeated frequently. All of us have good habits and bad habits. Keep in mind the phrase by John Dryden: “We first make our habits, and then our habits make us.” This is why it is so important that you make good habits a way of life, and consciously avoid practicing bad habits.

Some good habits that you should make part of your daily routine are:

- Always having a positive attitude
- Making exercise a part of your daily routine
- Reading motivational and inspirational stories
- Smiling! Make it a habit to smile as often as possible
- Making time for family and friends
- Going to bed early and waking up early

Some bad habits that you should quit immediately are:

- Skipping breakfast
- Snacking frequently even when you are not hungry
- Eating too much fattening and sugary food
- Smoking, drinking alcohol and doing drugs
- Spending more money than you can afford
- Worrying about unimportant issues
- Staying up late and waking up late



- Following healthy and hygienic practices every day will make you feel good mentally and physically.
- Hygiene is two-thirds of health – so good hygiene will help you stay strong and healthy.

### 6.1.2: Safety: Tips to Design a Safe Workplace

Every employer is obligated to ensure that his workplace follows the highest possible safety protocol. When setting up a business, owners must make it a point to:

- Use ergonomically designed furniture and equipment to avoid stooping and twisting
- Provide mechanical aids to avoid lifting or carrying heavy objects
- Have protective equipment on hand for hazardous jobs
- Designate emergency exits and ensure they are easily accessible
- Set down health codes and ensure they are implemented
- Follow the practice of regular safety inspections in and around the workplace
- Ensure regular building inspections are conducted
- Get expert advice on workplace safety and follow it

#### Non-Negotiable Employee Safety Habits

Every employer is obligated to ensure that his workplace follows the highest possible safety protocol. When setting up a business, owners must make it a point to:

- Immediately report unsafe conditions to a supervisor
- Recognize and report safety hazards that could lead to slips, trips and falls
- Report all injuries and accidents to a supervisor
- Wear the correct protective equipment when required
- Learn how to correctly use equipment provided for safety purposes
- Be aware of and avoid actions that could endanger other people
- Take rest breaks during the day and some time off from work during the week



- Be aware of what emergency number to call at the time of a workplace emergency
- Practice evacuation drills regularly to avoid chaotic evacuations

### 6.1.3 Self-Analysis – Attitude, Achievement Motivation

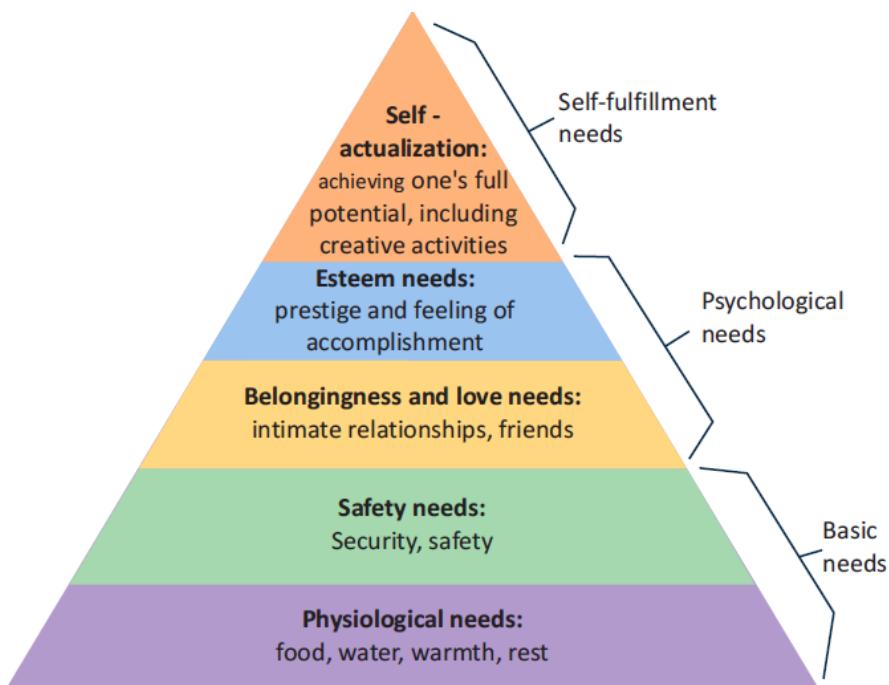
To truly achieve your full potential, you need to take a deep look inside yourself and find out what kind of person you really are. This attempt to understand your personality is known as self-analysis. Assessing yourself in this manner will help you grow, and will also help you to identify areas within yourself that need to be further developed, changed or eliminated. You can better understand yourself by taking a deep look at what motivates you, what your attitude is like, and what your strengths and weaknesses are.

#### What is Motivation?

Very simply put, motivation is your reason for acting or behaving in a certain manner. It is important to understand that not everyone is motivated by the same desires – people are motivated by many, many different things. We can understand this better by looking at Maslow's Hierarchy of Needs.

### Maslow's Hierarchy of Needs

Famous American psychologist Abraham Maslow wanted to understand what motivates people. He believed that people have five types of needs, ranging from very basic needs (called physiological needs) to more important needs that are required for self-growth (called self-actualization needs). Between the physiological and self-actualization needs are three other needs – safety needs, belongingness and love needs, and esteem needs. These needs are usually shown as a pyramid with five levels and are known as Maslow's Hierarchy of Needs.



*Fig 6.1.1: Maslow's Hierarchy of Needs*

As you can see from the pyramid, the lowest level depicts the most basic needs. Maslow believed that our behaviour is motivated by our basic needs, until those needs are met. Once they are fulfilled, we move to the next level and are motivated by the next level of needs. Let's understand this better with an example.

Rupa comes from a very poor family. She never has enough food, water, warmth or rest. According to Maslow, until Rupa is sure that she will get these basic needs, she will not even think about the next level of needs – her safety needs. But, once Rupa is confident that her basic needs will be met, she will move to the next level, and her behaviour will then be motivated by her need for security and safety. Once these new needs are met, Rupa will once again move to the next level, and be motivated by her need for relationships and friends. Once this need is satisfied, Rupa will then focus on the fourth level of needs – her esteem needs, after which she will move up to the fifth and last level of needs – the desire to achieve her full potential.

### Understanding Achievement Motivation

We now know that people are motivated by basic, psychological and self-fulfilment needs. However, certain people are also motivated by the achievement of highly challenging accomplishments. This is known as Achievement Motivation, or 'need for achievement'. The level of motivation achievement in a person differs from individual to individual. It is important that entrepreneurs have a high level of achievement motivation – a deep desire to accomplish something important and unique. It is equally important that they hire people who are also highly motivated by challenges and success.

#### What Motivates You?

What are the things that really motivate you? List down five things that really motivate you. Remember to answer honestly!

I am motivated by:

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#### Characteristics of Entrepreneurs with Achievement Motivation

Entrepreneurs with achievement motivation can be described as follows:

- Unafrfraid to take risks for personal accomplishment
- Love being challenged
- Future-oriented
- Flexible and adaptive
- Value negative feedback more than positive feedback
- Very persistent when it comes to achieving goals
- Extremely courageous
- Highly creative and innovative
- Restless - constantly looking to achieve more
- Feel personally responsible for solving problems

Think about it:

- How many of these traits do you have?
- Can you think of entrepreneurs who display these traits?

#### What is Attitude?

Now that we understand why motivation is so important for self-analysis, let's look at the role our attitude plays in better understanding ourselves. Attitude can be described as your tendency (positive or negative), to think and feel about someone or something. Attitude is the foundation for success in every aspect of life. Our attitude can be our best friend or our worst enemy. In other words:

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tendency (positive or negative), to think and feel about someone or something. Attitude is the foundation for success in every aspect of life. Our attitude can be our best friend or our worst enemy. In other words:

**“The only disability in life is a bad attitude.”**

When you start a business, you are sure to encounter a wide variety of emotions, from difficult times and failures to good times and successes. Your attitude is what will see you through the tough times and guide you towards success. Attitude is also infectious. It affects everyone around you, from your customers to your employees to your investors. A positive attitude helps build confidence in the workplace while a negative attitude is likely to result in the demotivation of your people.

### **How to Cultivate a Positive Attitude?**

The good news is attitude is a choice. So, it is possible to improve, control and change our attitude, if we decide we want to!

The following tips help foster a positive mindset:

- Remember that you control your attitude, not the other way around
- Devote at least 15 minutes a day towards reading, watching or listening to something positive
- Avoid negative people who only complain and stop complaining yourself
- Expand your vocabulary with positive words and delete negative phrases from your mind
- Be appreciative and focus on what's good in yourself, in your life, and in others
- Stop thinking of yourself as a victim and start being proactive
- Imagine yourself succeeding and achieving your goals

### **What Are Your Strengths and Weaknesses?**

Another way to analyse yourself is by honestly identifying your strengths and weaknesses. This will help you use your strengths to your best advantage and reduce your weaknesses.

Note down all your strengths and weaknesses in the two columns below. Remember to be honest with yourself!

| Strengths | Weaknesses |
|-----------|------------|
|           |            |



- Achievement motivation can be learned.
- Don't be afraid to make mistakes.
- Train yourself to finish what you start.
- Dream big.

### 6.1.4 Honesty & Work Ethics: What is Honesty?

Honesty is the quality of being fair and truthful. It means speaking and acting in a manner that inspires trust. A person who is described as honest is seen as truthful and sincere, and as someone who isn't deceitful or devious and doesn't steal or cheat. There are two dimensions of honesty – one is honesty in communication and the other is honesty in conduct.

Honesty is an extremely important trait because it results in peace of mind and builds relationships that are based on trust. Being dishonest, on the other hand, results in anxiety and leads to relationships full of distrust and conflict.

#### Qualities of Honest People

Honest individuals have certain distinct characteristics. Some common qualities among honest people are:

1. They don't worry about what others think of them. They believe in being themselves – they don't bother about whether they are liked or disliked for their personalities.
2. They stand up for their beliefs. They won't think twice about giving their honest opinion, even if they are aware that their point of view lies with the minority.
3. They are think skinned. This means they are not affected by others judging them harshly for their honest opinions.
4. They forge trusting, meaningful and healthy friendships. Honest people usually surround themselves with honest friends. They have faith that their friends will be truthful and upfront with them at all times.
5. They are trusted by their peers. They are seen as people who can be counted on for truthful and objective feedback and advice.

#### Importance of Honesty in Entrepreneurs

One of the most important characteristics of entrepreneurs is honesty. When entrepreneurs are honest with their customers, employees and investors, it shows that they respect those that they work with. It is also important that entrepreneurs remain honest with themselves.

Let's look at how being honest would lead to great benefits for entrepreneurs.

- **Honesty and customers:** When entrepreneurs are honest with their customers it leads to stronger relationships, which in turn results in business growth and a stronger customer network.
- **Honesty and employees:** When entrepreneurs build honest relationships with their employees, it leads to more transparency in the workplace, which results in higher work performance and better results.

- **Honesty and investors:** For entrepreneurs, being honest with investors means not only sharing strengths but also candidly disclosing current and potential weaknesses, problem areas and solution strategies. Keep in mind that investors have a lot of experience with start-ups and are aware that all new companies have problems. Claiming that everything is perfectly fine and running smoothly is a red flag for most investors.
- **Honesty with oneself:** The consequences of being dishonest with oneself can lead to dire results, especially in the case of entrepreneurs. For entrepreneurs to succeed, it is critical that they remain realistic about their situation at all times, and accurately judge every aspect of their enterprise for what it truly is.

### What are Work Ethics?

Being ethical in the workplace means displaying values like honesty, integrity and respect in all your decisions and communications. It means not displaying negative qualities like lying, eating and stealing.

Workplace ethics play a big role in the profitability of a company. It is as crucial to an enterprise as high morale and teamwork. This is why most companies lay down specific workplace ethic guidelines that must compulsorily be followed by their employees.

These guidelines are typically outlined in a company's employee handbook.

### Elements of a Strong Work Ethic

An entrepreneur must display strong work ethics, as well as hire only those individuals who believe in and display the same level of ethical behaviour in the workplace. Some elements of a strong work ethic are:

- **Professionalism:** This involves everything from how you present yourself in a corporate setting to the manner in which you treat others in the workplace.
- **Respectfulness:** This means remaining poised and diplomatic regardless of how stressful or volatile a situation is.
- **Dependability:** This means always keeping your word, whether it's arriving on time for a meeting or delivering work on time.
- **Dedication:** This means refusing to quit until the designated work is done, and completing the work at the highest possible level of excellence.
- **Determination:** This means embracing obstacles as challenges rather than letting them stop you, and pushing ahead with purpose and resilience to get the desired results.
- **Accountability:** This means taking responsibility for your actions and the consequences of your actions, and not making excuses for your mistakes.
- **Humility:** This means acknowledging everyone's efforts and hard work, and sharing the credit for accomplishments.

### How to Foster a Good Work Ethic?

As an entrepreneur, it is important that you clearly define the kind of behaviour that you expect from each and every team member in the workplace. You should make it clear that you expect employees to display positive work ethics like:

- **Honesty:** All work assigned to a person should be done with complete honesty, without any deceit or lies.
- **Good attitude:** All team members should be optimistic, energetic, and positive.
- **Reliability:** Employees should show up where they are supposed to be, when they are supposed to be there.
- **Good work habits:** Employees should always be well groomed, never use inappropriate language, conduct themselves professionally at all times and so on.
- **Initiative:** Doing the bare minimum is not enough. Every team member needs to be proactive and show initiative.
- **Trustworthiness:** Trust is non-negotiable. If an employee cannot be trusted, it's time to let that employee go.
- **Respect:** Employees need to respect the company, the law, their work, their colleagues and themselves.
- **Integrity:** Each and every team member should be completely ethical and must display above board behaviour at all times.
- **Efficiency:** Efficient employees help a company grow while inefficient employees result in a waste of time and resources.



- Don't get angry when someone tells you the truth and you don't like what you hear.
- Always be willing to accept responsibility for your mistakes.

### 6.1.5 Creativity & Innovation: What is Creativity?

Creativity means thinking outside the box. It means viewing things in new ways or from different perspectives, and then converting these ideas into reality. Creativity involves two parts: thinking and producing. Simply having an idea makes you imaginative, not creative. However, having an idea and acting on it makes you creative.

#### Characteristics of Highly Creative People

Some characteristics of creative people are:

- They are imaginative and playful
- They see issues from different angles
- They notice small details
- They have very little tolerance for boredom
- They detest rules and routine
- They love to daydream
- They are very curious

#### What is Innovation?

There are many different definitions of innovation. In simple terms, innovation means turning an idea into a solution that adds value. It can also mean adding value by implementing a new

product, service or process, or significantly improving on an existing product, service or process.

#### **Characteristics of Highly Innovative People**

Some characteristics of highly innovative people are:

- They embrace doing things differently
- They don't believe in taking shortcuts
- They are not afraid to be unconventional
- They are highly proactive and persistent
- They are organized, cautious and risk-averse



- Take regular breaks from your creative work to recharge yourself and gain fresh perspective.
- Build prototypes frequently, test them out, get feedback, and make the required changes.

### **6.1.6 Time Management: What is Time Management?**

Time management is the process organizing your time, and deciding how to allocate your time between different activities. Good time management is the difference between working smart (getting more done in less time) and working hard (working for more time to get more done).

Effective time management leads to an efficient work output, even when you are faced with tight deadlines and high pressure situations. On the other hand, not managing your time effectively results in inefficient output and increases stress and anxiety.

#### **Benefits of Time Management**

Time management can lead to huge benefits like:

- Greater productivity
- Better professional reputation
- Higher chances for career advancement
- Higher efficiency
- Reduced stress
- Greater opportunities to achieve goals

Not managing time effectively can result in undesirable consequences like:

- Missing deadlines
- Substandard work quality
- Stalled career
- Inefficient work output
- Poor professional reputation
- Increase in stress and anxiety

### Traits of Effective Time Managers

Some traits of effective time managers are:

- They begin projects early
- They set daily objectives
- They modify plans if required, to achieve better results
- They are flexible and open-minded
- They inform people in advance if their help will be required
- They know how to say no
- They break tasks into steps with specific deadlines
- They continually review long term goals
- They think of alternate solutions if and when required
- They ask for help when required
- They create backup plans

### Effective Time Management Techniques

You can manage your time better by putting into practice certain time management techniques. Some helpful tips are:

- Plan out your day as well as plan for interruptions. Give yourself at least 30 minutes to figure out your time plan. In your plan, schedule some time for interruptions.
- Put up a “Do Not Disturb” sign when you absolutely have to complete a certain amount of work.
- Close your mind to all distractions. Train yourself to ignore ringing phones, don’t reply to chat messages and disconnect from social media sites.
- Delegate your work. This will not only help your work get done faster, but will also show you the unique skills and abilities of those around you.
- Stop procrastinating. Remind yourself that procrastination typically arises due to the fear of failure or the belief that you cannot do things as perfectly as you wish to do them.
- Prioritize. List each task to be completed in order of its urgency or importance level. Then focus on completing each task, one by one.
- Maintain a log of your work activities. Analyse the log to help you understand how efficient you are, and how much time is wasted every day.
- Create time management goals to reduce time wastage.



- Always complete the most important tasks first.
- Get at least 7 – 8 hours of sleep every day.
- Start your day early.
- Don’t waste too much time on small, unimportant details.
- Set a time limit for every task that you will undertake.
- Give yourself some time to unwind between tasks.

## 6.1.7 Anger Management: What is Anger Management?

Anger management is the process of:

1. Learning to recognize the signs that you, or someone else, is becoming angry
2. Taking the best course of action to calm down the situation in a positive way

Anger management does not mean suppressing anger.

### Importance of Anger Management

Anger is a perfectly normal human emotion. In fact, when managed the right way, anger can be considered a healthy emotion. However, if it is not kept in check, anger can make us act inappropriately and can lead to us saying or doing things that we will likely later regret.

Extreme anger can:

- **Hurt you physically:** It leads to heart disease, diabetes, a weakened immune system, insomnia, and high blood pressure.
- **Hurt you mentally:** It can cloud your thinking and lead to stress, depression and mental health issues.
- **Hurt your career:** It can result in alienating your colleagues, bosses, clients and lead to the loss of respect.
- **Hurt your relationships:** It makes it hard for your family and friends to trust you, be honest with you and feel comfortable around you.

This is why anger management, or managing anger appropriately, is so important.

### Anger Management Strategies

Here are some strategies that can help you control your anger:

#### Strategy 1: Relaxation

Something as simple as breathing deeply and looking at relaxing images works wonders in calming down angry feelings. Try this simple breathing exercise:

1. Take a deep breath from your diaphragm (don't breathe from your chest)
2. Visualize your breath coming up from your stomach
3. Keep repeating a calming word like 'relax' or 'take it easy' (remember to keep breathing deeply while repeating the word)
5. Picture a relaxing moment (this can be from your memory or your imagination)
6. Follow this relaxation technique daily, especially when you realize that you're starting to feel angry.

#### Strategy 2: Cognitive Restructuring

Cognitive restructuring means changing the manner in which you think. Anger can make you curse, swear, exaggerate and act very dramatically. When this happens, force yourself to replace your angry thoughts with more logical ones. For instance, instead of thinking 'Everything is ruined' change your mindset and tell yourself 'It's not the end of the world and getting angry won't solve this'.

#### Strategy 3: Problem Solving

Getting angry about a problem that you cannot control is a perfectly natural response. Sometimes, try as you may, there may not be a solution to the difficulty you are faced with. In such cases, stop focusing on solving the problem, and instead focus on handling and

facing the problem. Remind yourself that you will do your best to deal with the situation, but that you will not blame yourself if you don't get the solution you desire.

#### **Strategy 4: Better Communication**

When you're angry, it is very easy to jump to inaccurate conclusions. In this case, you need to force yourself to stop reacting, and think carefully about what you want to say, before saying it. Avoid saying the first thing that enters your head. Force yourself to listen carefully to what the other person is saying. Then think about the conversation before responding.

#### **Strategy 5: Changing Your Environment**

If you find that your environment is the cause of your anger, try and give yourself a break from your surroundings. Make an active decision to schedule some personal time for yourself, especially on days that are very hectic and stressful. Having even a brief amount of quiet or alone time is sure to help calm you down.

#### **Tips for Anger Management**

The following tips will help you keep your anger in check:

- Take some time to collect your thoughts before you speak out in anger.
- Express the reason for your anger in an assertive, but non-confrontational manner once you have calmed down.
- Do some form of physical exercise like running or walking briskly when you feel yourself getting angry.
- Make short breaks part of your daily routine, especially during days that are stressful.
- Focus on how to solve a problem that's making you angry, rather than focusing on the fact that the problem is making you angry.



- Try to forgive those who anger you, rather than hold a grudge against them.
- Avoid using sarcasm and hurling insults. Instead, try and explain the reason for your frustration in a polite and mature manner.

### **6.1.8 Stress Management: What is Stress?**

We say we are 'stressed' when we feel overloaded and unsure of our ability to deal with the pressures placed on us. Anything that challenges or threatens our well-being can be defined as a stress. It is important to note that stress can be good and bad. While good stress keeps us going, negative stress undermines our mental and physical health. This is why it is so important to manage negative stress effectively.

### Causes of Stress

Stress can be caused by internal and external factors.

#### Internal causes of stress

- Constant worry
- Rigid thinking
- Unrealistic expectations
- Pessimism
- Negative self-talk
- All in or all out attitude

#### External causes of stress

- Major life changes
- Difficulties with relationships
- Having too much to do
- Difficulties at work or in school
- Financial difficulties
- Worrying about one's children and/or family

### Symptoms of Stress

Stress can manifest itself in numerous ways. Take a look at the cognitive, emotional, physical and behavioural symptoms of stress.

| Cognitive Symptoms  | Emotional Symptoms  |
|---|---|
| <ul style="list-style-type: none"> <li>• Memory problems</li> <li>• Concentration issues</li> <li>• Lack of judgement</li> <li>• Pessimism</li> <li>• Anxiety</li> <li>• Constant worrying</li> </ul> | <ul style="list-style-type: none"> <li>• Depression</li> <li>• Agitation</li> <li>• Irritability</li> <li>• Loneliness</li> <li>• Anxiety</li> <li>• Anger</li> </ul> |

Fig 6.1.1 (a): Stress symptoms

| Physical Symptoms   | Behavioural Symptoms  |
|---|---|
| <ul style="list-style-type: none"> <li>• Aches and pain</li> <li>• Diarrhoea or constipation</li> <li>• Nausea</li> <li>• Dizziness</li> <li>• Chest pain and/or rapid heartbeat</li> <li>• Frequent cold or flu like feelings</li> </ul> | <ul style="list-style-type: none"> <li>• Increase or decrease in appetite</li> <li>• Over sleeping or not sleeping enough</li> <li>• Withdrawing socially</li> <li>• Ignoring responsibilities</li> <li>• Consumption of alcohol or cigarettes</li> <li>• Nervous habits like nail biting and pacing</li> </ul> |

Fig 6.1.1 (b): Stress symptoms

### Tips to Manage Stress

The following tips can help you manage your stress better:

- Note down the different ways in which you can handle the various sources of your stress.
- Remember that you cannot control everything, but you can control how you respond.
-

- Practice relaxation techniques like meditation, yoga or tai chi when you start feeling stressed.
- Discuss your feelings, opinions and beliefs rather than reacting angrily, defensively or passively.
- Devote a part of your day towards exercise.
- Eat healthy foods like fruits and vegetables. Avoid unhealthy foods especially those containing large amounts of sugar.
- Plan your day so that you can manage your time better, with less stress.
- Say no to people and things when required.
- Schedule time to pursue your hobbies and interests.
- Ensure you get at least 7-8 hours of sleep.
- Reduce your caffeine intake.
- Increase the time spent with family and friends.



- Force yourself to smile even if you feel stressed. Smiling makes us feel relaxed and happy.
- Stop yourself from feeling and thinking like a victim. Change your attitude and focus on being proactive.

## UNIT 6.2: Digital Literacy: A Recap

### Unit Objectives



At the end of this unit, you will be able to:

1. Identify the basic parts of a computer
2. Identify the basic parts of a keyboard
3. Recall basic computer terminology
4. Recall the functions of basic computer keys
5. Discuss the main applications of MS Office
6. Discuss the benefits of Microsoft Outlook
7. Discuss the different types of e-commerce
8. List the benefits of e-commerce for retailers and customers
9. Discuss how the Digital India campaign will help boost e-commerce in India

#### 6.2.1 Computer and Internet basics: Basic Parts of a Computer

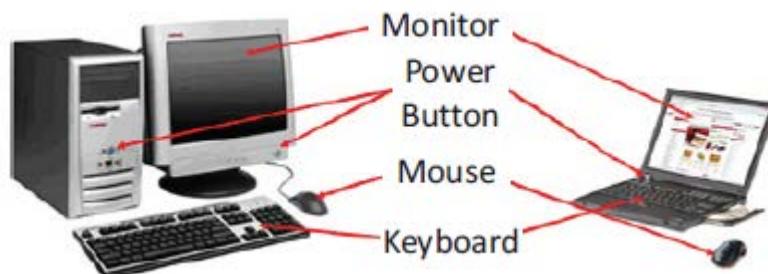
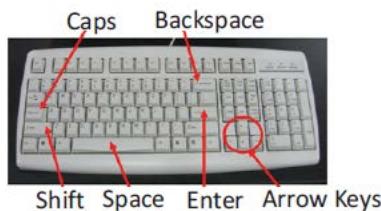


Fig.6.2.1. Parts of a Computer

- **Central Processing Unit (CPU):** The brain of the computer. It interprets and carries out program instructions.
- **Hard Drive:** A device that stores large amounts of data.
- **Monitor:** The device that contains the computer screen where the information is visually displayed.
- **Mouse:** A hand-held device used to point to items on the monitor.
- **Speakers:** Devices that enable you to hear sound from the computer.
- **Printer:** A device that converts output from a computer into printed paper documents.

### Basic Parts of a Keyboard



*Fig.6.2.2. Parts of a Keyboard*

- **Arrow Keys:** Press these keys to move your cursor.
- **Space bar:** Adds a space.
- **Enter/Return:** Moves your cursor to a new line.
- **Shift:** Press this key if you want to type a capital letter or the upper symbol of a key.
- **Caps Lock:** Press this key if you want all the letters you type to be capital letters. Press it again to revert back to typing lowercase letters.
- **Backspace:** Deletes everything to the left of your cursor.

### Basic Internet Terms

- **The Internet:** A vast, international collection of computer networks that transfers information.
- **The World Wide Web:** A system that lets you access information on the Internet.
- **Website:** A location on the World Wide Web (and Internet) that contains information about a specific topic.
- **Homepage:** Provides information about a website and directs you to other pages on that website.
- **Link/Hyperlink:** A highlighted or underlined icon, graphic, or text that takes you to another file or object.
- **Web Address/URL:** The address for a website.
- **Address Box:** A box in the browser window where you can type in a web address.



- When visiting a .com address, there no need to type http:// or even www. Just type the name of the website and then press Ctrl + Enter. (Example: Type 'apple' and press Ctrl + Enter to go to www.apple.com)
- Press the Ctrl key and press the + or - to increase and decrease the size of text.
- Press F5 or Ctrl + R to refresh or reload a web page.

## 6.2.2 MS Office and Email: About MS Office

MS Office or Microsoft Office is a suite of computer programs developed by Microsoft. Although meant for all users, it offers different versions that cater specifically to students, home users and business users. All the programs are compatible with both, Windows and Macintosh.

### Most Popular Office Products

Some of the most popular and universally used MS Office applications are:

- **Microsoft Word:** Allows users to type text and add images to a document.
- **Microsoft Excel:** Allows users to enter data into a spreadsheet and create calculations and graphs.
- **Microsoft PowerPoint:** Allows users to add text, pictures and media and create slideshows and presentations.
- **Microsoft Outlook:** Allows users to send and receive email.
- **Microsoft OneNote:** Allows users to make drawings and notes with the feel of a pen on paper.
- **Microsoft Access:** Allows users to store data over many tables.

### Why Choose Microsoft Outlook?

A popular email management choice especially in the workplace, Microsoft Outlook also includes an address book, notebook, web browser and calendar. Some major benefits of this program are:

- **Integrated search function:** You can use keywords to search for data across all Outlook programs.
- **Enhanced security:** Your email is safe from hackers, junk mail and phishing website email.
- **Email syncing:** Sync your mail with your calendar, contact list, notes in One Note and...your phone!
- **Offline access to email:** No Internet? No problem! Write emails offline and send them when you're connected again.



- Press Ctrl+R as a shortcut method to reply to email.
- Set your desktop notifications only for very important emails.
- Flag messages quickly by selecting messages and hitting the Insert key.
- Save frequently sent emails as a template to reuse again and again.
- Conveniently save important emails as files.

### 6.2.3 E-Commerce: What is E-Commerce?

E-commerce is the buying or selling of goods and services, or the transmitting of money or data, electronically on the internet. E-Commerce is the short form for “electronic commerce.”

#### Examples of E-Commerce

Some examples of e-commerce are:

- Online shopping
- Online auctions
- Online ticketing
- Electronic payments
- Internet banking

#### Types of E-Commerce

E-commerce can be classified based on the types of participants in the transaction. The main types of e-commerce are:

- **Business to Business (B2B):** Both the transacting parties are businesses.
- **Business to Consumer (B2C):** Businesses sell electronically to end-consumers.
- **Consumer to Consumer (C2C):** Consumers come together to buy, sell or trade items to other consumers.
- **Consumer-to-Business (C2B):** Consumers make products or services available for purchase to companies looking for exactly those services or products.
- **Business-to-Administration (B2A):** Online transactions conducted between companies and public administration.
- **Consumer-to-Administration (C2A):** Online transactions conducted between individual and public administration.

#### Benefits of E-Commerce

The e-commerce business provides some benefits for retailers and customers.

#### Benefits for retailers

- Establishes an online presence
- Reduces operational costs by removing overhead costs
- Increases brand awareness through the use of good keywords
- Increases sales by removing geographical and time constraints

#### Benefits for customers

- Offers a wider range of choice than any physical store
- Enables goods and services to be purchased from remote locations
- Enables consumers to perform price comparisons

#### Digital India Campaign

Prime Minister Narendra Modi launched the Digital India campaign in 2015, with the objective of offering every citizen of India access to digital services, knowledge and information. The campaign aims to improve the country's online infrastructure and increase internet connectivity, thus boosting the e-commerce industry.

Currently, the majority of online transactions come from tier 2 and tier 3 cities. Once the Digital India campaign is in place, the government will deliver services through mobile connectivity, which will help deliver internet to remote corners of the country. This will help the e-commerce market to enter India's tier 4 towns and rural areas.

#### E-Commerce Activity

Choose a product or service that you want to sell online. Write a brief note explaining how you will use existing e-commerce platforms, or create a new e-commerce platform, to sell your product or service.



- Before launching your e-commerce platform, test everything.
- Pay close and personal attention to your social media.

## UNIT 6.3: Money Matters

### Unit Objectives



At the end of this unit, you will be able to:

1. Discuss the importance of saving money
2. Discuss the benefits of saving money
3. Discuss the main types of bank accounts
4. Describe the process of opening a bank account
5. Differentiate between fixed and variable costs
6. Describe the main types of investment options
7. Describe the different types of insurance products
8. Describe the different types of taxes
9. Discuss the uses of online banking
10. Discuss the main types of electronic funds transfers

### 6.3.1 Personal Finance – Why to Save? Importance of Saving

We all know that the future is unpredictable. You never know what will happen tomorrow, next week or next year. That's why saving money steadily through the years is so important. Saving money will help improve your financial situation over time. But more importantly, knowing that you have money stashed away for an emergency will give you peace of mind. Saving money also opens the door to many more options and possibilities.

#### Benefits of Saving

Inculcating the habit of saving leads to a vast number of benefits. Saving helps you:

- **Become financially independent:** When you have enough money saved up to feel secure you can start making your choices, from taking a vacation whenever you want, to switching careers or starting your own business.
- **Invest in yourself through education:** Through saving, you can earn enough to pay up for courses that will add to your professional experience and ultimately result in higher paying jobs.
- **Get out of debt:** Once you have saved enough as a reserve fund, you can use your savings to pay off debts like loans or bills that have accumulated over time.
- **Be prepared for surprise expenses:** Having money saved enables you to pay for unforeseen expenses like sudden car or house repairs, without feeling financially stressed.
- **Pay for emergencies:** Saving helps you deal with emergencies like sudden health issues or emergency trips without feeling financially burdened.
- **Afford large purchases and achieve major goals:** Saving diligently makes it possible to place down payments towards major purchases and goals, like buying a home or a car.
- **Retire:** The money you have saved over the years will keep you comfortable when you no longer have the income you would get from your job.



- Break your spending habit. Try not spending on one expensive item per week, and put the money that you would have spent into your savings.
- Decide that you will not buy anything on certain days or weeks and stick to your word.

## 6.3.2 Types of Bank Accounts, Opening a Bank Account

### Types of Bank Accounts

In India, banks offer four main types of bank accounts. These are:

- Current Accounts
- Savings Accounts
- Recurring Deposit Accounts
- Fixed Deposit Accounts

### Current Accounts

Current accounts offer the most liquid deposits and thus, are best suited for businessmen and companies. As these accounts are not meant for investments and savings, there is no imposed limit on the number or amount of transactions that can be made on any given day. Current account holders are not paid any interest on the amounts held in their accounts. They are charged for certain services offered on such accounts.

### Saving Accounts

Savings accounts are meant to promote savings, and are therefore the number one choice for salaried individuals, pensioners and students. While there is no restriction on the number and amount of deposits made, there are usually restrictions on the number and amount of withdrawals. Savings account holders are paid interest on their savings.

### Recurring Deposit Accounts

Recurring Deposit accounts, also called RD accounts, are the accounts of choice for those who want to save an amount every month, but are unable to invest a large sum at one time. Such account holders deposit a small, fixed amount every month for a pre-determined period (minimum 6 months). Defaulting on a monthly payment results in the account holder being charged a penalty amount. The total amount is repaid with interest at the end of the specified period.

### Fixed Deposit Accounts

Fixed Deposit accounts, also called FD accounts, are ideal for those who wish to deposit their savings for a long term in return for a high rate of interest. The rate of interest offered depends on the amount deposited and the time period, and also differs from bank to bank. In the case of an FD, a certain amount of money is deposited by the account holder for a fixed period of time. The money can be withdrawn when the period expires. If necessary, the depositor can break the fixed deposit prematurely. However, this usually attracts a penalty amount which also differs from bank to bank.

## Opening a Bank Account



Opening a bank account is quite a simple process. Take a look at the steps to open an account of your own:

### Step 1: Fill in the Account Opening Form

This form requires you to provide the following information:

- Personal details (name, address, phone number, date of birth, gender, occupation, address)
- Method of receiving your account statement (hard copy/email)
- Details of your initial deposit (cash/cheque)
- Manner of operating your account (online/mobile banking/traditional via cheque, slip books)

Ensure that you sign wherever required on the form.

### Step 2: Affix your Photograph

Stick a recent photograph of yourself in the allotted space on the form.

### Step 3: Provide your Know Your Customer (KYC) Details

KYC is a process that helps banks verify the identity and address of their customers. To open an account, every individual need to submit certain approved documents with respect to photo identity (ID) and address proof. Some Officially Valid Documents (OVDs) are:

- Passport
- Driving License
- Voters' Identity Card
- PAN Card
- UIDAI (Aadhar) Card

### Step 4: Submit All your Documents

Submit the completed Account Opening Form and KYC documents. Then wait until the forms are processed and your account has been opened!



- Select the right type of account.
- Fill in complete nomination details.
- Ask about fees.
- Understand the rules.
- Check for online banking – it's convenient!
- Keep an eye on your bank balance.

### 6.3.3 Costs: Fixed vs Variable: What are Fixed and Variable Costs?

Fixed costs and variable costs together make up a company's total cost. These are the two types of costs that companies have to bear when producing goods and services. A fixed cost does not change with the volume of goods or services a company produces. It always remains the same.

A variable cost, on the other hand, increases and decreases depending on the volume of goods and services produced. In other words, it varies with the amount produced.

#### Differences Between Fixed and Variable Costs

Let's take a look at some of the main differences between fixed and variable costs:

| Criteria         | Fixed Costs  | Variable Costs   |
|------------------|--|--|
| <b>Meaning</b>   | A cost that stays the same, regardless of the output produced. | A cost that changes when the                                       |
| <b>Nature</b>    | Time related.  | Volume related.  |
| <b>Incurred</b>  | Incurred irrespective of units being produced.                 | Incurred only when units are produced                              |
| <b>Unit cost</b> | Inversely proportional to the number of units produced         | Remains the same, per unit.  |
| <b>Examples</b>  | Depreciation, rent, salary, insurance and tax                  | Material consumed, wages, commission on sales and packing expenses |

Fig 6.3.1: Variable and fixed costs



- When trying to determine whether a cost is fixed or variable, simply ask the following question: Will the particular cost change if the company stopped its production activities? If the answer is no, then it is a fixed cost. If the answer is yes, then it is probably a variable cost.

### 6.3.4 Investment, Insurance and Taxes: Investment

Investment means that money is spent today with the aim of reaping financial gains at a future time. The main types of investment options are as follows:

- Bonds:** Bonds are instruments used by public and private companies to raise large sums of money – too large to be borrowed from a bank. These bonds are then issued in the public market and are bought by lenders.

- **Stocks:** Stocks or equity are shares that are issued by companies and are bought by the general public.
- **Small Savings Schemes:** Small Savings Schemes are tools meant to save money in small amounts. Some popular schemes are the Employees Provident Fund, Sukanya Samriddhi Scheme and National Pension Scheme.
- **Mutual Funds:** Mutual Funds are professionally managed financial instruments that invest money in different securities on behalf of investors.
- **Fixed Deposits:** A fixed amount of money is kept aside with a financial institution for a fixed amount of time in return for interest on the money.
- **Real Estate:** Loans are taken from banks to purchase real estate, which is then leased or sold with the aim of making a profit on the appreciated property price.
- **Hedge Funds:** Hedge funds invest in both financial derivatives and/or publicly traded securities.
- **Private Equity:** Private Equity is trading in the shares of an operating company that is not publicly listed and whose shares are not available on the stock market.

### **Insurance**

There are two types of insurance – Life Insurance and Non-Life or General Insurance.

#### **Life Insurance**

Life Insurance deals with all insurance covering human life.

#### **Life Insurance Products**

The main life insurance products are:

- **Term Insurance:** This is the simplest and cheapest form of insurance. It offers financial protection for a specified tenure, say 15 to 20 years. In the case of your death, your family is paid the sum assured. In the case of your surviving the term, the insurer pays nothing.
- **Endowment Policy:** This offers the dual benefit of insurance and investment. Part of the premium is allocated towards the sum assured, while the remaining premium gets invested in equity and debt. It pays a lump sum amount after the specified duration or on the death of the policyholder, whichever is earlier.
- **Unit-Linked Insurance Plan (ULIP):** Here part of the premium is spent on the life cover, while the remaining amount is invested in equity and debt. It helps develop a regular saving habit.
- **Money Back Life Insurance:** While the policyholder is alive, periodic payments of the partial survival benefits are made during the policy tenure. On the death of the insured, the insurance company pays the full sum assured along with survival benefits.
- **Whole Life Insurance:** It offers the dual benefit of insurance and investment. It offers insurance cover for the whole life of the person or up to 100 years whichever is earlier.

#### **General Insurance**

General Insurance deals with all insurance covering assets like animals, agricultural crops, goods, factories, cars and so on.

## General Insurance Products

The main general insurance products are:

- **Motor Insurance:** This can be divided into Four-Wheeler Insurance and Two-Wheeler insurance.
- **Health Insurance:** The main types of health insurance are individual health insurance, family floater health insurance, comprehensive health insurance and critical illness insurance.
- **Travel Insurance:** This can be categorised into Individual Travel Policy, Family Travel Policy, Student Travel Insurance and Senior Citizen Health Insurance.
- **Home Insurance:** This protects the house and its contents from risk.
- **Marine Insurance:** This insurance covers goods, freight and cargo against loss or damage during transit by rail, road, sea and/or air.

## Taxes

There are two types of taxes – Direct Taxes and Indirect Taxes.

### Direct Tax

Direct taxes are levied directly on an entity or a person and are non-transferrable. Some examples of Direct Taxes are:

- **Income Tax:** This tax is levied on your earning in a financial year. It is applicable to both, individuals and companies.
- **Capital Gains Tax:** This tax is payable whenever you receive a sizable amount of money. It is usually of two types – short term capital gains from investments held for less than 36 months and long term capital gains from investments held for longer than 36 months.
- **Securities Transaction Tax:** This tax is added to the price of a share. It is levied every time you buy or sell shares.
- **Perquisite Tax:** This tax is levied is on perks that have been acquired by a company or used by an employee.
- **Corporate Tax:** Corporate tax is paid by companies from the revenue they earn.

### Indirect Tax

Indirect taxes are levied on goods or services. Some examples of Indirect Taxes are:

- **Sales Tax:** Sales Tax is levied on the sale of a product.
- **Service Tax:** Service Tax is added to services provided in India.
- **Value Added Tax:** Value Added Tax is levied at the discretion of the state government. The tax is levied on goods sold in the state. The tax amount is decided by the state.
- **Customs Duty & Octroi:** Customs Duty is a charge that is applied on purchases that are imported from another country. Octroi is levied on goods that cross state borders within India.
- **Excise Duty:** Excise Duty is levied on all goods manufactured or produced in India



- Think about how quickly you need your money back and pick an investment option accordingly.
- Ensure that you are buying the right type of insurance policy for yourself.
- Remember, not paying taxes can result in penalties ranging from fines to imprisonment.

### 6.3.5 Online Banking, NEFT, RTGS etc.: What is Online Banking?

Internet or online banking allows account holders to access their account from a laptop at any location. In this way, instructions can be issued. To access an account, account holders simply

Internet banking can be used to:

- Find out an account balance
- Transfer amounts from one account to another
- Arrange for the issuance of cheques
- Instruct payments to be made
- Request for a cheque book
- Request for a statement of accounts
- Make a fixed deposit

#### Electronic Funds Transfers

Electronic funds transfer is a convenient way of transferring money from the comfort of one's own home, using integrated banking tools like internet and mobile banking.

Transferring funds via an electronic gateway is extremely convenient. With the help of online banking, you can choose to:

- Transfer funds into your own accounts of the same bank.
- Transfer funds into different accounts of the same bank.
- Transfer funds into accounts in different bank, using NEFT.
- Transfer funds into other bank accounts using RTGS.
- Transfer funds into various accounts using IMPS.

#### NEFT

NEFT stands for National Electronic Funds Transfer. This money transfer system allows you to electronically transfer funds from your respective bank accounts to any other account, either in the same bank or belonging to any other bank. NEFT can be used by individuals, firms and corporate organizations to transfer funds between accounts.

In order to transfer funds via NEFT, two things are required:

- A transferring bank
- A destination bank

Before you can transfer funds through NEFT, you will need to register the beneficiary who will be receiving the funds. In order to complete this registration, you will require the following information:

- Recipient's name
- Recipient's account number
- Recipient's bank's name
- Recipient's bank's IFSC code

**RTGS**

RTGS stands for Real Time Gross Settlement. This is a real-time fund transfer system which enables you to transfer funds from one bank to another, in real time or on a gross basis. The transferred amount is immediately deducted from the account of one bank, and instantly credited to the other bank's account. The RTGS payment gateway is maintained by the Reserve Bank of India. The transactions between banks are made electronically. RTGS can be used by individuals, companies and firms to transfer large sums of money. Before remitting funds through RTGS, you will need to add the beneficiary and his bank account details via your online banking account. In order to complete this registration, you will require the

- Name of the beneficiary
- Beneficiary's account number
- Beneficiary's bank address
- Beneficiary's bank's IFSC code

**IMPS**

IMPS stands for Immediate Payment Service. This is a real-time, inter-bank, electronic funds transfer system used to transfer money instantly within banks across India. IMPS enables users to make instant electronic transfer payments using mobile phones through both, Mobile Banking and SMS. It can also be used through ATMs and online banking. IMPS is available 24 hours a day and 7 days a week. The system features a secure transfer gateway and immediately confirms orders that have been fulfilled.

- Register for IMPS with your bank
- Receive a Mobile Money Identifier (MMID) from the bank
- Receive a MPIN from the bank

To transfer money through IMPS, the you need to:

Once you have both these, you can login or make a request through SMS to transfer a particular amount to a beneficiary.

For the beneficiary to receive the transferred money, he must:

1. Link his mobile number with his respective account
2. Receive the MMID from the bank

In order to initiate a money transfer through IMPS, you will need to enter the following information:

1. The beneficiary's mobile number
2. The beneficiary's MMID
3. The transfer amount
4. Your MPIN

As soon as money has been deducted from your account and credited into the beneficiary's account, you will be sent a confirmation SMS with a transaction reference number, for future reference.

### Differences Between NEFT, RTGS & IMPS

| Criteria                               | NEFT  | RTGS  | IMPS   |
|--|---|---|--|
| Settlement                             | Done in batches   | Real-time                                     | Real-time  |
| Full form                              | National Electronic Fund Transfer   | Real Time Gross Settlement                    | Immediate Payment Service  |
| Timings on Monday – Friday             | 8:00 am – 6:30 pm   | 9:00 am – 4:30 pm                             | 24x7   |
| Timings on Saturday                    | 8:00 am – 1:00 pm   | 9:00 am – 1:30 pm                             | 24x7   |
| Minimum amount of money transfer limit | ₹1  | ₹2 lacs                                       | ₹1   |
| Maximum amount of money transfer limit | ₹10 lacs  | ₹10 lacs per day                              | ₹2 lacs  |
| Maximum charges as per RBI             | Up to 10,000 – ₹2.5<br>above 10,000 – 1 lac – ₹5<br>above 1 – 2 lacs ₹15<br>above 2 – 5 lacs ₹25<br>above 5 – 10 lacs ₹25 | above 2 – 5 lacs ₹25<br>above 5 – 10 lacs ₹50 | Up to 10,000 – ₹5<br>above 10,000 – 1 lac – ₹5<br>above 1 – 2 lacs – ₹15 |

Fig 6.3.2:NEFT, RTGS &NEFT



- Never click on any links in any e-mail message to access your online banking website.
- You will never be asked for your credit or debit card details while using online banking.
- Change your online banking password regularly.

## UNIT 6.4: Preparing for Employment & Self Employment

### Unit Objectives



At the end of this unit, you will be able to:

1. Discuss the steps to prepare for an interview
2. Discuss the steps to create an effective Resume
3. Discuss the most frequently asked interview questions
4. Discuss how to answer the most frequently asked interview questions
5. Discuss basic workplace terminology

### 6.4.1 Interview Preparation: How to Prepare for an Interview?

The success of your getting the job that you want depends largely on how well your interview for that job goes. Therefore, before you go in for your interview, it is important that you prepare for it with a fair amount of research and planning. Take a look at the steps to follow in order to be well prepared for an interview:

- 1. Research the organization that you are having the interview with.**
  - Studying the company beforehand will help you be more prepared at the time of the interview. Your knowledge of the organization will help you answer questions at the time of the interview, and will leave you looking and feeling more confident. This is sure to make you stand out from other, not as well informed, candidates.
  - Look for background information on the company. Try and find an overview of the company and its industry profile.
  - Visit the company website to get a good idea of what the company does. A company website offers a wealth of important information. Read and understand the company's mission statement. Pay attention to the company's products/services and client list. Read through any press releases to get an idea of the company's projected growth and stability.
  - Note down any questions that you have after your research has been completed.
- 2. Think about whether your skills and qualifications match the job requirements.**
  - Carefully read through and analyse the job description.
  - Make a note of the knowledge, skills and abilities required to fulfil the job requirements.
  - Take a look at the organization hierarchy. Figure out where the position you are applying for fits into this hierarchy.
- 3. Go through the most typical interview questions asked, and prepare your responses.**
  - Remember, in most interviews a mix of resume-based, behavioural and case study questions are asked.
  - Think about the kind of answers you would like to provide to typical questions asked in these three areas.
  - Practice these answers until you can express them confidently and clearly.

**4. Plan your attire for the interview.**

- It is always safest to opt for formal business attire, unless expressly informed to dress in business casual (in which case you should use your best judgement)
- Ensure that your clothes are clean and well-ironed. Pick neutral colours – nothing too bright or flashy.
- The shoes you wear should match your clothes, and should be clean and suitable for a n interview.
- Remember, your aim is to leave everyone you meet with the impression that you are a professional and highly efficient person.

**5. Ensure that you have packed everything that you may require during the interview.**

- Carry a few copies of your resume. Use a good quality paper for your resume print outs.
- Always take along a notepad and a pen.
- Take along any information you may need to refer to, in order to fill out an application form.
- Carry a few samples of your work, if relevant.

**6. Remember the importance of non-verbal communication.**

- Practice projecting confidence. Remind yourself to smile and make eye contact. Practice giving a firm handshake.
- Keep in mind the importance of posture. Practice sitting up straight. Train yourself to stop nervous gestures like fidgeting and foot-tapping.
- Practice keeping your reactions in check. Remember, your facial expressions provide a good insight into your true feelings. Practice projecting a positive image.

**7. Make a list of questions to end the interview with.**

- Most interviews will end with the interviewer(s) asking if you have any questions. This is your chance to show that you have done your research and are interested in learning more about the company.
- If the interviewer does not ask you this question, you can inform him/her that you have some queries that you would like to discuss. This is the time for you to refer to the notes you made while studying the company.
- Some good questions to ask at this point are:
  - What do you consider the most important criteria for success in this job?
  - How will my performance be evaluated?
  - What are the opportunities for advancement?
  - What are the next steps in the hiring process?
- Remember, never ask for information that is easily available on the company website.



- Ask insightful and probing questions.
- When communicating, use effective forms of body language like smiling, making eye contact, and actively listening and nodding. Don't slouch, play with nearby items, fidget, chew gum, or mumble.

## 6.4.2 Preparing an Effective Resume: How to Create an Effective Resume?

A resume is a formal document that lists a candidate's work experience, education and skills. A good resume gives a potential employer enough information to believe the applicant is worth interviewing. That's why it is so important to create a résumé that is effective. Take a look at the steps to create an effective resume:

### Step 1: Write the Address Section

The Address section occupies the top of your resume. It includes information like your name, address, phone number and e-mail address. Insert a bold line under the section to separate it from rest of your resume.

#### Example:

Khyati Mehta  
Breach Candy, Mumbai – India  
Contact No: +91 2223678270  
Email: [jasmine.watts@gmail.com](mailto:jasmine.watts@gmail.com)

### Step 2: Add the Profile Summary Section

This part of your resume should list your overall experiences, achievements, awards, certifications and strengths. You can make your summary as short as 2-3 bullet points or as long as 8-10 bullet points.

#### Example:

#### Profile Summary

- A Floor Supervisor graduated from University of Delhi having 6 years of experience in managing a retail outlet.
- Core expertise lies in managing retail staff, including cashiers and people working on the floor.

### Step 3: Include Your Educational Qualifications

When listing your academic records, first list your highest degree. Then add the second highest qualification under the highest one and so on. To provide a clear and accurate picture of your educational background, it is critical that include information on your position, rank, percentage or CPI for every degree or certification that you have listed.

If you have done any certifications and trainings, you can add a Trainings & Certifications section under your Educational Qualifications section.

**Example:**

**Educational Qualifications**

*<Enter qualification> <enter date of qualification> from <enter name of institute> with <enter percentage or any other relevant scoring system>.*

**Step 4: List Your Technical Skills**

When listing your technical skills, start with the skills that you are most confident about. Then add the skills that you do not have as good a command over. It is perfectly acceptable to include just one skill, if you feel that particular skill adds tremendous value to your résumé. If you do not have any technical skills, you can omit this step.

**Example:**

**Technical Skills**

- *<Enter your technical skill here, if applicable>*

**Step 5: Insert Your Academic Project Experience**

List down all the important projects that you have worked on. Include the following information in this section:

- |   |   |   |
|---|---|---|
| <ul style="list-style-type: none"> <li>• Project title</li> <li>• Contribution</li> </ul> | <ul style="list-style-type: none"> <li>• Organization</li> <li>• Description</li> </ul> | <ul style="list-style-type: none"> <li>• Platform used</li> </ul> |
|---|---|---|

**Example:**

**Academic Projects**

**Project Title:** *<Insert project title>*

**Organization:** *<Insert the name of the organization for whom you did the project>*

**Platform used:** *<Insert the platform used, if any>*

**Contribution:** *<Insert your contribution towards this project>*

**Description:** *<Insert a description of the project in one line>*

**Step 6: List Your Strengths**

This is where you list all your major strengths. This section should be in the form of a bulleted list.

**Example:**

**Strengths**

- Excellent oral, written and presentation skills
- Action-oriented and result-focused
- Great time management skills

### Step 7: List Your Extracurricular Activities

It is very important to show that you have diverse interests and that your life consists of more than academics. Including your extracurricular activities can give you an added edge over other candidates who have similar academic scores and project experiences. This section should be in the form of a bulleted list.

**Example:**

< Insert your extracurricular activity here. E.g.: Member of, \_\_\_\_\_ played (name of sport) at \_\_\_\_\_ level, won (name of prize/award) for \_\_\_\_\_ >

### Step 8: Write Your Personal Details

The last section of your résumé must include the following personal information:

- Date of birth
- Nationality
- Gender & marital status
- Languages known

**Example:**

#### Personal Details

- |                            |                               |
|----------------------------|-------------------------------|
| • Date of birth:           | 25 <sup>th</sup> May, 1981    |
| • Gender & marital status: | Female, Single                |
| • Nationality:             | Indian                        |
| • Languages known:         | English, Hindi, Tamil, French |



- Keep your resume file name short, simple and informational.
- Make sure the resume is neat and free from typing errors.
- Always create your resume on plain white paper.

### 6.4.3 Interview FAQs

Take a look at some of the most frequently asked interview questions, and some helpful tips on how to answer them.

#### Q1. Can you tell me a little about yourself?

**Tips to answer:**

- Don't provide your full employment or personal history.
- Offer 2-3 specific experiences that you feel are most valuable and relevant.
- Conclude with how those experiences have made you perfect for this specific role.

**Q2. How did you hear about the position?****Tips to answer:**

- Tell the interviewer how you heard about the job – whether it was through a friend (name the friend), event or article (name them) or a job portal (say which one).
- Explain what excites you about the position and what in particular caught your eye about this role.

**Q3. What do you know about the company?****Tips to answer:**

- Don't recite the company's About Us page.
- Show that you understand and care about the company's goals.
- Explain why you believe in the company's mission and values.

**Q4. Why do you want this job?****Tips to answer:**

- Show that you are passionate about the job.
- Identify why the role is a great fit for you.
- Explain why you love the company.

**Q5. Why should we hire you?****Tips to answer:**

- Prove through your words that you can not only do the work, but can definitely deliver excellent results.
- Explain why you would be a great fit with the team and work culture.
- Explain why you should be chosen over any other candidate.

**Q6. What are your greatest professional strengths?****Tips to answer:**

- Be honest – share some of your real strengths, rather than give answers that you think sound good.
- Offer examples of specific strengths that are relevant to the position you are applying for.
- Provide examples of how you've demonstrated these strengths.

**Q7. What do you consider to be your weaknesses?****Tips to answer:**

- The purpose of this question is to gauge your self-awareness and honesty.
- Give an example of a trait that you struggle with, but that you're working on to improve.

**Q8. What are your salary requirements?****Tips to answer:**

- Do your research beforehand and find out the typical salary range for the job you are applying for.
- Figure out where you lie on the pay scale based on your experience, education, and skills.
- Be flexible. Tell the interviewer that you know your skills are valuable, but that you want the job and are willing to negotiate.

**Q9. What do you like to do outside of work?**

**Tips to answer:**

- The purpose of this question is to see if you will fit in with the company culture.
- Be honest – open up and share activities and hobbies that interest and excite you.

**Q10. If you were an animal, which one would you want to be?**

**Tips to answer:**

- The purpose of this question is to see if you are able to think on your feet.
- There's no wrong answer – but to make a great impression try to bring out your strengths or personality traits through your answer.

**Q11: What do you think we could do better or differently?**

**Tips to answer:**

- The purpose of this question is to see if you have done your research on the company, and to test whether you can think critically and come up with new ideas.
- Suggest new ideas. Show how your interests and expertise would help you execute these ideas.

**Q12: Do you have any questions for us?**

**Tips to answer:**

- Do not ask questions to which the answers can be easily found on the company website or through a quick online search.
- Ask intelligent questions that show your ability to think critically.



- Be honest and confident while answering.
- Use examples of your past experiences wherever possible to make your answers more impactful.

## 6.4.4 Work Readiness – Terms & Terminologies: Basic Workplace Terminology

Every employee should be well versed in the following terms:

- **Annual leave:** Paid vacation leave given by employers to employees.
- **Background Check:** A method used by employers to verify the accuracy of the information provided by potential candidates.
- **Benefits:** A part of an employee's compensation package.
- **Breaks:** Short periods of rest taken by employees during working hours.
- **Compensation Package:** The combination of salary and benefits that an employer provides to his/her employees.
- **Compensatory Time (Comp Time):** Time off in lieu of pay.
- **Contract Employee:** An employee who works for one organization that sells said employee's service to another company, either on a project or time basis.
- **Contract of Employment:** When an employee is offered work in exchange for wages or salary, and accepts the offer made by the employer, a contract of employment exists.
- **Corporate Culture:** The beliefs and values shared by all the members of a company, and imparted from one generation of employees to another.
- **Counter Offer/Counter Proposal:** A negotiation technique used by potential candidates to increase the amount of salary offered by a company.
- **Cover Letter:** A letter that accompanies a candidate's resume. It emphasizes the important points in the candidate's resume and provides real examples that prove the candidate's ability to perform the expected job role.
- **Curriculum Vitae (CV)/Resume:** A summary of a candidate's achievements, educational work experience, skills and strengths.
- **Declining Letter:** A letter sent by an employee to an employer, turning down the job offer employer to the employee.
- **Deductions:** Amounts subtracted from an employee's pay and listed on the employee's pay slip.
- **Discrimination:** The act of treating one person not as favourably as another person.
- **Employee:** A person who works for another person in exchange for payment.
- **Employee Training:** A workshop or in-house training that an employee is asked to attend by his or her superior, for the benefit of the employer.
- **Employment Gaps:** Periods of unemployed time between jobs.
- **Fixed-Term Contract:** A contract of employment which gets terminated on an agreed-upon date.
- **Follow-Up:** The act of contacting a potential employer after a candidate has submitted his or her resume.
- **Freelancer/Consultant/Independent Contractor:** A person who works for him or herself for temporary jobs and projects with different employers.
- **Holiday:** Paid time-off from work.
- **Hourly Rate:** The amount of salary or wages paid for 60 minutes of work.
- **Internship:** A job opportunity offered by an employer to a potential employee, called an at the employer's company for a fixed, limited time period.

- **Interview:** A conversation between a potential employee and a representative of an order to determine if the potential employee should be hired.
- **Job Application:** A form which asks for a candidate's information like the candidate's name, details and work experience. The purpose of a candidate submitting a job application, is to show that candidate's interest in working for a particular company.
- **Job Offer:** An offer of employment made by an employer to a potential employee.
- **Job Search Agent:** A program that enables candidates to search for employment opportunities by selecting criteria listed in the program, for job vacancies. background, made by the and pitches intern, to work employer, in address, contact
- **Lay Off:** A lay off occurs when an employee is temporarily let go from his or her job, due to the employer not having any work for that employee.
- **Leave:** Formal permission given to an employee, by his or her employer, to take a leave of absence from work.
- **Letter of Acceptance:** A letter given by an employer to an employee, confirming the offer of employment made by the employer, as well as the conditions of the offer.
- **Letter of Agreement:** A letter that outlines the terms of employment.
- **Letter of Recommendation:** A letter written for the purpose of validating the work skills o f a person.
- **Maternity Leave:** Leave taken from work by women who are pregnant, or who have just given birth.
- **Mentor:** A person who is employed at a higher level than you, who offers you advice and guides you in your career.
- **Minimum wage:** The minimum wage amount paid on an hourly basis.
- **Notice:** An announcement made by an employee or an employer, stating that the employment contract will end on a particular date.
- **Offer of Employment:** An offer made by an employer to a prospective employee that contains important information pertaining to the job being offered, like the starting date, salary, working conditions etc.
- **Open-Ended Contract:** A contract of employment that continues till the employer or terminates it.
- **Overqualified:** A person who is not suited for a particular job because he or she has too m any years of work experience, or a level of education that is much higher than required f or the job, or is currently or was previously too highly paid.
- **Part-Time Worker:** An employee who works for fewer hours than the standard number of hours normally worked.
- **Paternity Leave:** Leave granted to a man who has recently become a father.
- **Recruiters/Head-hunters/Executive Search Firms:** Professionals who are paid by employers to search for people to fill particular positions.
- **Resigning/Resignations:** When an employee formally informs his or her employer that he or she is quitting his or her job.
- **Self-Employed:** A person who has his or her own business and does not work in the capacity of an employee.
- **Time Sheet:** A form that is submitted to an employer, by an employee, that contains the number of hours worked every day by the employee.

## UNIT 6.5: Understanding Entrepreneurship

### Unit Objectives



**At the end of this unit, you will be able to:**

1. Discuss the concept of entrepreneurship
2. Discuss the importance of entrepreneurship
3. Describe the characteristics of an entrepreneur
4. Describe the different types of enterprises
5. List the qualities of an effective leader
6. Discuss the benefits of effective leadership
7. List the traits of an effective team
8. Discuss the importance of listening effectively
9. Discuss how to listen effectively
10. Discuss the importance of speaking effectively
11. Discuss how to speak effectively
12. Discuss how to solve problems
13. List important problem solving traits
14. Discuss ways to assess problem solving skills
15. Discuss the importance of negotiation
16. Discuss how to negotiate
17. Discuss how to identify new business opportunities
18. Discuss how to identify business opportunities within your business
19. Explain the meaning of entrepreneur
20. Describe the different types of entrepreneurs
21. List the characteristics of entrepreneurs
22. Recall entrepreneur success stories
23. Discuss the entrepreneurial process
24. Describe the entrepreneurship ecosystem
25. Discuss the purpose of the Make in India campaign
26. Discuss key schemes to promote entrepreneurs
27. Discuss the relationship between entrepreneurship and risk appetite
28. Discuss the relationship between entrepreneurship and resilience
29. Describe the characteristics of a resilient entrepreneur
30. Discuss how to deal with failure

## 6.5.1 Concept Introduction (Characteristic of Entrepreneur, types of firms / types of enterprises)

### Entrepreneurs and Entrepreneurship

Anyone who is determined to start a business, no matter what the risk, is an entrepreneur. Entrepreneurs run their own start-up, take responsibility for the financial risks and use creativity, innovation and vast reserves of self-motivation to achieve success. They dream big and are determined to do whatever it takes to turn their idea into a viable offering. The aim of a n entrepreneur is to create an enterprise. The process of creating this enterprise is known as entrepreneurship.

### Importance of Entrepreneurship

1. Entrepreneurship is very important for the following reasons:
2. It results in the creation of new organizations
3. It brings creativity into the marketplace
4. It leads to improved standards of living
5. It helps develop the economy of a country

### Characteristics of Entrepreneurs

All successful entrepreneurs have certain characteristics in common.

They are all:

- Extremely passionate about their work
- Confident in themselves
- Disciplined and dedicated
- Motivated and driven
- Highly creative
- Visionaries
- Open-minded
- Decisive

Entrepreneurs also have a tendency to:

- Have a high-risk tolerance
- Thoroughly plan everything
- Manage their money wisely
- Make their customers their priority
- Understand their offering and their market in detail
- Ask for advice from experts when required
- Know when to cut their losses

### Examples of Famous Entrepreneurs

Some famous entrepreneurs are:

- Dhirubhai Ambani (Reliance)
- Dr. Karsanbhai Patel (Nirma)
- Azim Premji (Wipro)
- Anil Agarwal (Vedanta Resources)

### Types of Enterprises

As an entrepreneur in India, you can own and run any of the following types of enterprises:

#### Sole Proprietorship

In a sole proprietorship, a single individual owns, manages and controls the enterprise. This type of business is the easiest to form with respect to legal formalities. The business and the owner have no separate legal existence. All profit belongs to the proprietor, as do all the losses the liability of the entrepreneur is unlimited.

#### Partnership

A partnership firm is formed by two or more people. The owners of the enterprise are called partners. A partnership deed must be signed by all the partners. The firm and its partners have no separate legal existence. The profits are shared by the partners. With respect to losses, the liability of the partners is unlimited. A firm has a limited life span and must be dissolved when any one of the partners dies, retires, claims bankruptcy or goes insane.

#### Limited Liability Partnership (LLP)

In a Limited Liability Partnership or LLP, the partners of the firm enjoy perpetual existence as well as the advantage of limited liability. Each partner's liability is limited to their agreed contribution to the LLP. The partnership and its partners have a separate legal existence.



- Learn from others' failures.
- Be certain that this is what you want.
- Search for a problem to solve, rather than look for a problem to attach to your idea.

### 6.5.2 Leadership & Teamwork: Leadership and Leaders

Leadership means setting an example for others to follow. Setting a good example means not asking someone to do something that you wouldn't willingly want to do yourself.

Leadership is about figuring out what to do in order to win as a team, and as a company.

Leaders believe in doing the right things. They also believe in helping others to do the right things. An effective leader is someone who:

- Creates an inspiring vision of the future.
- Motivates and inspires his team to pursue that vision.

### Leadership Qualities That All Entrepreneurs Need

Building a successful enterprise is only possible if the entrepreneur in charge possesses excellent leadership qualities. Some critical leadership skills that every entrepreneur must have are:

1. **Pragmatism:** This means having the ability to highlight all obstacles and challenges, in order to resolve issues and reduce risks.
2. **Humility:** This means admitting to mistakes often and early, and being quick to take responsibility for your actions. Mistakes should be viewed as challenges to overcome, not opportunities to point blame.
3. **Flexibility:** It is critical for a good leader to be very flexible and quickly adapt to change. It is equally critical to know when to adapt and when not to.
4. **Authenticity:** This means showing both, your strengths and your weaknesses. It means being human and showing others that you are human.
5. **Reinvention:** This means refreshing or changing your leadership style when necessary. To do this, it's important to learn where your leadership gaps lie and find out what resources are required to close them.
6. **Awareness:** This means taking the time to recognize how others view you. It means understanding how your presence affects those around you.

### Benefits of Effective Leadership

Effective leadership results in numerous benefits. Great leadership leads to the leader successfully:

- Gaining the loyalty and commitment of the team members
- Motivating the team to work towards achieving the company's goals and objectives
- Building morale and instilling confidence in the team members
- Fostering mutual understanding and team-spirit among team members
- Convincing team members about the need to change when a situation requires adaptability

### Teamwork and Teams

Teamwork occurs when the people in a workplace combine their individual skills to pursue a common goal. Effective teams are made up of individuals who work together to achieve this common goal. A great team is one who holds themselves accountable for the end result.

1. **Unity of purpose:** All the team members should clearly understand and be equally committed to the purpose, vision and goals of the team.
2. **Great communication skills:** Team members should have the ability to express their concerns, ask questions and use diagrams, and charts to convey complex information.
3. **The ability to collaborate:** Every member should feel entitled to provide regular feedback on new ideas.
4. **Initiative:** The team should consist of proactive individuals. The members should have the enthusiasm to come up with new ideas, improve existing ideas, and conduct their own research.
5. **Visionary members:** The team should have the ability to anticipate problems and act on these potential problems before they turn into real problems.

6. **Great adaptability skills:** The team must believe that change is a positive force. Change should be seen as the chance to improve and try new things.
7. **Excellent organizational skills:** The team should have the ability to develop standard work processes, balance responsibilities, properly plan projects, and set in place methods to measure progress and ROI.



- Don't get too attached to your original idea. Allow it to evolve and change.
- Be aware of your weaknesses and build a team that will complement your shortfalls.
- Hiring the right people is not enough. You need to promote or incentivize your most talented people to keep them motivated.
- Earn your team's respect.

### 6.5.3 Communication Skills: Listening & Speaking the Importance of Listening Effectively

Listening is the ability to correctly receive and understand messages during the process of communication. Listening is critical for effective communication. Without effective listening skills, messages can easily be misunderstood. This results in a communication breakdown and can lead to the sender and the receiver of the message becoming frustrated or irritated. It's very important to note that listening is not the same as hearing. Hearing just refers to sounds that you hear. Listening is a whole lot more than that. To listen, one requires focus. It means not only paying attention to the story, but also focusing on how the story is relayed, the way language and voice is used, and even how the speaker uses their body language. The ability to listen depends on how effectively one can perceive and understand both, verbal and non-verbal cues.

#### How to Listen Effectively?

To listen effectively you should:

- Stop talking
- Stop interrupting
- Focus completely on what is being said
- Nod and use encouraging words and gestures
- Be open-minded
- Pay attention to the tone that is being used
- Pay attention to the speaker's gestures, facial expressions and eye movements
- Not try and rush the person
- Not let the speaker's mannerisms or habits irritate or distract you

- Think about the speaker's perspective
- Be very, very patient

### **The Importance of Speaking Effectively**

How successfully a message gets conveyed depends entirely on how effectively you are able to get it through. An effective speaker is one who enunciates properly, pronounces words correctly, chooses the right words and speaks at a pace that is easily understandable.

Besides this, the words spoken out loud need to match the gestures, tone and body language used. What you say, and the tone in which you say it, results in numerous perceptions being formed. A person who speaks hesitantly may be perceived as having low self-esteem or lacking in knowledge of the discussed topic. Those with a quiet voice may very well be labelled as shy. And those who speak in commanding tones with high levels of clarity, are usually considered to be extremely confident. This makes speaking a very critical communication skill.

### **How to Speak Effectively?**

To speak effectively you should:

- Incorporate body language in your speech like eye contact, smiling, nodding, gesturing etc.
- Build a draft of your speech before actually making your speech.
- Ensure that all your emotions and feelings are under control.
- Pronounce your words distinctly with the correct pitch and intensity. Your speech should be crystal clear at all times. Use a pleasant and natural tone when speaking. Your audience should not feel like you are putting on an accent or being unnatural in any way.
- Use precise and specific words to drive your message home. Ambiguity should be avoided at all costs.
- Ensure that your speech has a logical flow.
- Be brief. Don't add any unnecessary information.
- Make a conscious effort to avoid irritating mannerisms like fidgeting, twitching etc.
- Choose your words carefully and use simple words that the majority of the audience will have no difficulty understanding.
- Use visual aids like slides or a whiteboard.
- Speak slowly so that your audience can easily understand what you're saying. However, be careful not to speak too slowly because this can come across as stiff, unprepared or even condescending.
- Remember to pause at the right moments.



- If you're finding it difficult to focus on what someone is saying, try repeating their words in your head.
- Always maintain eye contact with the person that you are communicating with, when speaking as well as listening. This conveys and also encourages interest in the conversation.

## 6.5.4 Problem Solving & Negotiation Skills: What is a Problem?

As per The Concise Oxford Dictionary (1995), a problem is, “A doubtful or difficult matter requiring a solution”

All problems contain two elements:

1. Goals
2. Obstacles

The aim of problem solving is to recognize the obstacles and remove them in order to achieve the goals.

### How to Solve Problems?



Solving a problem requires a level of rational thinking. Here are some logical steps to follow when faced with an issue:

**Step 1:** Identify the problem

**Step 3:** List all possible solutions

**Step 5:** Implement the chosen solution

**Step 2:** Study the problem in detail

**Step 4:** Select the best solution

**Step 6:** Check that the problem has really been solved

### Important Traits for Problem Solving

Highly developed problem solving skills are critical for both, business owners and their employees. The following personality traits play a big role in how effectively problems are solved:

Being open minded

Not panicking

Asking the right questions

Having a positive attitude

Being proactive

Focusing on the right problem

### How to Assess for Problem Solving Skills?

As an entrepreneur, it would be a good idea to assess the level of problem solving skills of potential candidates before hiring them. Some ways to assess this skill are through:

1. Application forms: Ask for proof of the candidate's problem solving skills in the application form.
2. Psychometric tests: Give potential candidates logical reasoning and critical thinking tests and see how they fare.

3. Interviews: Create hypothetical problematic situations or raise ethical questions and see how the candidates respond.
4. Technical questions: Give candidates examples of real life problems and evaluate their thought process.

### What is Negotiation?

Negotiation is a method used to settle differences. The aim of negotiation is to resolve differences through a compromise or agreement while avoiding disputes. Without negotiation, conflicts are likely to lead to resentment between people. Good negotiation skills help satisfy both parties and go a long way towards developing strong relationships.

### Why Negotiate?

Starting a business requires many, many negotiations. Some negotiations are small while others are critical enough to make or break a start-up. Negotiation also plays a big role inside the workplace. As an entrepreneur, you need to know not only how to negotiate yourself, but also how to train employees in the art of negotiation.

### How to Negotiate?



Take a look at some steps to help you negotiate:

|   |  |
|---|--|
| <b>Step 1:</b> Pre-Negotiation Preparation        | Agree on where to meet to discuss the problem, decide who all will be present and set a time limit for the discussion.                       |
| <b>Step 2:</b> Discuss the problem                | This involves asking questions, listening to the other side, putting your views forward and clarifying doubts.                               |
| <b>Step 3:</b> Clarify the Objective              | Ensure that both parties want to solve the same problem and reach the same goal.   |
| <b>Step 4:</b> Aim for a Win-Win Outcome          | Try your best to be open minded when negotiating. Compromise and offer alternate solutions to reach an outcome where both parties win.       |
| <b>Step 5:</b> Clearly Define the Agreement       | When an agreement has been reached, the details of the agreement should be crystal clear to both sides, with no scope for misunderstandings. |
| <b>Step 6:</b> Implement the Agreed Upon Solution | Agree on a course of action to set the solution in motion  |



- Know exactly what you want before you work towards getting it
- Give more importance to listening and thinking, than speaking
- Focus on building a relationship rather than winning
- Remember that your people skills will affect the outcome
- Know when to walk away – sometimes reaching an agreement may not be possible

## 6.5.5 Business Opportunities Identification: Entrepreneurs and Opportunities

*"The entrepreneur always searches for change, responds to it and exploits it as an opportunity."*

Peter Drucker

The ability to identify business opportunities is an essential characteristic of an entrepreneur.

### What is an Opportunity?

The word opportunity suggests a good chance or a favourable situation to do something offered by circumstances.

### Common Questions Faced by Entrepreneurs

A critical question that all entrepreneurs face is how to go about finding the business opportunity that is right for them.

- Some common questions that entrepreneurs constantly think about are:
- Should the new enterprise introduce a new product or service based on an unmet need?
- Should the new enterprise select an existing product or service from one market and offer it in another where it may not be available?
- Should the enterprise be based on a tried and tested formula that has worked elsewhere?

It is therefore extremely important that entrepreneurs must learn how to identify new and existing business opportunities and evaluate their chances of success.

### When is an Idea an Opportunity?

An idea is an opportunity when:

- It creates or adds value to a customer
- It solves a significant problem, removes a pain point or meets a demand
- Has a robust market and profit margin
- Is a good fit with the founder and management team at the right time and place

### Factors to Consider When Looking for Opportunities

Consider the following when looking for business opportunities:

- |   |   |
|---|---|
| <ul style="list-style-type: none"><li>• Economic trends</li><li>• Changes in funding</li><li>• Changing relationships between vendors, partners and suppliers</li></ul> | <ul style="list-style-type: none"><li>• Market trends</li><li>• Changes in political support</li><li>• Shift in target audience</li></ul> |
|---|---|

### Ways to Identify New Business Opportunities

#### 1. Identify Market Inefficiencies

When looking at a market, consider what inefficiencies are present in the market. Think about ways to correct these inefficiencies.

## 2. Remove Key Hassles

Rather than create a new product or service, you can innovatively improve a product, service or process.

## 3. Create Something New

Think about how you can create a new experience for customers, based on existing business models.

## 4. Pick a Growing Sector/Industry

Research and find out which sectors or industries are growing and think about what opportunities you can tap in the same.

## 5. Think About Product Differentiation

If you already have a product in mind, think about ways to set it apart from the existing ones.

### Ways to Identify Business Opportunities Within Your Business

#### 1. SWOT Analysis

An excellent way to identify opportunities inside your business is by creating a SWOT analysis. The acronym SWOT stands for strengths, weaknesses, opportunities, and threats. SWOT analysis framework:

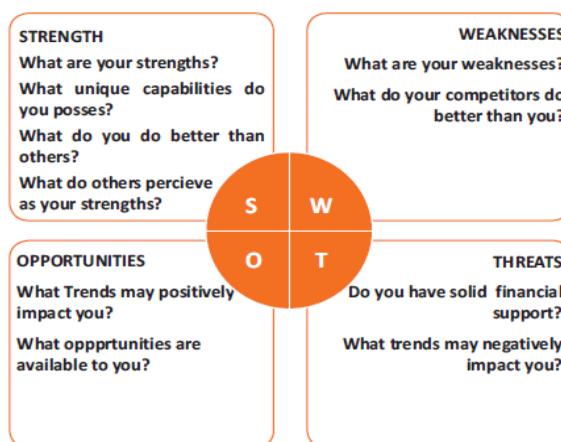


Fig.6.5.1. SWOT Analysis

#### Consider the following when looking for business opportunities:

By looking at yourself and your competitors using the SWOT framework, you can uncover opportunities that you can exploit, as well as manage and eliminate threats that could derail your success.

## 2. Establishing Your USP

Establish your USP and position yourself as different from your competitors. Identify why customers should buy from you and promote that reason.

### Opportunity Analysis

Once you have identified an opportunity, you need to analyse it.

To analyse an opportunity, you must:

- Remember, opportunities are situational.
- Look for a proven track record.
- Avoid the latest craze.
- Love your idea.

## 6.5.6 Entrepreneurship Support Eco-System: Who is an Entrepreneur?

An entrepreneur is a person who:

- Does not work for an employee
- Runs a small enterprise
- Assumes all the risks and rewards of the enterprise, idea, good or service

### Types of Entrepreneurs

There are four main types of entrepreneurs:

1. **The Traditional Entrepreneur:** This type of entrepreneur usually has some kind of skill – they can be a carpenter, mechanic, cook etc. They have businesses that have been around for numerous years like restaurants, shops and carpenters. Typically, they gain plenty of experience in a particular industry before they begin their own business in a similar field.
2. **The Growth Potential Entrepreneur:** The desire of this type of entrepreneur is to start an enterprise that will grow, win many customers and make lots of money. Their ultimate aim is to eventually sell their enterprise for a nice profit. Such entrepreneurs usually have a science or technical background.
3. **The Project-Oriented Entrepreneur:** This type of entrepreneur generally has a background in the Arts or psychology. Their enterprises tend to be focus on something that they are very passionate about.
4. **The Lifestyle Entrepreneur:** This type of entrepreneur has usually worked as a teacher or a secretary. They are more interested in selling something that people will enjoy, rather than making lots of money.

### Characteristics of an Entrepreneur

Successful entrepreneurs have the following characteristics:

- They are highly motivated
- They are creative and persuasive
- They are mentally prepared to handle each and every task
- They have excellent business skills – they know how to evaluate their cash flow, sales and revenue
- They are willing to take great risks
- They are very proactive – this means they are willing to do the work themselves, rather than wait for someone else to do it
- They have a vision – they are able to see the big picture
- They are flexible and open-minded
- They are good at making decisions

## Entrepreneur Success Stories

### Dhiru Bhai Ambani

Dhirubhai Ambani began his entrepreneurial career by selling “bhajias” to pilgrims in Mount Girnar on weekends. At 16, he moved to Yemen where he worked as a gas-station attendant, and as a clerk in an oil company. He returned to India with Rs. 50,000 and started a textile trading company. Reliance went on to become the first Indian company to raise money in global markets and the first Indian company to feature in Forbes 500 list.

### Dr. Karsanbhai Patel

Karsanbhai Patel made detergent powder in the backyard of his house. He sold his product door-to door and offered a money back guarantee with every pack that was sold. He charged Rs.3 per kg when the cheapest detergent at that time was Rs.13 per kg. Dr. Patel eventually started Nirma which became a whole new segment in the Indian domestic detergent market.

### The Entrepreneurial Process



Let's take a look at the stages of the entrepreneurial process.

**Stage 1:** Idea Generation. The entrepreneurial process begins with an idea that has been thought of by the entrepreneur. The idea is a problem that has the potential to be solved.

**Stage 2:** Germination or Recognition. In this stage a possible solution to the identified problem is thought of.

**Stage 3:** Preparation or Rationalization. The problem is studied further and research is done to find out how others have tried to solve the same problem.

**Stage 4:** Incubation or Fantasizing. This stage involves creative thinking for the purpose of coming up with more ideas. Less thought is given to the problem areas.

**Stage 5:** Feasibility Study: The next step is the creation of a feasibility study to determine if the idea will make a profit and if it should be seen through.

**Stage 6:** Illumination or Realization. This is when all uncertain areas suddenly become clear. The entrepreneur feels confident that his idea has merit.

**Stage 7:** Verification or Validation. In this final stage, the idea is verified to see if it works and if it is useful.

Take a look at the diagram below to get a better idea of this process.

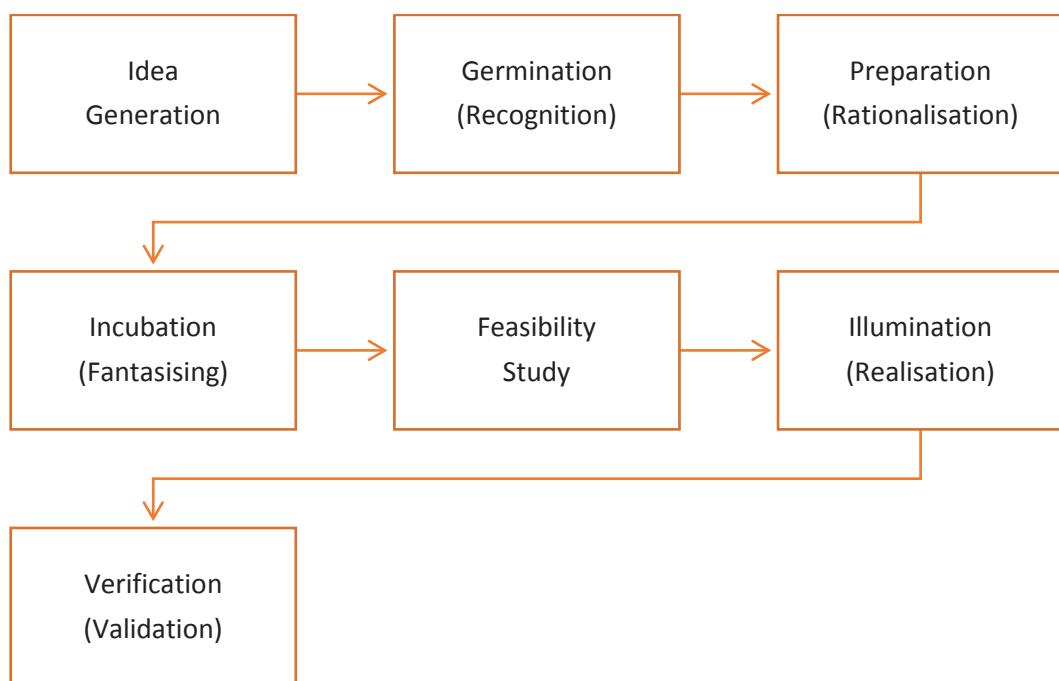


Fig.6.5.2: Entrepreneurial process

### Introduction to the Entrepreneurship Ecosystem

The entrepreneurship support ecosystem signifies the collective and complete nature of entrepreneurship. New companies emerge and flourish not only because of the courageous, visionary entrepreneurs who launch them, but they thrive as they are set in an environment or 'ecosystem' made of private and public participants. These players nurture and sustain the new ventures, facilitating the entrepreneurs' efforts. An entrepreneurship ecosystem comprises of the following six domains:

- Favourable Culture:** This includes elements such as tolerance of risk and errors, valuable networking and positive social standing of the entrepreneur.
- Facilitating Policies & Leadership:** This includes regulatory framework incentives and existence of public research institutes.
- Financing Options:** Angel financing, venture capitalists and micro loans would be good examples of this.
- Human Capital:** This refers to trained and untrained labour, entrepreneurs and entrepreneurship training programmes, etc.
- Conducive Markets for Products & Services:** This refers to an existence or scope of existence of a market for the product/service.
- Institutional & Infrastructural Support:** This includes legal and financing advisers, telecommunications, digital and transportation infrastructure, and entrepreneurship networking programmes.

These domains indicate whether there is a strong entrepreneurship support ecosystem and what actions should the government put in place to further encourage this ecosystem.

The six domains and their various elements have been graphically depicted.

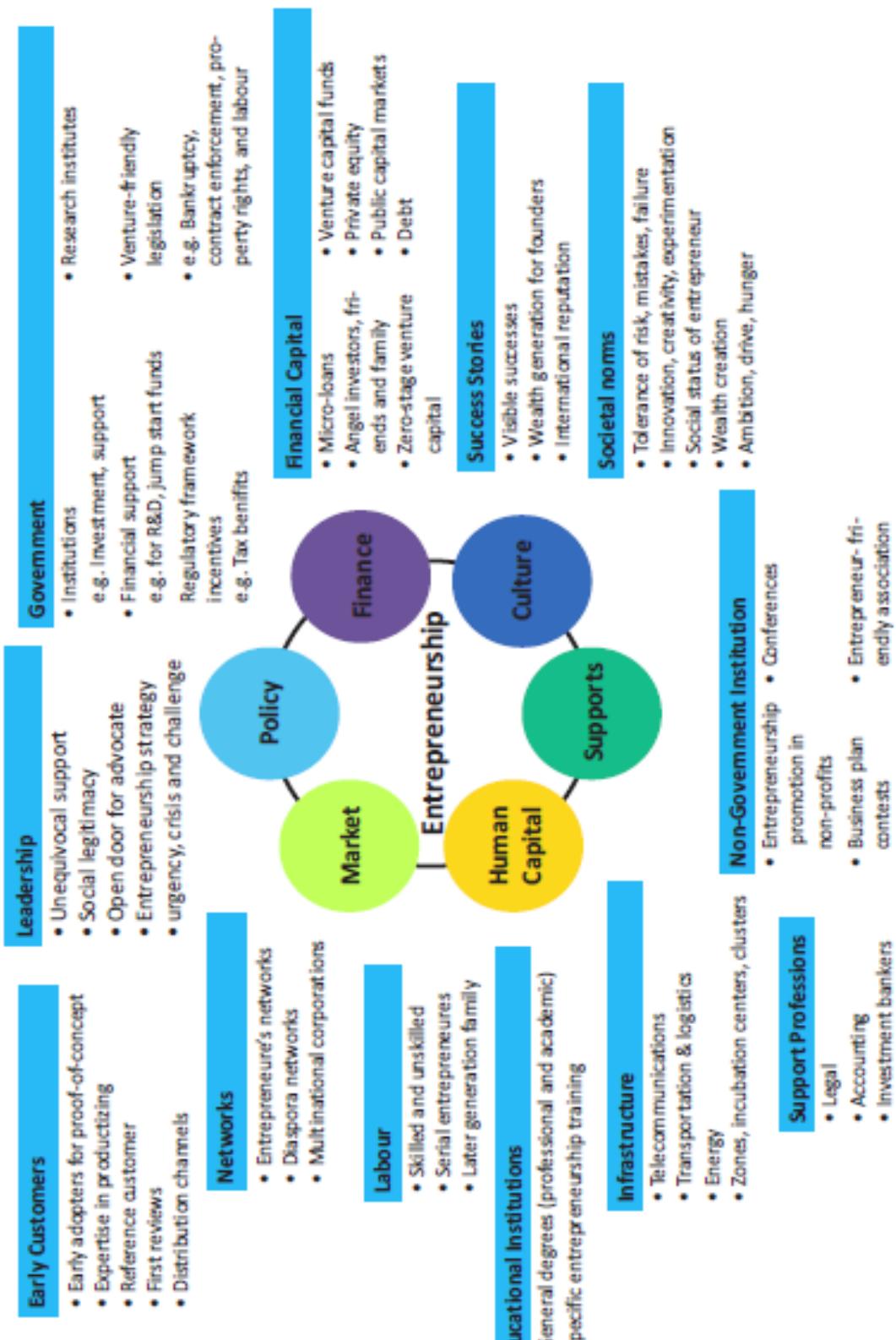


Fig.6.5.3. Entrepreneurship at a Glance

Every entrepreneurship support ecosystem is unique and all the elements of the ecosystem are interdependent. Although every region's entrepreneurship ecosystem can be broadly described by the above features, each ecosystem is the result of the hundred elements interacting in highly complex and particular ways.

Entrepreneurship ecosystems eventually become (largely) self-sustaining. When the six domains are resilient enough, they are mutually beneficial. At this point, government involvement can and should be significantly minimized. Public leaders do not need to invest a lot to sustain the ecosystem. It is imperative that the entrepreneurship ecosystem incentives are formulated to be self-liquidating, hence focussing on sustainability of the environment.

### **Make in India Campaign**

Every entrepreneur has certain needs. Some of their important needs are:

- To easily get loans
- To easily find investors
- To get tax exemptions
- To easily access resources and good infrastructure
- To enjoy a procedure that is free of hassles and is quick
- To be able to easily partner with other firms

The Make in India campaign, launched by Prime Minister Modi aims to satisfy all these needs of young, aspiring entrepreneurs. Its objective is to:

- Make investment easy
- Support new ideas
- Enhance skill development
- Safeguard the ideas of entrepreneurs
- Create state-of-the-art facilities for manufacturing goods

### **Key Schemes to Promote EntrepreneurS**

The government offers many schemes to support entrepreneurs. These schemes are run by various Ministries/Departments of Government of India to support First Generation Entrepreneurs. Take a look at a few key schemes to promote entrepreneurship:

#### **SI. Name of the Scheme**

1. Pradhan Mantri MUDRA Yojana - Micro Units Development and Refinance Agency (MUDRA),
2. STAND UP INDIA
3. Prime Minister Employment Generation Programme (PMEGP)
4. International Cooperation
5. Performance and Credit Rating
6. Marketing Assistance Scheme
7. Reimbursement of Registration Fee for Bar Coding
8. Enable Participation of MSMEs in State/District level Trade Fairs and Provide Funding Support
9. Capital Subsidy Support on Credit for Technology up gradation
10. Credit Guarantee Fund for Micro and Small Enterprise (CGFMSE)
11. Reimbursement of Certification Fees for Acquiring ISO Standards

12. Agricultural Marketing
  13. Small Agricultural Marketing
  14. Mega Food Park
  15. Adivasi Mahila Sashaktikaran Yojana
- 1. Pradhan Mantri MUDRA Yojana**, - Micro Units Development and Refinance Agency (MUDRA),

#### Description

Under the aegis support of Pradhan Mantra MUDRA Yojana, MUDRA has already created its initial products/schemes. The interventions have been named 'Shisha', 'Kishore' and 'Taren' to signify the stage of growth/development and funding needs of the beneficiary micro unit/entrepreneur and also provide a reference point for the next phase of graduation/growth to look forward to:

- a. Shisha: Covering loans up to Rs. 50,000/-
- b. Kishor: Covering loans above Rs. 50,000/- and up to Rs.5 lakh
- c. Tarun: Covering loans above Rs. 5 lakh to Rs.10 lakh

#### Who can apply?

Any Indian citizen who has a business plan for a non-farm sector income generating activity such as manufacturing, processing, trading or service sector and whose credit need is less than Rs.10 lakh can approach either a Bank, MFI, or NBFC for availing of MUDRA loans under Pradhan Mantri Mudra Yojana (PMMY).

#### 2. Stand Up India

##### Description

The objective of the Standup India scheme is to facilitate bank loans between Rs.10 lakh and Rs.1 crore to at least one Schedule Caste (SC) or Scheduled Tribe (ST) borrower and at least one woman borrower per bank branch for setting up a Greenfield enterprise. This enterprise may be in manufacturing, services or the trading sector. In case of non-Individual enterprises at least 51% of the shareholding and controlling stake should be held by either an SC/ST or Woman Entrepreneur.

##### Who can apply?

ST, SC &Women

#### 3. Prime Minister Employment Generation Programme (PMEGP)

##### Description

The Scheme is implemented by Khadi and Village Industries Commission (KVIC), as the nodal agency at the National level. At the State level, the Scheme is implemented through State KVIC Directorates, State Khadi and Village Industries Boards (KVBs) and District Industries Centres (DICs) and banks. The Government subsidy under the Scheme is routed by KVIC through identified banks for eventual distribution to the beneficiaries/entrepreneurs in their bank accounts.

##### Nature of assistance

The maximum cost of the project/unit admissible under manufacturing sector is Rs.25 lakh and under business/service sector is Rs.10 lakh. Levels of funding under PMEGP

| <b>Categories of beneficiaries under PMEGP</b>  | <b>Beneficiary's contribution (of project cost)</b> | <b>Rate of Subsidy (of project cost)</b> |
|---|---|--|
| Area (location of project/unit)   |   | Urban Rural                              |
| General Category  | 10%   | 15%<br>25%                               |
| Special (including SC / ST / OBC / Minorities / Women, Ex-servicemen, Physically handicapped, NER, Hill and Border areas, etc.) | 05%   | 25%<br>35%                               |

*Fig.6.5.4. PMEGP*

The balance amount of the total project cost will be provided by Banks as term loan as well as working capital.

#### **Who can apply?**

Any individual, above 18 years of age. At least VIII standard pass for projects costing above Rs.10 lakh in the manufacturing sector and above Rs.5 lakh in the business/service sector. Only new projects are considered for sanction under PMEGP. Self Help Groups (including those belonging to BPL provided that they have not availed benefits under any other Scheme), Institutions registered under Societies Registration Act,1860; Production Co-operative Societies, and Charitable Trusts are also eligible. Existing Units (under PMRY, REGP or any other scheme of Government of India or State Government) and the units that have already availed Government Subsidy under any other scheme of Government of India or State Government are NOT eligible.

#### **4. International Cooperation**

##### **Description**

The Scheme would cover the following activities:

- Deputation of MSME business delegations to other countries for exploring new areas of technology infusion/upgradation, facilitating joint ventures, improving market of MSMEs products, foreign collaborations, etc.
- Participation by Indian MSMEs in international exhibitions, trade fairs and buyer-seller meets in foreign countries as well as in India, in which there is international participation.
- Holding international conferences and seminars on topics and themes of interest to the MSME.

##### **Nature of assistance**

IC Scheme provides financial assistance towards the airfare and space rent of entrepreneurs. Assistance is provided on the basis of size and the type of the enterprise.

##### **Who can apply?**

- State/Central Government Organisations;
- Industry/Enterprise Associations; and

c. Registered Societies/Trusts and Organisations associated with the promotion and development of MSMEs

## 5. Performance and Credit Rating for Micro and Small Enterprises

### Description

The objective of the Scheme is to create awareness amongst micro & small enterprises about the strengths and weaknesses of their operations and also their credit worthiness.

| Turn Over                       | Fee to be reimbursed by Ministry of MSME  |
|---------------------------------|---|
| Up to Rs.50 lacs                | 75% of the fee charged by the rating agency subject to a ceiling Rs. 15,000/-   |
| Above Rs.50 lacs to Rs.200 Lacs | 75% of the fee charged by the rating agency subject to a ceiling of Rs.30,000/- |
| Above Rs.200 lacs               | 75% of the fee charged by the rating agency subject                             |

Fig.6.5.5: Small enterprises

### Nature of assistance

### Who can apply?

Any enterprise registered in India as a micro or small enterprise is eligible to apply.

## 6. Marketing Assistance Scheme

### Description

The assistance is provided for the following activities:

- a. Organizing exhibitions abroad and participation in international exhibitions/trade fairs
- b. Co-sponsoring of exhibitions organized by other organisations/industry associations/agencies
- c. Organizing buyer-seller meets, intensive campaigns and marketing promotion events

### Nature of assistance

Financial assistance of up to 95% of the airfare and space rent of entrepreneurs. Assistance is provided on the basis of size and the type of the enterprise. Financial assistance for co-sponsoring would be limited to 40% of the net expenditure, subject to maximum amount of Rs.5 lakh.

### Who can apply?

MSMEs, Industry Associations and other organizations related to MSME sector.

## 7. Reimbursement of Registration Fee for Bar Coding

### Description

The financial assistance is provided towards 75% reimbursement of only one-time registration fee and 75% of annual recurring fee for first three years paid by MSEs to GS1 India for using bar coding.

### Nature of assistance

Funding support for reimbursement of 75% of one time and recurring bar code registration fees.

**Who can apply?**

All MSMEs with EM registration.

#### **8. Enabling Participation of MSMEs in State/District Level Trade Fairs and Provide Funding Support**

**Description**

Provide marketing platform to manufacturing MSMEs by enabling their participation in state/district level exhibitions being organized by state/district authorities/associations.

**Nature of assistance**

1. Free registration for participating in trade fairs

**Note:** *The selection of participants would be done by the MSME-DIs post the submission of application.*

2. Reimbursement of 50% of to and fro actual fare by shortest distance/direct train (limited to AC II tier class) from the nearest railway station/bus fare to the place of exhibition and 50% space rental charges for MSMEs (General category entrepreneurs).
3. For Women/SC/ST entrepreneurs & entrepreneurs from North Eastern Region Govt. of India will reimburse 80% of items listed above in Point (2).

**Note:** The total reimbursement will be max. Rs. 30,000/- per unit for the SC/ST/Women/Physically Handicapped entrepreneurs, while for the other units the max. limit will be Rs. 20,000/- per person per MSME unit.

**Note:** *The participant is required to submit follow-up proofs post attending the event to claim reimbursement. The proofs can be submitted after logging in online under the section "My Applications" or directly contacting a DI office.*

**Who can apply?**

All MSMEs with EM registration.

#### **9. Capital Subsidy Support on Credit for Technology Upgradation**

**Description**

MSMEs can get a capital subsidy (~15%) on credit availed for technology upgradation.

**Nature of assistance**

Financial assistance for availing credit and loan.

**Who can apply?**

1. Banks and financial institutions can apply to DC-MSME for availing support.
2. MSMEs need to directly contact the respective banks for getting credit and capital subsidy.

**How to apply?**

If you are a financial institution, click on the "Apply Now" button or else you can also directly contact the Office of DC-MSME. You can view the contact details of Office of DC-MSME. If you are an MSME, directly contact the respective banks/financial institutions as listed in the scheme guidelines.

## **10. Provision of Collateral Free Credit for MSMEs**

### **Description**

Banks and financial institutions are provided funding assistance under this scheme so that they can in turn lend collateral free credit to MSMEs.

### **Nature of assistance**

Funding support to banks and financial institutions for lending collateral-free credit to MSMEs.

### **Who can apply?**

Banks and financial institutions can apply to office of DC-MSME/MSME-DIs for availing support. MSMEs need to directly contact the respective banks for getting credit.

## **11. Reimbursement of certification fees for acquiring ISO standards**

ISO 9000/ISO 14001 Certification Reimbursement.

### **Description**

The GoI assistance will be provided for one-time reimbursement of expenditure to such MSME manufacturing units which acquire ISO 18000/ISO 22000/ISO 27000 certification.

### **Nature of assistance**

Reimbursement of expenditure incurred on acquiring ISO standards.

### **Who can apply?**

MSMEs with EM registration.

## **12. Agricultural Marketing**

### **Description**

A capital investment subsidy for construction/renovation of rural godowns . Creation of scientific storage capacity and prevention of distress sale.

### **Nature of assistance**

Subsidy @ 25% to farmers, 15% of project cost to companies.

### **Who can apply?**

NGOs, SHGs, companies, co-operatives.

## **13. Small Agricultural Marketing**

### **Description**

Business development description provides venture capital assistance in the form of equity, and arranges training and visits of agri-preneurs

### **Farmers' Agriculture Business Consortium**

Business development description provides venture capital assistance in the form of equity, and arranges training and visits of agri-preneurs.

### **Nature of assistance**

Financial assistance with a ceiling of Rs.5 lakh.

### **Who can apply?**

Individuals, farmers, producer groups, partnership/proprietary firms, SGHs, agri-preneurs, etc.

#### **14. Mega Food Park**

##### **Description**

Mechanism to link agricultural production and market to maximize value addition, enhance farmer's income, create rural employment.

##### **Nature of assistance**

One-time capital grant of 50% of project cost with a limit of Rs.50 crore.

##### **Who can apply?**

Farmers, farmer groups, SHGs.

#### **15. Adivasi Mahila Sashaktikaran Yojana**

##### **Description**

Concessional scheme for the economic development of ST women.

##### **Nature of assistance**

Term loan at concessional rates up to 90% of cost of scheme.

##### **Who can apply?**

Scheduled Tribes Women.



- Research the existing market, network with other entrepreneurs, venture capitalists, angel investors, and thoroughly review the policies in place to enable your entrepreneurship.
- Failure is a stepping stone and not the end of the road. Review yours and your peers' errors and correct them in your future venture.
- Be proactive in your ecosystem. Identify the key features of your ecosystem and enrich them to ensure self-sustainability of your entrepreneurship support ecosystem.

#### **6.5.7 Risk Appetite & Resilience: Entrepreneurship and Risk**

Entrepreneurs are inherently risk takers. They are path-makers not path-takers. Unlike a normal, cautious person, an entrepreneur would not think twice about quitting his job (his sole income) and taking a risk on himself and his idea.

An entrepreneur is aware that while pursuing his dreams, assumptions can be proven wrong and unforeseen events may arise. He knows that after dealing with numerous problems, success is still not guaranteed. Entrepreneurship is synonymous with the ability to take risks. This ability, called risk-appetite, is an entrepreneurial trait that is partly genetic and partly acquired.

### What is Risk Appetite?

Risk appetite is defined as the extent to which a company is equipped to take risk, in order to achieve its objectives. Essentially, it refers to the balance, struck by the company, between possible profits and the hazards caused by changes in the environment (economic ecosystem, policies, etc.). Taking on more risk may lead to higher rewards but have a high probability of losses as well. However, being too conservative may go against the company as it can miss out on good opportunities to grow and reach their objectives. The levels of risk appetite can be broadly categorized as “low”, “medium” and “high.” The company’s entrepreneur(s) have to evaluate all potential alternatives and select the option most likely to succeed. Companies have varying levels of risk appetites for different objectives.

The levels depend on:

- The type of industry
- Market pressures
- Company objectives

For example, a start-up with a revolutionary concept will have a very high risk appetite. The start-up can afford short term failures before it achieves longer term success. This type of appetite will not remain constant and will be adjusted to account for the present circumstances of the company.

### Risk Appetite Statement

Companies have to define and articulate their risk appetite in sync with decisions made about their objectives and opportunities. The point of having a risk appetite statement is to have a framework that clearly states the acceptance and management of risk in business. It sets risk taking limits within the company. The risk appetite statement should convey the following:

- The nature of risks the business faces.
- Which risks the company is comfortable taking on and which risks are unacceptable.
- The nature of risks the business faces.
- Which risks the company is comfortable taking on and which risks are unacceptable.
- How much risk to accept in all the risk categories.
- The desired trade-off between risk and reward.
- Measures of risk and methods of examining and regulating risk exposures.

### Entrepreneurship and Resilience

Entrepreneurs are characterized by a set of qualities known as resilience. These qualities play an especially large role in the early stages of developing an enterprise. Risk resilience is an extremely valuable characteristic as it is believed to protect entrepreneurs against the threat of challenges and changes in the business environment.

### What is Entrepreneurial Resilience?

Resilience is used to describe individuals who have the ability to overcome setbacks related to their life and career aspirations. A resilient person is someone who is capable of easily and quickly recovering from setbacks. For the entrepreneur, resilience is a critical trait.

Entrepreneurial resilience can be enhanced in the following ways:

- By developing a professional network of coaches and mentors
- By accepting that change is a part of life
- By viewing obstacles as something that can be overcome

#### **Characteristics of a Resilient Entrepreneur**

The characteristics required to make an entrepreneur resilient enough to go the whole way in their business enterprise are:

- |  |   |
|--|---|
| <ul style="list-style-type: none"><li>• A strong internal sense of control</li><li>• Ability to diversify and expand</li><li>• Strong social connections</li><li>• Survivor attitude</li></ul> | <ul style="list-style-type: none"><li>• Skill to learn from setbacks</li><li>• Cash-flow conscious habits</li><li>• Ability to look at the bigger picture</li><li>• Attention to detail</li></ul> |
|--|---|



- Cultivate a great network of clients, suppliers, peers, friends and family. This will not only help you promote your business, but will also help you learn, identify new opportunities and stay tuned to changes in the market.
- Don't dwell on setbacks. Focus on what you need to do next to get moving again.
- While you should try, and curtail expenses, ensure that it is not at the cost of your growth.

## 6.5.8 Success & Failures: Understanding Successes and Failures in Entrepreneurship

Shyam is a famous entrepreneur, known for his success story. But what most people don't know, is that Shyam failed numerous times before his enterprise became a success. Read his interview to get an idea of what entrepreneurship is really about, straight from an entrepreneur who has both, failed and succeeded.

**Interviewer:** Shyam, I have heard that entrepreneurs are great risk-takers who are never afraid of failing. Is this true?

**Shyam:** Ha ha, no of course it's not true! Most people believe that entrepreneurs need to be fearlessly enthusiastic. But the truth is, fear is a very normal and valid human reaction, especially when you are planning to start your own business! In fact, my biggest fear was the fear of failing. The reality is, entrepreneurs fail as much as they succeed. The trick is to not allow the fear of failing to stop you from going ahead with your plans. Remember, failures are lessons for future success!

**Interviewer:** What, according to you, is the reason that entrepreneurs fail?

**Shyam:** Well, there is no one single reason why entrepreneurs fail. An entrepreneur can fail due to numerous reasons. You could fail because you have allowed your fear of failure to defeat you. You could fail because you are unwilling to delegate (distribute) work. As the saying goes, "You can do anything, but not everything!" You could fail because you gave up too easily – maybe you were not persistent enough. You could fail because you were focusing your energy on small, insignificant tasks and ignoring the tasks that were most important. Other reasons for failing are partnering with the wrong people, not being able to sell your product to the right customers at the right time at the right price... and many more reasons!

**Interviewer:** As an entrepreneur, how do you feel failure should be looked at?

**Shyam:** I believe we should all look at failure as an asset, rather than as something negative. The way I see it, if you have an idea, you should try to make it work, even if there is a chance that you will fail. That's because not trying is failure right there, anyway! And failure is not the worst thing that can happen. I think having regrets because of not trying, and wondering 'what if' is far worse than trying and actually failing.

**Interviewer:** How did you feel when you failed for the first time?

**Shyam:** I was completely heartbroken! It was a very painful experience. But the good news is, you do recover from the failure. And with every subsequent failure, the recovery process gets a lot easier. That's because you start to see each failure more as a lesson that will eventually help you succeed, rather than as an obstacle that you cannot overcome. You will start to realize that failure has many benefits.

**Interviewer:** Can you tell us about some of the benefits of failing?

**Shyam:** One of the benefits that I have experienced personally from failing is that the failure made me see things in a new light. It gave me answers that I didn't have before. Failure can make you a lot stronger. It also helps keep your ego in control.

**Interviewer:** What advice would you give entrepreneurs who are about to start their own enterprises?

**Shyam:** I would tell them to do their research and ensure that their product is something that is actually wanted by customers. I'd tell them to pick their partners and employees very wisely and cautiously. I'd tell them that it's very important to be aggressive – push and market your product as aggressively as possible. I would warn them that starting an enterprise is very expensive and that they should be prepared for a situation where they run out of money. I would tell them to create long term goals and put a plan in action to achieve that goal. I would tell them to build a product that is truly unique. Be very careful and ensure that you are not copying another start-up. Lastly, I'd tell them that it's very important that they find the right investors.

**Interviewer:** That's some really helpful advice, Shyam! I'm sure this will help all entrepreneurs to be more prepared before they begin their journey! Thank you for all your insight!



- Remember that nothing is impossible.
- Identify your mission and your purpose before you start.
- Plan your next steps – don't make decisions hastily.

## UNIT 6.6: Preparing to be an Entrepreneur

### Unit Objectives



**At the end of this unit, you will be able to:**

1. Discuss how market research is carried out
2. Describe the 4 Ps of marketing
3. Discuss the importance of idea generation
4. Recall basic business terminology
5. Discuss the need for CRM
6. Discuss the benefits of CRM
7. Discuss the need for networking
8. Discuss the benefits of networking
9. Discuss the importance of setting goals
10. Differentiate between short-term, medium-term and long-term goals
11. Discuss how to write a business plan
12. Explain the financial planning process
13. Discuss ways to manage your risk
14. Describe the procedure and formalities for applying for bank finance
15. Discuss how to manage your own enterprise
16. List important questions that every entrepreneur should ask before starting an enterprise

### 6.6.1 Market Study / The 4 Ps of Marketing / Importance of an IDEA: Understanding Market Research

Market research is the process of gathering, analysing and interpreting market information on a product or service that is being sold in that market. It also includes information on:

- Past, present and prospective customers
- Customer characteristics and spending habits
- The location and needs of the target market
- The overall industry
- Relevant competitors

Market research involves two types of data:

- Primary information. This is research collected by yourself or by someone hired by you.
- Secondary information. This is research that already exists and is out there for you to find and use.

#### Primary research

Primary research can be of two types:

- Exploratory: This is open-ended and usually involves detailed, unstructured interviews.
- Specific: This is precise and involves structured, formal interviews. Conducting specific

### Secondary research

Secondary research uses outside information. Some common secondary sources are:

- **Public sources:** These are usually free and have a lot of good information. Examples are government departments, business departments of public libraries etc.
- **Commercial sources:** These offer valuable information but usually require a fee to be paid. Examples are research and trade associations, banks and other financial institutions etc.
- **Educational institutions:** These offer a wealth of information. Examples are colleges, universities, technical institutes etc.

### The 4 Ps of Marketing

The 4 Ps of marketing are Product, Price, Promotion and Place. Let's look at each of these 4 Ps in detail.

#### Product

A product can be:

- A tangible good
- An intangible service

Whatever your product is, it is critical that you have a clear understanding of what you are offering, and what its unique characteristics are, before you begin with the marketing process.

Some questions to ask yourself are:

- What does the customer want from the product/service?
- What needs does it satisfy?
- Are there any more features that can be added?
- Does it have any expensive and unnecessary features?
- How will customers use it?
- What should it be called?
- How is it different from similar products?
- How much will it cost to produce?

#### Price

Once all the elements of Product have been established, the Price factor needs to be considered. The Price of a Product will depend on several factors such as profit margins, supply, demand and the marketing strategy.

Some questions to ask yourself are:

|   |   |
|---|---|
| • What is the value of the product/service to customers?    | • Is the customer price sensitive?                        |
| • Do local products/services have established price points? | • Should discounts be offered?                            |
|   | • How is your price compared to that of your competitors? |

Fig 6.6.1: Questions

### Promotion

Once you are certain about your Product and your Price, the next step is to look at ways to promote it. Some key elements of promotion are advertising, public relations, social media marketing, email marketing, search engine marketing, video marketing and more.

Some questions to ask yourself are:

- Where should you promote your product or service?
- What is the best medium to use to reach your target audience
- When would be the best time to promote your product?
- How are your competitors promoting their products?

### Place

According to most marketers, the basis of marketing is about offering the right product, at the right price, at the right place, at the right time. For this reason, selecting the best possible location is critical for converting prospective clients into actual clients.

Some questions to ask yourself are:

- Will your product or service be looked for in a physical store, online or both?
- What should you do to access the most appropriate distribution channels?
- Will you require a sales force?
- Where are your competitors offering their products or services?
- Should you follow in your competitors' footsteps?
- Should you do something different from your competitors?

### Importance of an IDEA

Some questions to ask yourself are:

Ideas are the foundation of progress. An idea can be small or ground-breaking, easy to accomplish or extremely complicated to implement. Whatever the case, the fact that it is an idea gives it merit. Without ideas, nothing is possible. Most people are afraid to speak out their ideas, out for fear of being ridiculed. However, if you are an entrepreneur and want to remain competitive and innovative, you need to bring your ideas out into the light.

Some ways to do this are by:

- Establishing a culture of brainstorming where you invite all interested parties to contribute
- Discussing ideas out loud so that people can add their ideas, views, opinions to them
- Being open minded and not limiting your ideas, even if the idea seems ridiculous
- Not discarding ideas that you don't work on immediately, but instead making a note of them and shelving them so they can be revisited at a later date.



- Keep in mind that good ideas do not always have to be unique.
- Remember that timing plays a huge role in determining the success of your idea.
- Situations and circumstances will always change, so be flexible and adapt your idea accordingly.

### 6.6.2 Business Entity Concepts: Basic Business Terminology

If your aim is to start and run a business, it is crucial that you have a good understanding of basic business terms. Every entrepreneur should be well versed in the following terms:

- Accounting: A systematic method of recording and reporting financial transactions.
- Accounts payable: Money owed by a company to its creditors.
- Accounts Receivable: The amount a company is owed by its clients.
- Assets: The value of everything a company owns and uses to conduct its business.
- Balance Sheet: A snapshot of a company's assets, liabilities and owner's equity at a given moment.
- Bottom Line: The total amount a business has earned or lost at the end of a month.
- Business: An organization that operates with the aim of making a profit.
- Business to Business (B2B): A business that sells goods or services to another business.
- Business to Consumer (B2C): A business that sells goods or services directly to the end user.
- Capital: The money a business has in its accounts, assets and investments. The two main types of capital are debt and equity.
- Cash Flow: The overall movement of funds through a business each month, including income and expenses.
- Cash Flow Statement: A statement showing the money that entered and exited a business during a specific period of time.
- Contract: A formal agreement to do work for pay.
- Depreciation: The degrading value of an asset over time.
- Expense: The costs that a business incurs through its operations.
- Finance: The management and allocation of money and other assets.
- Financial Report: A comprehensive account of a business' transactions and expenses.
- Fixed Cost: A one-time expense.
- Income Statement (Profit and Loss Statement): Shows the profitability of a business during a period of time.
- Liabilities: The value of what a business owes to someone else.
- Marketing: The process of promoting, selling and distributing a product or service.
- Net Income/Profit: Revenues minus expenses.
- Net Worth: The total value of a business.
- Payback Period: The amount of time it takes to recover the initial investment of a business.
- Profit Margin: The ratio of profit, divided by revenue, displayed as a percentage.

- Return on Investment (ROI): The amount of money a business gets as return from an investment.
- Revenue: The total amount of income before expenses are subtracted.
- Sales Prospect: A potential customer.
- Supplier: A provider of supplies to a business.
- Target Market: A specific group of customers at which a company's products and services are aimed.
- Valuation: An estimate of the overall worth of the business.
- Variable Cost: Expenses that change in proportion to the activity of a business.
- Working Capital: Calculated as current assets minus current liabilities.
- Business Transactions: There are three types of business transactions. These are:
  - Simple Transactions – Usually a single transaction between a vendor and a customer. For example: Buying a cup of coffee.
  - Complex Transactions – These transactions go through a number of events before they can be completed. For example: Buying a house.
  - Ongoing transactions – These transactions usually require a contract. For example: Contract with a vendor.

### **Basic Accounting Formulas**

Take a look at some important accounting formula that every entrepreneur needs to know.

1. **The Accounting Equation:** This is value of everything a company owns and uses to conduct its business.

Formula: Assets = Liability + Owner's Equity

2. **Net Income:** This is the profit of the company.

Formula: Net Income = Revenues – Expenses

3. **Break-Even Point:** This is the point at which the company will not make a profit or a loss. The total cost and total revenues are equal.

Formula: Break-Even = Fixed Costs/Sales Price – Variable Cost per Unit

4. **Cash Ratio:** This tells us about the liquidity of a company.

Formula: Cash Ratio = Cash/Current Liabilities

5. **Profit Margin:** This is shown as a percentage. It shows what percentage of sales are left over after all the expenses are paid by the business.

Formula: Profit Margin = Net Income/Sales

6. **Debt-to-Equity Ratio:** This ratio shows how much equity and debt a company is using to finance its assets, and whether the shareholder equity can fulfil obligations to creditors if the business starts making a loss.

Formula: Debt-to-Equity Ratio = Total Liabilities/Total Equity

7. **Cost of Goods Sold:** This is the total of all costs used to create a product or service, which has been sold.

Formula: Cost of Goods Sold = Cost of Materials/Inventory – Cost of Outputs

8. **Return on Investment (ROI):** This is usually shown as a percentage. It calculates the profits of an investment as a percentage of the original cost.

Formula: ROI = Net Profit/Total Investment \* 100

9. **Simple Interest:** This is money you can earn by initially investing some money (the principal).

Formula:

$$A = P(1 + rt); R = r * 100$$

Where:

A = Total Accrued Amount (principal + interest)

P = Principal Amount

I = Interest Amount

r = Rate of Interest per year in decimal;  $r = R/100$

t = Time Period involved in months or years

10. **Annual Compound Interest:** The calculates the addition of interest to the principal sum of a loan or deposit.

Formula:

$$A = P (1 + r/n) ^ nt$$

Where:

A = the future value of the investment/loan, including interest

P = the principal investment amount (the initial deposit or loan amount)

r = the annual interest rate (decimal)

n = the number of times that interest is compounded per year

t = the number of years the money is invested or borrowed for

### 6.6.3 CRM & Networking: What is CRM?

CRM stands for Customer Relationship Management. Originally the expression Customer Relationship Management meant managing one's relationship with customers. However, today it refers to IT systems and software designed to help companies manage their relationships.

#### The Need for CRM

The better a company can manage its relationships with its customers, the higher the chances of the company's success. For any entrepreneur, the ability to successfully retain existing customers and expand the enterprise is paramount. This is why IT systems that focus on addressing the problems of dealing with customers on a daily basis are becoming more and more in demand.

Customer needs change over time, and technology can make it easier to understand what customers really want. This insight helps companies to be more responsive to the needs of their customers. It enables them to modify their business operations when required, so that their customers are always served in the best manner possible. Simply put, CRM helps companies recognize the value of their clients and enables them to capitalize on improved customer relations.

#### Benefits of CRM

CRM has a number of important benefits:

- It helps improve relations with existing customers which can lead to:
  - Increased sales

- Identification of customer needs
- Cross-selling of products
- It results in better marketing of one's products or services
- It results in better marketing of one's products or services
- It enhances customer satisfaction and retention
- It improves profitability by identifying and focusing on the most profitable customers

### **What is Networking?**

In business, networking means leveraging your business and personal connections in order to bring in a regular supply of new business. This marketing method is effective as well as low cost. It is a great way to develop sales opportunities and contacts. Networking can be based on referrals and introductions, or can take place via phone, email, and social and business networking websites.

### **The Need for Networking**

Networking is an essential personal skill for business people, but it is even more important for entrepreneurs. The process of networking has its roots in relationship building.

Networking results in greater communication and a stronger presence in the entrepreneurial ecosystem. This helps build strong relationships with other entrepreneurs. Business networking events held across the globe play a huge role in connecting like-minded entrepreneurs who share the same fundamental beliefs in communication, exchanging ideas and converting ideas into realities. Such networking events also play a crucial role in connecting entrepreneurs with potential investors. Entrepreneurs may have vastly different experiences and backgrounds but they all have a common goal in mind – they all seek connection, inspiration, advice, opportunities and mentors. Networking offers them a platform to do just that.

### **Benefits of Networking**

Networking offers numerous benefits for entrepreneurs. Some of the major benefits are:

- Getting high quality leads
- Increased business opportunities
- Good source of relevant connections
- Advice from like-minded entrepreneurs
- Gaining visibility and raising your profile
- Meeting positive and enthusiastic people
- Increased self-confidence
- Satisfaction from helping others
- Building strong and lasting friendships



- Use social media interactions to identify needs and gather feedback.
- When networking, ask open-ended questions rather than yes/no type questions.

## 6.6.4 Business Plan: Why Set Goals?

Setting goals is important because it gives you long-term vision and short-term motivation. Goals can be short term, medium term and long term.

### Short-Term Goals

- These are specific goals for the immediate future.

**Example:** Repairing a machine that has failed.

### Medium-Term Goals

- These goals are built on your short-term goals.
- They do not need to be as specific as your short-term goals.

**Example:** Arranging for a service contract to ensure that your machines don't fail again.

### Long-Term Goals

These goals require time and planning.

They usually take a year or more to achieve.

**Example:** Planning your expenses so you can buy new machinery

### Why Create a Business Plan?

A business plan is a tool for understanding how your business is put together. It can be used to monitor progress, foster accountable and control the fate of the business. It usually offers a 3-5year projection and outlines the plan that the company intends to follow to grow its revenues. A business plan is also a very important tool for getting the interest of key employees or future investors.

A business plan typically comprises of eight elements.

### Executive Summary

The executive summary follows the title page. The summary should clearly state your desires as the business owner in a short and business like way. It is an overview of your business and your plans. Ideally this should not be more than 1-2 pages.

Your Executive Summary should include:

- The Mission Statement: Explain what your business is all about.

### Example: Nike's Mission Statement

Nike's mission statement is "To bring inspiration and innovation to every athlete in the world."

- Company Information: Provide information like when your business was formed, the names and roles of the founders, the number of employees, your business location(s) etc.
- Growth Highlights: Mention examples of company growth. Use graphs and charts where possible.
- Your Products/Services: Describe the products or services provided.
- Financial Information: Provide details on current bank and investors.
- Summarize future plans: Describe where you see your business in the future.

### **Business Description**

The second section of your business plan needs to provide a detailed review of the different elements of your business. This will help potential investors to correctly understand your business goal and the uniqueness of your offering.

Your Business Description should include:

- A description of the nature of your business
- The market needs that you are aiming to satisfy
- The ways in which your products and services meet these needs
- The specific consumers and organizations that you intend to serve
- Your specific competitive advantages

### **Market Analysis**

The market analysis section usually follows the business description. The aim of this section is to showcase your industry and market knowledge. This is also the section where you should lay down your research findings and conclusions.

Your Market Analysis should include:

- Your industry description and outlook
- Information on your target market
- The needs and demographics of your target audience
- The size of your target market
- The amount of market share you want to capture
- Your pricing structure
- Your competitive analysis
- Any regulatory requirements

### **Organization & Management**

This section should come immediately after the Market Analysis.

Your Organization & Management section should include:

- Your company's organizational structure
- Details of your company's ownership
- Details of your management team
- Qualifications of your board of directors
- Detailed descriptions of each division/department and its function
- The salary and benefits package that you offer your people

### **Service or Product Line**

The next section is the service or product line section. This is where you describe your service or product, and stress on their benefits to potential and current customers. Explain in detail why your product of choice will fulfil the needs of your target audience.

Your Service or Product Line section should include:

- A description of your product/service
- A description of your product or service's life cycle
- A list of any copyright or patent filings
- A description of any R&D activities that you are involved in or planning

## Marketing & Sales

Once the Service or Product Line section of your plan has been completed, you should start on the description of the marketing and sales management strategy for your business.

Your Marketing section should include the following strategies:

- **Market penetration strategy:** This strategy focuses on selling your existing products or services in existing markets, in order to increase your market share.
- **Growth strategy:** This strategy focuses on increasing the amount of market share, even if it reduces earnings in the short-term.
- **Channels of distribution strategy:** These can be wholesalers, retailers, distributors and even the internet.
- **Communication strategy:** These can be written strategies (e-mail, text, chat), oral strategies (phone calls, video chats, face-to-face conversations), non-verbal strategies (body language, facial expressions, tone of voice) and visual strategies (signs, webpages, illustrations).

Your Sales section should include the following information:

- **A salesforce strategy:** This strategy focuses on increasing the revenue of the enterprise.
- **A breakdown of your sales activities:** This means detailing out how you intend to sell your products or services – will you sell it offline or online, how many units do you intend to sell, what price do you plan to sell each unit at, etc.

## Funding Request

This section is specifically for those who require funding for their venture.

The Funding Request section should include the following information:

- How much funding you currently require.
- How much funding you will require over the next five years. This will depend on your long-term goals.
- The type of funding you want and how you plan to use it. Do you want funding that can be used only for a specific purpose, or funding that can be used for any kind of requirement?
- Strategic plans for the future. This will involve detailing out your long-term plans – what these plans are and how much money you will require to put these plans in motions.
- Historical and prospective financial information. This can be done by creating and maintaining all your financial records, right from the moment your enterprise started, to the present day. Documents required for this are your balance sheet which contains details of your company's assets and liabilities, your income statement which lists your company's revenues, expenses and net income for the year, your tax returns (usually for the last three years) and your cash flow budget which lists the cash that came in, the cash that went out and states whether you had a cash deficit (negative balance) or surplus (positive balance) at the end of each month.

## Financial Planning



Before you begin building your enterprise, you need to plan your finances. Take a look at the steps for financial planning:

**Step 1:** Create a financial plan. This should include your goals, strategies and timelines for accomplishing these goals.

**Step 2:** Organize all your important financial documents. Maintain a file to hold your investment details, bank statements, tax papers, credit card bills, insurance papers and any other financial records.

**Step 3:** Calculate your net worth. This means figure out what you own (assets like your house, bank accounts, investments etc.), and then subtract what you owe (liabilities like loans, pending credit card amounts etc.) the amount you are left with is your net worth.

**Step 4:** Make a spending plan. This means write down in detail where your money will come from, and where it will go.

**Step 5:** Build an emergency fund. A good emergency fund contains enough money to cover at least 6 months' worth of expenses.

**Step 6:** Set up your insurance. Insurance provides long term financial security and protects you against risk.

### Risk Management

As an entrepreneur, it is critical that you evaluate the risks involved with the type of enterprise that you want to start, before you begin setting up your company. Once you have identified potential risks, you can take steps to reduce them. Some ways to manage risks are:

- Research similar business and find out about their risks and how they were minimized.
- Evaluate current market trends and find out if similar products or services that launched a while ago are still being well received by the public.
- Think about whether you really have the required expertise to launch your product or service.
- Examine your finances and see if you have enough income to start your enterprise.
- Be aware of the current state of the economy, consider how the economy may change over time, and think about how your enterprise will be affected by any of those changes.
- Create a detailed business plan.



Ensure all the important elements are covered in your plan.

Scrutinize the numbers thoroughly.

Be concise and realistic.

Be conservative in your approach and your projections.

Use visuals like charts, graphs and images wherever possible.

## 6.6.5 Procedure and Formalities for Bank Finance: The Need for Bank Finance

For entrepreneurs, one of the most difficult challenges faced involves securing funds for start-ups. With numerous funding options available, entrepreneurs need to take a close look at which funding methodology works best for them. In India, banks are one of the largest funders of start-ups, offering funding to thousands of start-ups every year.

### What Information Should Entrepreneurs Offer Banks for Funding?

When approaching a bank, entrepreneurs must have a clear idea of the different criteria that banks use to screen, rate and process loan applications. Entrepreneurs must also be aware of the importance of providing banks with accurate and correct information. It is now easier than ever for financial institutions to track any default behaviour of loan applicants.

Entrepreneurs looking for funding from banks must provide banks with information relating to their general credentials, financial situation and guarantees or collaterals that can be offered.

### General Credentials

This is where you, as an entrepreneur, provide the bank with background information on yourself. Such information includes:

- Letter(s) of Introduction: This letter should be written by a respected business person who knows you well enough to introduce you. The aim of this letter is set across your achievements and vouch for your character and integrity.
- Your Profile: This is basically your resume. You need to give the bank a good idea of your educational achievements, professional training, qualifications, employment record and achievements.
- Business Brochure: A business brochure typically provides information on company products, clients, how long the business has been running for etc.
- Bank and Other References: If you have an account with another bank, providing those bank references is a good idea.
- Proof of Company Ownership or Registration: In some cases, you may need to provide the bank with proof of company ownership and registration. A list of assets and liabilities may also be required.

### Financial Situation

Banks will expect current financial information on your enterprise. The standard financial reports you should be prepared with are:

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Balance Sheet</li> <li>• Cash-Flow Statement</li> <li>• Business Plan</li> </ul> | <ul style="list-style-type: none"> <li>• Profit-and-Loss Account</li> <li>• Projected Sales and Revenues</li> <li>• Feasibility Study</li> </ul> |
|---|--|

### Guarantees or Collaterals

Usually banks will refuse to grant you a loan without security. You can offer assets which the bank can seize and sell off if you do not repay the loan. Fixed assets like machinery, equipment, vehicles etc. are also considered to be security for loans.

### The Lending Criteria of Banks

Your request for funding will have a higher chance of success if you can satisfy the following lending criteria:

- Good cash flow
- Adequate security
- Good reputation
- Adequate shareholders' funds
- Experience in business

### The Procedure



To apply for funding the following procedure will need to be followed.

1. Submit your application form and all other required documents to the bank.
2. The bank will carefully assess your credit worthiness and assign ratings by analysing your business information with respect to parameters like management, financial, operational and industry information as well as past loan performance.
3. The bank will make a decision as to whether or not you should be given funding.



- Get advice on funding options from experienced bankers.
- Be cautious and avoid borrowing more than you need, for longer than you need, at an interest rate that is higher than you are comfortable with.

### 6.6.6 Enterprise Management - An Overview: How to Manage Your Enterprise?



To manage your enterprise effectively you need to look at many different aspects, right from managing the day-to-day activities to figuring out how to handle a large-scale event. Let's take a look at some simple steps to manage your company effectively.

#### **Step 1: Use your leadership skills and ask for advice when required.**

Let's take the example of Ramu, an entrepreneur who has recently started his own enterprise. Ramu has good leadership skills – he is honest, communicates well, knows how to delegate work etc. These leadership skills definitely help Ramu in the management of his enterprise. However, sometimes Ramu comes across situations that he is unsure how to handle. What should Ramu do in this case? One solution is for him to find a more experienced manager who is willing to mentor him. Another solution is for Ramu to use his networking skills so that he can connect with managers from other organizations, who can give him advice on how to handle such situations.

**Step 2: Divide your work amongst others – realize that you cannot handle everything yourself.**

Even the most skilled manager in the world will not be able to manage every single task that an enterprise will demand of him. A smart manager needs to realize that the key to managing his enterprise lies in his dividing all his work between those around him. This is known as delegation. However, delegating is not enough. A manager must delegate effectively if he wants to see results. This is important because delegating, when done incorrectly, can result in you creating even more work for yourself. To delegate effectively, you can start by making two lists. One list should contain the things that you know you need to handle yourself. The second list should contain the things that you are confident can be given to others to manage and handle. Besides incorrect delegation, another issue that may arise is over-delegation. This means giving away too many of your tasks to others. The problem with this is, the more tasks you delegate, the more time you will spend tracking and monitoring the work progress of those you have handed the tasks to. This will leave you with very little time to finish your own work.

**Step 3: Hire the right people for the job.**

Hiring the right people goes a long way towards effectively managing your enterprise. To hire the best people suited for the job, you need to be very careful with your interview process. You should ask potential candidates the right questions and evaluate their answers carefully. Carrying out background checks is always a good practice. Running a credit check is also a good idea, especially if the people you are planning to hire will be handling your money. Create a detailed job description for each role that you want filled and ensure that all candidates have a clear and correct understanding of the job description. You should also have an employee manual in place, where you put down every expectation that you have from your employees. All these actions will help ensure that the right people are approached for running your enterprise.

**Step 4: Motivate your employees and train them well.**

Your enterprise can only be managed effectively if your employees are motivated to work hard for your enterprise. Part of being motivated involves your employees believing in the vision and mission of your enterprise and genuinely wanting to make efforts towards pursuing the same. You can motivate your employees with recognition, bonuses and rewards for achievements. You can also motivate them by telling them about how their efforts have led to the company's success. This will help them feel pride and give them a sense of responsibility that will increase their motivation. Besides motivating your people, your employees should be constantly trained in new practices and technologies. Remember, training is not a one-time effort. It is a consistent effort that needs to be carried out regularly.

**Step 5: Train your people to handle your customers well.**

Your employees need to be well-versed in the art of customer management. This means they should be able to understand what their customers want, and also know how to satisfy their needs. For them to truly understand this, they need to see how you deal effectively with customers.

This is called leading by example. Show them how you sincerely listen to your clients and the efforts that you put into understand their requirements. Let them listen to the type of questions that you ask your clients so they understand which questions are appropriate.

#### **Step 6: Market your enterprise effectively.**

Also, hire a marketing agency if you feel you need help in this area. Now that you know what is required to run your enterprise effectively, put these steps into play, and see how much easier managing your enterprise becomes!



- Get advice on funding options from experienced bankers.
- Be cautious and avoid borrowing more than you need, for longer than you need, at an interest rate that is higher than you are comfortable with.

#### **6.6.7 20 Questions to Ask Yourself Before Considering Entrepreneurship**

1. Why am I starting a business?
2. What problem am I solving?
3. Have others attempted to solve this problem before? Did they succeed or fail?
4. Do I have a mentor or industry expert that I can call on?
5. Who is my ideal customer?
6. Who are my competitors?
7. What makes my business idea different from other business ideas?
8. What are the key features of my product or service?
9. Have I done a SWOT analysis?
10. What is the size of the market that will buy my product or service?
11. What would it take to build a minimum viable product to test the market?
12. How much money do I need to get started?
13. Will I need to get a loan?
14. How soon will my products or services be available?
15. When will I break even or make a profit?
16. How will those who invest in my idea make a profit?
17. How should I set up the legal structure of my business?
18. What taxes will I need to pay?
19. What kind of insurance will I need?
20. Have I reached out to potential customers for feedback?



- It is very important to validate your business ideas before you invest significant time, money and resources into it.
- The more questions you ask yourself, the more prepared you will be to handle the highs and lows of starting an enterprise.

Footnotes:

1. A mentor is a trusted and experienced person who is willing to coach and guide you.
2. A customer is someone who buys goods and/or services.
3. A competitor is a person or company that sells products and/or services similar to your products and/or services.
4. SWOT stands for Strengths, Weaknesses, Opportunities and Threats. To conduct a SWOT analysis of your company, you need to list down all the strengths and weaknesses of your company, the opportunities that are present for your company and the threats faced by your company.
5. A minimum viable product is a product that has the fewest possible features, that can be sold to customers, for the purpose of getting feedback from customers on the product.
6. A company is said to break even when the profits of the company are equal to the costs.
7. The legal structure could be a sole proprietorship, partnership or limited liability partnership.
8. There are two types of taxes – direct taxes payable by a person or a company, or indirect taxes charged on goods and/or services.
9. There are two types of insurance – life insurance and general insurance. Life insurance covers human.
- life while general insurance covers assets like animals, goods, cars etc

