UNIT 4
FUNCTIONAL COMPONENTS OF DESIGN

Structure

4.1 INTRODUCTION

Any design is problem-solving. In architectural design we solve problems at various levels. These can be broadly classified in two categories - **functional problems** and **Aesthetic/semantic problems.** The functional problems deal with how a building functions to satisfy the requirements for which it is built. One of the important functions of a building is to protect us from climatic elements such as heat, cold and rain and provide a comfortable environment within the building. Knowledge of climatology, therefore, is a very important aspect of an architect's training.

All buildings depend on services such as water supply/sanitation, electricity, air-conditioning and ventilation, fire protection etc. in varying degrees so as to make the life of inhabitants comfortable. These services are so much an integral part of a building that we often forget about them until an adverse situation arises. Proper planning of these services is crucial for success of a building. The planning of services therefore has to go parallel to the design of a building.

Buildings consume a lot of energy for heating/cooling, lighting etc. Intelligent planning can reduce the energy consumption of a building to a great extent. These are some of the functional aspects that we will examine in this unit.

4.2 OBJECTIVES

After studying this unit, you should be able to:

- describe various elements of climate and different climatic zones of India,
- discuss the climate modulation and energy conservation in buildings, and

- familiarize yourself with the important services of buildings like water supply,
- sanitation, electricity, air conditioning, ventilation and firefighting etc.

4.3 MAN, ENVIRONMENT AND BUILDING

Have you ever wondered why you feel hot or cold? Do you think it is because of the Weather? Suppose you are on the road and you feeling hot, what would you do? You either seek the shade of a tree or you go into your house to escape the heat.

All the above phenomena are related to the environment that surrounds us. Environment consists of mainly elements in a complex relationship. We can describe these elements as temperature, light, sound, climate, space and animate (living things or moving things).

They all act directly upon us and we have to adjust ourselves to their effects. Take the example of light. We use light to see. During day time we use the light coming from the sun. Often we get an excess of sunlight causing glare and we tend to reduce its effects by putting the curtains over windows, wearing a hat or sunglasses etc. At night there is no sunlight, and we have to put on a tube-light to get our work done. So in each case we have either excess light or no light and we act accordingly. When there is just enough light and we do not have to strain ourselves to get work done, the condition is called comfortable.

Similarly, in summer when temperature gets too high, we feel hot and so we put on a fan or go into the shade. During winter, we put on woolen cloths to ward off the cold.

So our body can either absorb or try to counteract the effects of environment. This struggle occurs at three levels, the closest one being our skin. It acts as a heat exchanger, e.g. as weather becomes hotter we tend to sweat more; that means our body is trying to lose excess heat to the air so that we can maintain a comfortable body temperature.

The next level of protection is the clothes that we wear. We can either put on a heavy woolen sweater during winter or wear light cotton clothing for summer conditions.

The third and most important one is our home or shelter. It is one of the main instruments for fulfilling requirements of comfort. Comfort is required so that our energy can be put to productive use instead of trying to fight off the effects of environment. So a building modifies the natural environment to approach optimum conditions of livability. It filters, absorbs or repels environmental elements according to their beneficial or adverse contributions to man's comfort.

Hence, the building acts as a modulator of environment, and so it is important to study climate and comfort conditions for man. Various techniques and new methods that can be used in the construction of a building to achieve comfort have to be identified.

We know that throughout the history, man has used shelter to shield himself from the adverse effects of climate. Caves were one of the first shelters that he inhabited. They provided protection both from weather as well as wild animals. Traditionally, all shelters were built by instinct but as

generations passed, knowledge was refined and buildings became more and more sophisticated. They became finely tuned to the environment they were situated in.

A very famous example of such a shelter is the Eskimo' igloo. It is a well-known solution to the problem of survival in extreme cold. These low dome like shelters deflect the cold winds and take advantage of the insulation value of snow that surrounds them. The smooth ice lining which form on their interior surface is an effective seal against air seepage, and their tunnel exits face away from the prevailing winds to reduce drafts and prevent the escape of warmed air. The heat retention of this type of structure makes it possible to maintain a temperature of 15^0C inside when outside temperature can be as low as -10^0C. Such structures are heated by lamp and supplemented by body heat.

The above example is valid for a cold region, but what type of houses were found in extremely hot climates. You will find that such houses usually have thick walls made of mud or stone, so that outside heat cannot penetrate. The size of the windows was kept to a minimum to prevent hot dusty winds entering into the living spaces. Also houses were closely packed in clusters so that they shaded each other. Examples of these type of houses are still found in many parts of Rajasthan.

Nowadays, we have to contend with newer materials, newer techniques and also newer problems like building in very congested spaces in big cities. So we cannot apply the same construction techniques that were traditionally used, and have to develop newer strategies to keep out the adverse elements while at the same time allowing the beneficial ones in.

For this, we must know the climatic conditions of the place (mostly available at closest meteorological stations). After analyzing these conditions, a suitable strategy to achieve human comfort can be evolved.

4.3.1 Elements of Climate

Climate is an integration of all atmospheric variables at a given place for a period of many years. It is described by a certain number of atmospheric variables which are known as climatic parameters.

Climatic parameters are as follows:

a. solar radiation,
b. air temperature,
c. air humidity,
d. precipitation, and
e. wind

Solar Radiation (W/m^2): The temperature of a large area is determined by the amount of solar radiation, which falls upon that area during each season. Regions that are fully exposed to the sun for a longer part of the year are predominantly hot, while those that receive sunshine only at low angles and for small portions of the year are predominantly cold. Considering the sun-earth relationship, it might be expected that the equatorial regions would be the hottest area on the map, with the mean temperature dropping steadily, at higher latitudes. However, the fall of temperature

from the equator to the pole is not uniform, i.e. regions receiving more solar radiation may not necessarily be the hottest due to topography and other related factors.

Air Temperature (0^0C): Air-temperature, measured in degrees Celsius (^{0}C) is the most important climatic parameter determining the requirement of heating or cooling at a given location. The temperature variations are, however, influenced by other climatic parameters, namely wind speed and direction of wind besides topography and altitude of the place.

Air Humidity (%): The humidity of air is a measure of the amount of moisture present in it. The usual term used to express humidity is relative humidity (R.H.) which gives a direct indication of the evaporation potential. Relative humidity, which is a function of temperature, is defined by the following expression:

$$\text{RH} = \frac{\text{Absolute vapour pressure (A. H.) x 100}}{\text{Saturated Humidity (SH)}}$$

Where, A. H. is defined as the amount of moisture actually present in unit mass or unit volume of air (g/kg)or (g/m^2) and S.H. is the maximum amount of moisture that a unit mass or unit volume of air can hold at that temperature.

Precipitation (mm): All forms of water such as rain, snow, bail or dew that descend on the earth's surface from the atmosphere are called precipitation. Quantities of precipitation are generally measured by rain gauges, which show how many millimeters of water accumulate in them during a given defined period (day or month). These values, recorded over several years indicate the length and intensity of wet and dry seasons, which are important factors that have to be considered while designing a building.

Wind (m/s): Data on wind speed and direction is of importance when considering measures for cross ventilation in warmer regions or exclusion of undesirable cold drafts of wind in cooler regions. Wind speed is measured in m/s by an anemometer while direction is measured by a wind vane. The essential data required is the prevailing wind direction which can be expressed as anyone of eight directions (N, NE, E, SE, S, SW, W, and NW). The direction of wind determines the orientation of the buildings and design of openings. It is also useful to know the typical daily and seasonal changes of wind speed and direction.

6.2.2 Climatic Zones of India

India possesses a large variety of climates, ranging from extremely hot regions to high altitude locations with severe cold conditions, similar to Northern Europe. On the basis of monthly mean data recorded in 233 stations, located in all parts of India, the country can be conveniently divided into six climatic zones. Following are the six climatic zones of India as shown map in 4.1:

a. Hot and dry (HD)
b. Cold and Cloudy (CC)
c. Warm and humid (WH)
d. Moderate (MO)
e. Cold and Sunny (CS)
f. Composite (CO)

Table 4.1: Criteria for Classification of Climatic Zones				
Climate	Mean Monthly Temperature (0C)	Relative Humidity (%)	Precipitation (mm)	Number of Clear Days
Hot and Dry (HD)	>30	<55	<5	>20
Warm and humid (WH)	>30	>55	>5	<20
Moderate (MO)	20-30	<75	<5	>20
Cold and Cloudy (CC)	<25	>55	>5	<20
Cold and Sunny (CS)	<25	>55	<5	>20
Composite (CO)	This applies when 6 months or more do not fall within any of the above Categories.			

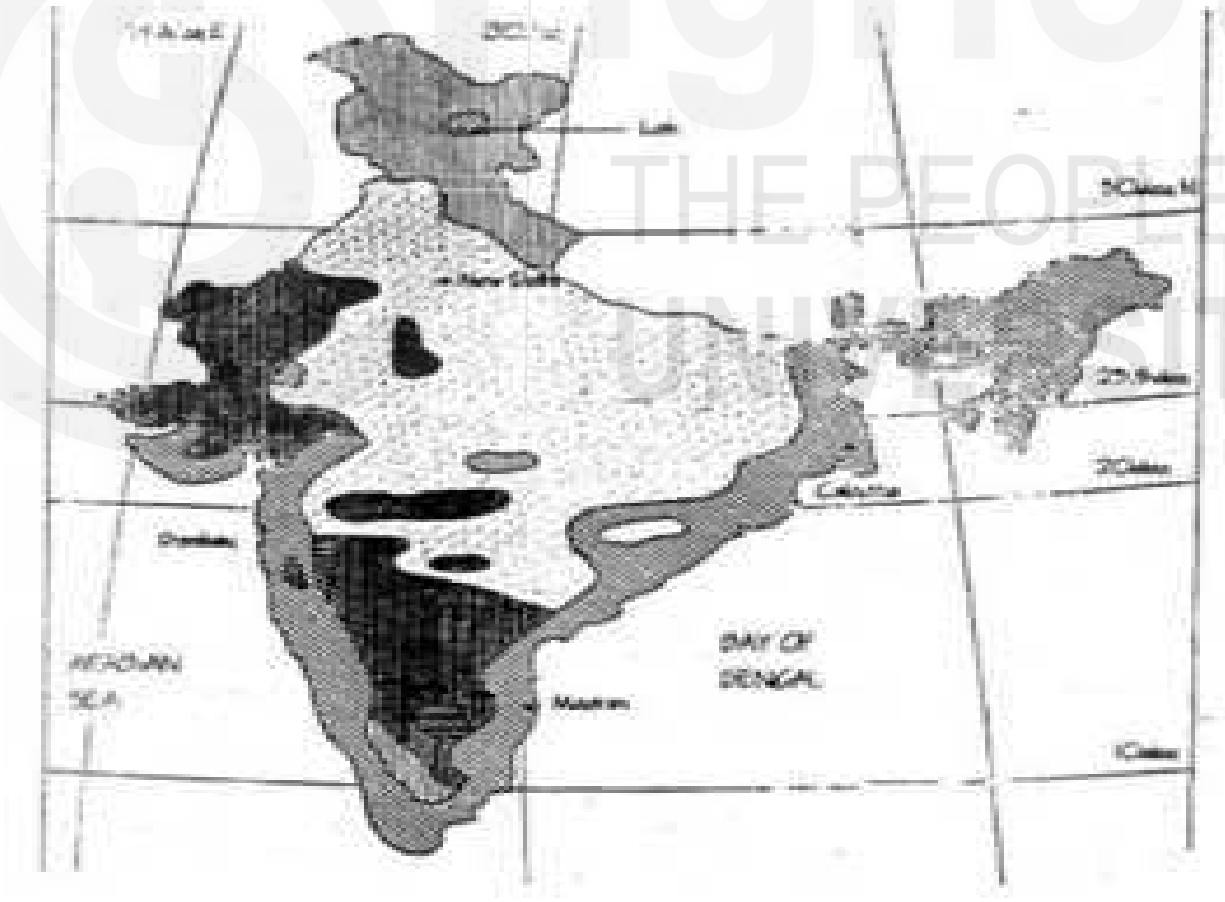


Figure 4.1: Climatic Zones Of India

The main determining factors for the classification of the climatic zones, air temperature and relative humidity (Table 4.1), are those that predominantly influence heat exchange of between the human body and the surroundings. The two other factors, i.e. solar radiation and precipitation, are those that influence building design. The criteria for allocation of a station to one of the first five climate zones is that the defined conditions prevail for more than 6 months. In cases, where none of these categories can be identified for six months or longer, the climate zone is called composite.

Below are given the characteristics of the various climatic zones:

Hot and Dry (HD): This region is characterized by high solar radiation, little or no vegetation, low relative humidity and very low annual precipitation.
The main conditions for discomfort is the high temperatures and low relative humidity, which cause sweating to occur at a faster rate. If the above conditions become excessive, dehydration and heat stroke may occur. Nights are cool and pleasant. Summers are very hot and winters are very cool. It is an example of extreme climate.
Examples: Jaipur and Udaipur.

Warm and Humid (WH): As the name suggests, the temperatures are not too high and discomfort is mainly due to the high relative humidity of the air. These conditions generally prevail in the coastal regions. There is abundant vegetation and heavy rainfall. Winds bring in welcome relief.
Examples: Mumbai, Guwahati and Pondicherry

Moderate (MO): Conditions are not very excessive and are usually within comfortable range.
Examples: Bangalore and Pune.

Cold and Cloudy (CC): Extremely cold conditions reaching sub-zero temperatures with heavy snowfall and high wind speeds. These regions have abundant vegetation. Summers are very pleasant. Most hill stations in the north have this type of climate.
Examples: Shimla and Mussoorie.

Cold and Sunny (CS): The conditions are extremely cold with little or no vegetation. Usually, cold deserts at high altitudes.
Examples: Leh and Ladakh.

Composite (CO): Composite zones are places whose climate cannot be described by any of the above. They cannot be described as hot and dry, cold and cloudy or warm and humid. They have distinct seasons, summer, winter, and monsoon during which different conditions are prevalent. Hence, they are called composite regions.
Examples: Delhi and Nagpur

Check your Progress-I

1. What are the various climatic parameters?

_____

_____

_____

2. What are the various climatic zones of India?

4.4 DESIRABLE CLIMATIC CONDITIONS IN BUILDINGS

Subsequent paragraphs give the limits for some of the climatic parameters desirable for buildings and its inhabitants.

Temperature: India being a tropical country and people being acclimatized, the desirable temperature in shade generally falls between 27.5^0C $\pm 2^0$C ranges.

Relative Humidity: Depending upon the temperature, Relative humidity (RH) is desirable in range of 30% to 70%.

Ventilation: Ventilation is required both for health and comfort. It is needed to dissipate body odors, prevent concentration of harmful bacteria, dust and harmful gases. For a person to be comfortable, ventilation (in terms of wind speed) in the range of 0.5m/s to 1.5 m/s is desirable.

Illumination: Lighting should be such that adequate level of illumination falls on the work place. Different activities require different amounts of illuminations, e.g. a jeweler would need higher illumination than a person reading a book which in turn would be more than that required for watching T.V.

4.4.1 Climate Modulating Devices in Buildings

Buildings have a modulating effect on the environment. We all seek shelter inside a building to protect ourselves from outside heat (sun), cold and rain. Depending on the climate, a building can be constructed in a variety of manners. It can be made to either bring in heat or keep it out, by using different techniques. The most important element fare the building envelope (external walls and roofs) and windows.

Described below are some typical building elements and their uses.

Orientation: Orientation refers to how a building is located with respect to cardinal directions, i.e. N-S and E-W. Orientation of a building is an important parameter. In cold climate, orientation of a building for admitting suns radiation is needed while it is not desirable in hot regions. Similarly, winds can be desirable or unwanted. Sometimes a compromise is required between these two orientations. Shading or deflecting devices can be incorporated to include or exclude the effect of sun and wind. Thus it is essential to have an idea about the sun's position and its movement pattern on a daily (diurnal) as well as seasonal basis.

Position and Size of Openings: Openings (windows) are provided in the walls to control the ventilation in the building. Appropriate design of openings and shading devices help to keep out sun and wind or allow them to enter the building.

Arrangement and Shape of Buildings: In hot and dry climate, compact buildings with small surface to volume ratios should be placed close to each other for maximum shading. For warm and humid climate, buildings should be well shaded and sufficient ventilation is to be provided.

Building Materials: The capacity of a building to modulate the inside environment in comparison to outside depends largely on the material used to construct it.

Proper choice of materials and their surface treatments help in achieving indoor comfort. For example, during the hottest part of the day, the heat storage capacity of a material can be used to absorb the sun's heat. This is radiated into interior when the temperature falls below the comfort level. This can be achieved it the material and wall thickness are chosen correctly. Otherwise the heat will be given off too early or too late. The use of insulating, transparent, translucent or reflecting materials has considerable significance.

Site Selection: In most building projects, the site and position of the building are not given due consideration. Careful selection can help to save a considerable amount of energy and yet provide a fairly satisfactory indoor environment throughout the year. The points to be kept in mind are as follows:

a. Whether the site is partly or entirely exposed to the sun or shaded by surrounding hills, building or vegetation?
b. Whether it is on windward or leeward side of a hill or building?
c. Whether the ground is barren or covered with vegetation
d. Whether it is close to a large water body such as lake or river?

4.4.2 Climatology as a Science to Achieve Comfort in Buildings

We have seen how the sun, wind and rain and other climatic factors affect the building. If we have knowledge of the pattern of the sun's movement, the direction and speed of wind etc. it would be easier to achieve a more predictable indoor environment.

For example, the east and west walls receives the maximum amount of solar radiation, and hence it is desirable to shade them. The north wall receives least amount of direct sunlight so large windows can be placed there to take advantage of glare free light. The above strategies can be applied for a hot region. Applying the same principles to a cold region would lead to disastrous results.

So it is important to know the climatic zone the building is situated in and what are the characteristics of the environmental factors during different seasons.

4.4.3 Energy Conservation in Building

Most traditional houses were used to modulate the environment. After industrialization, inventions like the tube-light and air-conditioners were developed. Widespread use of these led to a total lack

of concern for building shelters taking climate into consideration, as all controls for comfort could be achieved artificially.

It is estimated that 45% of the world's total energy consumption is used for lighting, heating and cooling of buildings. The conventional sources of energy like oil and coal are fast dwindling; hence there is a growing worldwide concern for conservation of energy.

Introduction of appropriate passive features at the planning and design stage could definitely lead to an optimally energy efficient building and achieve a better quality of indoor environment.

The key to achieve energy conservation in a building is as follows:

a. Reduce the heating, cooling or lighting loads by using appropriate techniques and materials. An example of this would be an air-conditioned building which is well insulated and has less area of glazing so that the outside heat is prevented from entering the building.
b. Try to achieve comfort conditions by using passive solar techniques like wind towers, trombe walls and roof ponds etc.
c. Lastly, if additional energy is needed to provide optimum comfort levels then employ components/systems that do not consume too much energy. For example, compact fluorescent lights are more energy efficient than fluorescent tube-lights which in turn are better than tungsten filament lamps.

Photovoltaic cells can be used to generate electricity for running small applications like tube-lights, fans and computers. Solar hot water heaters can be used instead of boilers for domestic purposes.

Check your Progress-II

1. What are the various climatic parameters?

2. What are the various climatic zones of India?

4.5 SERVICES IN BUILDINGS

Any building, in order to function properly requires several services such as water supply and sanitation, electrical supply, telecommunication, firefighting and so on. You might have seen houses in a village having no water supply, sanitation or electricity. How different it is to live in such houses. You may also recall how much inconvenience we face when the electrical supply fails or water supply is not proper. We have become so accustomed to these services in our buildings that we often take them for granted. It is important to understand that these services have to be carefully planned and provided during the design and construction of buildings. Let us understand the role of some of the major services in buildings.

4.5.1 Water Supply and Sanitation

A characteristic of all such services is that something enters and/or leaves the building. Quantification and installation are the two main aspects to be considered.

Water, after air is the most important thing for our living and well-being. We require water to drink, cook, wash and many other things. It is possible to quantify the water requirement for a building.

Water requirements for domestic purposes roughly forms about 40 to 50% of the total water requirement per capita per day for a city. This includes drinking, cooking, bathing, hand and face washing, household sanitary purposes, private gardening, domestic animals and vehicles washing.

To this, if we add the civic requirements of water in a town like road washing, sanitation, firefighting etc., the per capita per day water requirement for a town would vary from 150 to 300 liters. The requirement for a residential building can be worked out to, say 50% of that.

The supply of water to a building may be continuous or intermittent. Water supply works on pressure head. Water flows from higher pressure to lower pressure. Or by gravity from a higher elevation to a lower one. Water is generally distributed to a part of town from a water reservoir placed at a high elevation or high structural frame. Usually low rise buildings will get water directly but the high rise buildings may have problem.

The other method of supply is by a pumping system where a pressure is generated by a pump or number of pumps. Also even the low rise buildings will get water only intermittently depending on the supply. What is done therefore in most buildings is that an underground tank receives and stores water from the supply. This is then pumped up to an overhead tank which provides water to all floors at all times.

The volume of the underground and overhead tanks have to be worked out on the basis of how many persons use the building for what purpose. The diameter of the supply pipe is also important thing to ascertain.

Having got adequate amount of water to the building, the next important thing is to distribute it to different parts of the building. This is done by pipes (generally, galvanized iron) and outlets of various kinds.

Some of the fitments used in a building water supply are as follows:

Air Valves: Air valves, also called the air relief valves, are provided at the high ends of pipes to help release the air that often accumulates in the pipes. The air valves should be located at points which are close to or above the hydraulic gradient. If air locks are not provided, there are chances of pipes to be air-locked, affecting the flow of the water.

Bib Cocks: Bib cocks are water taps attached at the end of the pipe from which water is made available for use. It comes in different sizes and types. It usually has a handle or a knob which, when turned, controls the flow of water. They may also be push-type Bib-cocks should be water tight in order to avoid wastage of water.

Reflux Valves: Reflux valves, also called check valves or non-return valves, allow water to flow only in one direction. In case of intermittent water supply or where water is pumped, these valves help in preventing the water in the pipes to flow back.

Sluice Valves: Sluice valves, also called the stop valves or shut-off valves or gate valves, control the flow of water and help in dividing the water mains into suitable sections. They are generally placed at a distance of 150 to 200 meters and at all junctions.

Stop Cocks: Stop cocks are small size sluice valves and are installed in service pipes before the outlets.

Water Meters: Water meters are devices installed on the pipes to measure the quantity of water flowing through so that the consumers can be charged accordingly.

Fire Hydrant: It is an outlet provided in water pipes for tapping water mainly in case of fire. They are generally provided at street junctions but larger buildings and building complexes should also have fire hydrants at suitable locations.

Toilet and bathrooms have fixtures like wash basin water closet, taps and geyser connections which require water supply. Some other parts of buildings may also require a tap or a sink.

Water is delivered to the building under pressure from a street main. The pipe coming into the building is called the service pipe. Distributing pipes carry water from the service pipe to the outlets at fixtures. Any pipe that runs vertically one storey or more, and carries water to fixtures or branch pipes is called a “riser”. The supply pipe between a water distributing pipe and the fixture is called the fixture branch. Water pipes are generally made of steel or wrought iron and are galvanized. Branch pipes are either fitted on the surface of the wall or are concealed. The diameters (inner) of pipes in a building may vary from 32 mm for service pipe to 12 mm branch pipe.

The joining and branching of pipes is done with the help of different types of pipe fittings, providing straight, angular ‘T’ or cross joints.

Toilets and kitchen fittings such as wash basins, sinks, water closets, taps, showers etc. are manufactured by several companies. Elaborate catalogues are available from companies and

suppliers which give all installation details, which must be carefully studied before installing any fixture or fitments. It is important to select a good contractor for plumbing and sanitary fittings. Special consultants for water supply, sanitation and plumbing are also available whose services should be used for proper planning and installation of such services.

Drainage and Sewer: It is a system of piping within private ***or*** public premises that conveys sewage (any liquid waste containing animal, vegetable or chemical waste in solution), rain water or other liquid wastes to an approved point of disposal. Sanitary sewage contains human excrements and liquid house-hold wastes.

Sanitary drainage system must provide for the safe, sanitary disposal of sewage from all fixtures in a building. Where public sewer systems are available, building systems should be connected to them. In case of public sewer systems not being available, adequate and approved private disposal treatment systems must be designed and constructed. Suitable provisions must be made to prevent back flow of sewage into building premises.

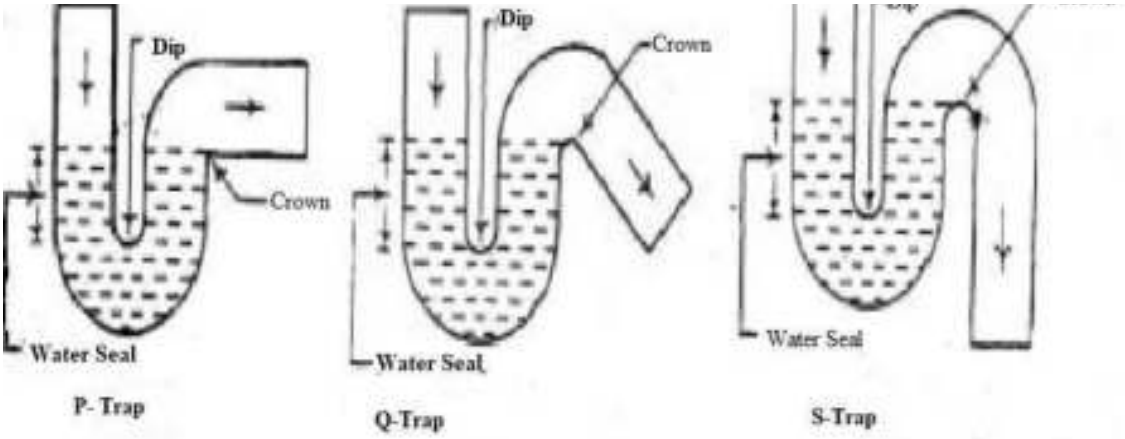
Where public sewer system exists, the private plot holders construct the sewer line in their own plot and its final point is then joined to the public sewer.

It is important to keep in mind the following while designing and constructing house drainage system:

a. Sewers should be laid by the side of building rather than below the building.
b. Drains should be laid straight between inspection chambers or manholes. Sharp bend and junctions should be avoided.
c. The entire system should be properly ventilated.
d. The house drain should be connected to the public sewer only when public sewer is deeper than house drain in order to prevent reverse flow.
e. The house drainage should have enough number of traps at suitable points.
f. The joints of sewers should be water tight.
g. Lateral sewers should be laid at proper gradient so as to give self-cleaning velocity.

Traps: A trap is a bent sanitary fitting which always remains full of water-water seal which prevents foul air or gases to go through, while allowing, at the same time the sewage to pass. The depth of water seal in a trap varies from 25 to 75 mm. It should contain water at all times. They are classified as P-trap, Q-trap and S-trap according to shape as shown in Figure 4.2.

Figure 4.2: Traps



According to use, the traps are of following three categories:

a. Floor trap,
b. Gully trap, and
c. Intercepting trap.

Floor Trap

Floor trap, made of cast iron, is provided on floor at the point of entry of waste water from bath, sink etc. A floor trap forms the starting point of waste water flow. It is provided with removable cover with grating so as to prevent any solid matter entering it.

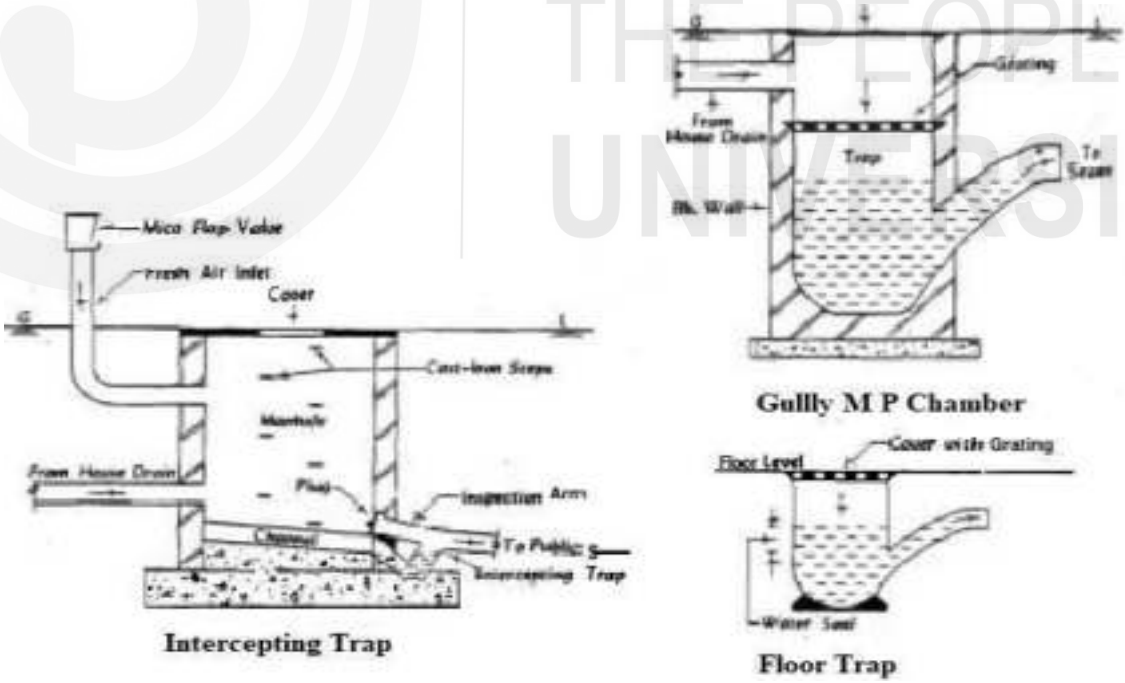
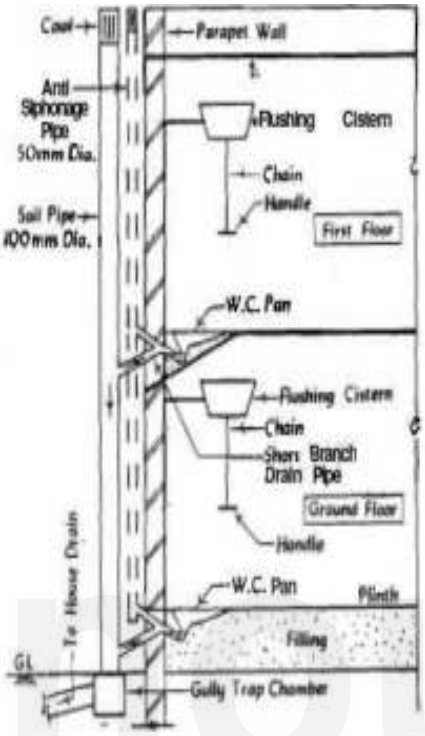


Figure 4.3: Traps classified according to use

Gully trap: Gully trap, usually of stone ware with cast iron grating, is fitted inside a masonry chamber. The gully-trap forms the starting point of horizontal flow of sewage. It is placed near the external face of wall at ground or pavement level or slightly higher with a cast iron cover. It leads the sewer to either inspection chamber or to manhole.

Intercepting Trap: Intercepting trap is provided in the last manhole of house drainage system, which conveys sewage from house to the public sewer. Figure 4.3 shows manhole with intercepting trap. The main function of this trap is to prevent the sewer gases of public sewer from entering the house drains.

All above mentioned three types of trap have been shown in Figure 4.3.



Anti-siphonage Pipe: Antisiphonage pipe is installed in the house drainage to preserve the water seal of traps e.g. and maintain proper ventilation. The top of 'vent pipes' is covered with a 'cowl' with slits to prevent birds from building nest on it. Vent pipes are provided for the purpose of ventilation. 'Soil pipes' are the pipes that carry discharges from soil fittings such as water closets, urinals etc. 'Waste pipes' are the pipes that carry the discharge from sanitary fittings such as bath, wash basin, kitchen sink etc.

Sanitary Fittings: These are the fittings required in the house drainage to collect and remove the waste water and soil from house to house drain, bath tubs, wash basins, water closets, urinals, sinks, flushing cisterns, drinking fountains etc. Figure 4.4 gives a general idea of house drainage arrangements and some of the sanitary fittings.

It is necessary to prepare a detailed plan showing house drainage system which needs to be approved and sanctioned by competent authority. One such plan is shown in Figure 6.5.

Septic Tanks: In case of buildings which are not connected to public sewer systems for disposal, it is necessary to provide their own disposal-cum-treatment system. Generally, this is done with the help of a septic tank (Figure 4.6). It is like a plain sedimentation tank where the biochemical reaction by anaerobic bacteria takes place. During the detention period, sewage is purified and the effluent is taken to soak pits for disposal.

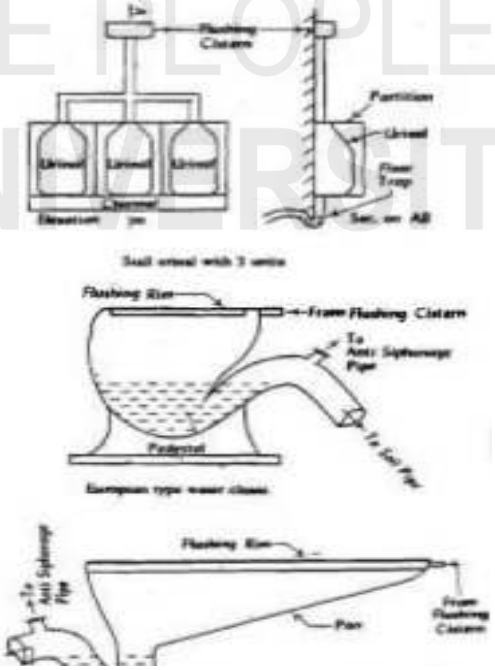


Figure 4.4(b): Details of some Sanitary Fittings

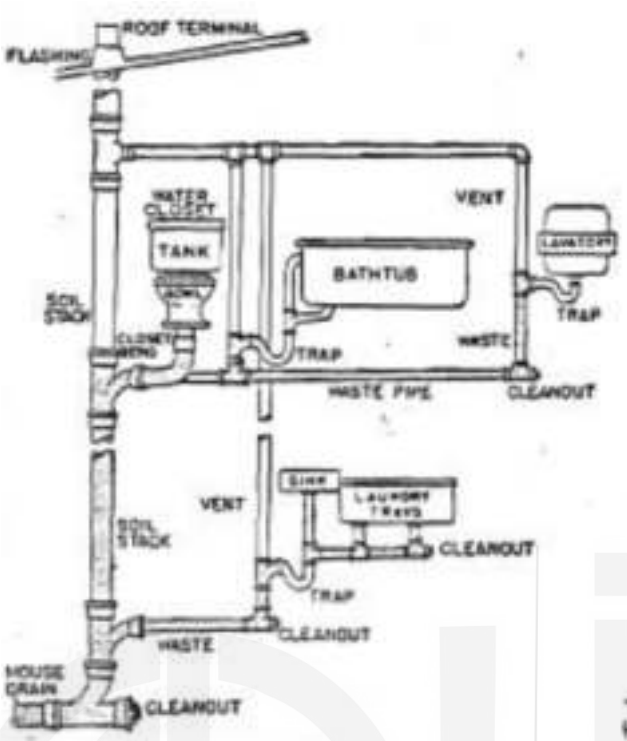


Figure 4.5 (a): Drainage system with Vents

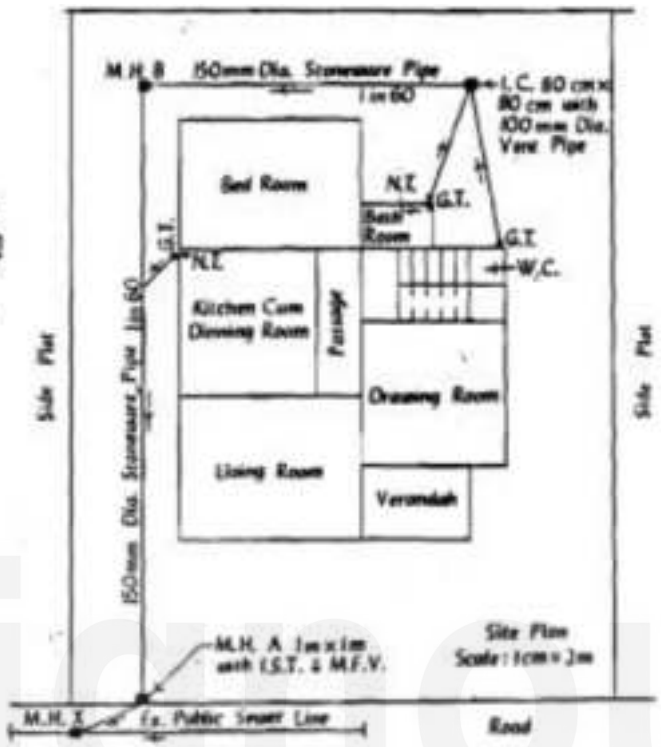


Figure 4.5(b): Drainage Plan of a Building

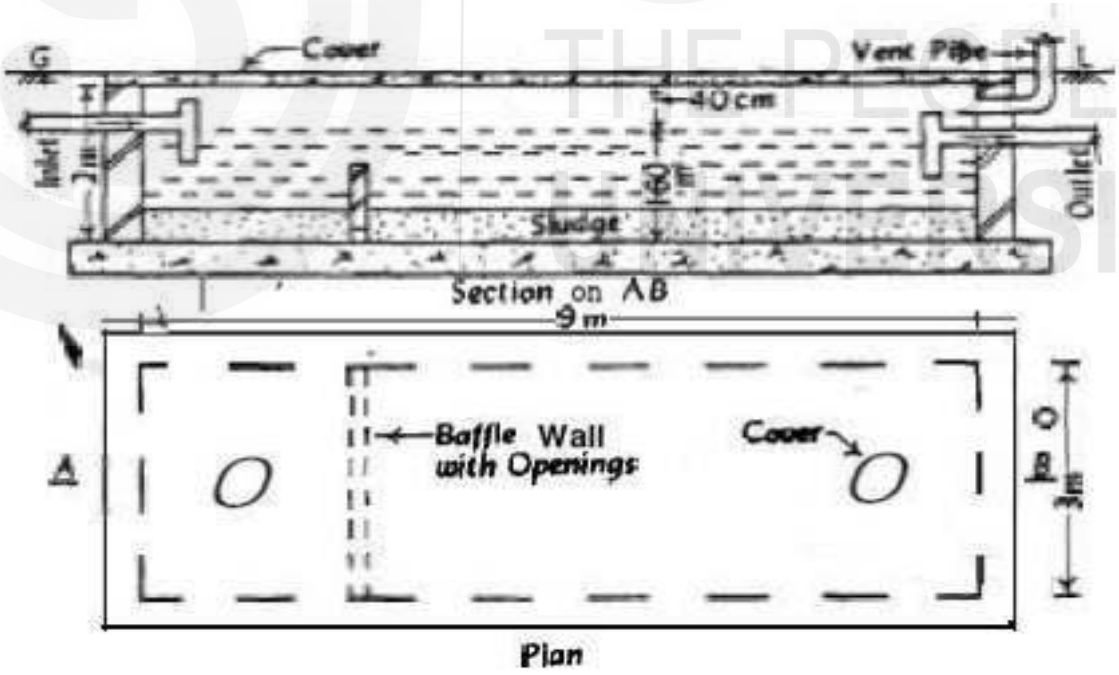


Figure 4.6: Septic Tank

4.5.2 Electrical Services

Electric power is usually supplied to buildings and building complexes by electric supply agencies overload or underground. Electrical service for a building extends from the point where power is received from this supply agency -called the 'service point' or 'connection'. There is service equipment at this point in the form of circuit breaker or a switch and fuse combination.

Proper designing and execution of electrical wiring and fittings is very vital for the efficient functioning of a building and the safety of the users of building. Apart from lights and fans there are many other applications of electricity in a building. Electrical work in a building is a specialised job. Architects generally appoint electrical consultants to design the electrical services for a building. Even for execution of electrical work special contractors are commissioned. However, an architect has to have sufficient basic knowledge of how electrical services work in a building so that he can provide adequately for it in his building design.

Guidelines are available in several Indian Standards and National Electrical Code, dealing with the various aspects relating to electrical installation practice.

At the planning stage of building, the architect anticipates the electrical requirements in various parts of the building. He prepares, with the help of electrical consultant, an electrical layout. It indicates, on plan, with the help of symbols, different installations and connections and other links with its operation. Such a layout helps electrical consultant to quantify and estimate the electrical work. The electrical contractor uses such layout to execute the work. It is also helpful for maintenance work when the building is in use. A typical example of an electrical layout and the conventional symbols used therein are shown in Figure 4.7 and Figure 4.8, respectively.

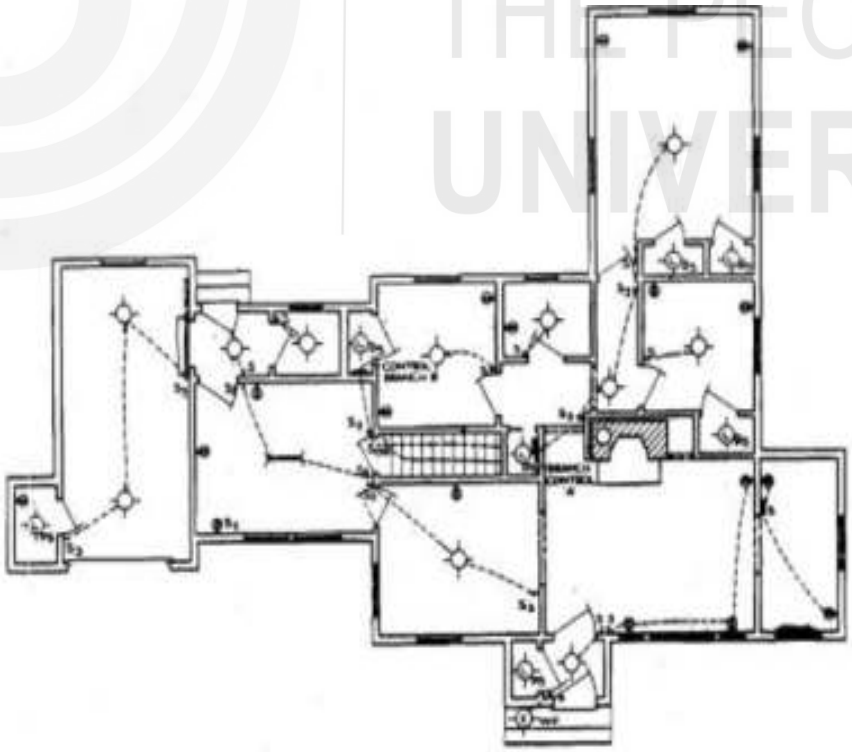


Figure 4.7: An Example of a Typical Electrical Layout

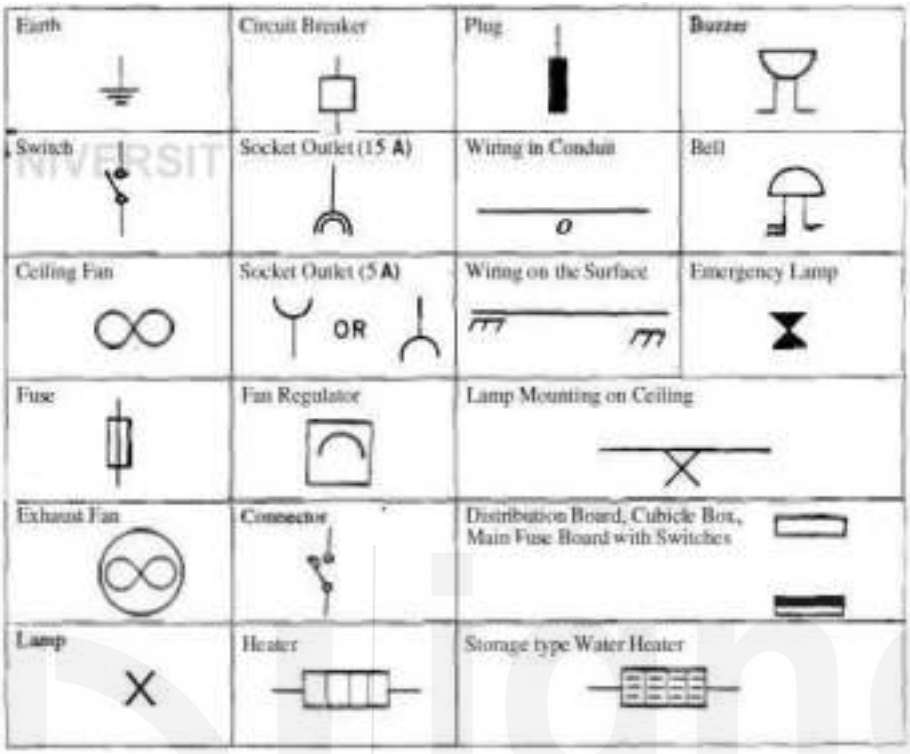


Figure 4.8: Symbols

Since electricity is so vital in a building and since safety is very important, it is necessary that:

a. electrical installations in a building are done strictly conforming the Bureau of Indian Standards, Indian Electricity Rules and relevant regulations of the electric supply authority,

b. all electrical fittings, equipment and their accessories, appliances etc. used in an electrical installation should conform to Indian Standard Specifications or approved by competent authority, and

c. good workmanship is insisted on as an essential requirement. Both the workmen as well as the person supervising the work should have appropriate certificate of competency.

A proper coordination between-the architect, building engineer and the electrical engineer is essential at planning stage **as** well as the execution of building.

Wiring Installation: The wiring forms the major portion of the fixed electrical installation in a building. At the point of commencement of supply there should be a circuit breaker or a linked switch with a fuse. This should be located as close to the service line and should be easily accessible.

Main Switch and Switch Board: It is an insulated metal box located near the point of entry. It should be placed indoor and preferably in a lockable cupboard. It should be kept away from moisture, inflammable materials and storage batteries. It should be properly mounted on wall on either metal or wooden board or recessed in the wall if specified.

Distribution Board (DB): They are provided depending upon the area of distribution. Usually, in a house there will be one distribution board but in case of larger buildings several DB's are provided zone-wise. It will consist of switch and fuses or circuit breakers properly marked to indicate each branch.

Wiring: Wiring in a building is either exposed or concealed. Exposed wiring on walls and ceiling is either created directly on walls (not recommended) or fitted on casing and capping made of wood or PVC. Concealed wiring is carried inside walls and slab in a metal or PVC conduit, with inspection and junction boxes suitably provided for servicing the wires if necessary!

Equipment Fittings and Accessories

Ceiling Rose: These are provided on the ceiling to connect fan or a light point.

Socket Outlets and Plugs: These are provided on the walls for connecting different electrical appliances. Each socket has its own switch. These sockets may be of 5A or 15A rating. Normally, 15A socket outlets are fitted with a fuse.

Lighting Fittings: Lighting fittings are the fittings of various kinds to provide bulb or tube type of luminary. Each light point or a group if provided with a switch. Various types of lamp holders and luminaries are available to suite different functional and decorative purposes.

Fans - ceiling fans and table or pedestal fans are provided with individual switch and regulators. Exhaust fans are fitted along with a frame on a hole provided in the walls.

It is important from the point of view of safety that proper earthing is provided to all electrical systems.

4.5.3 Air Conditioning

In many buildings, either for specialized functional need or for the sake of comfort, air-conditioning is provided. This is a device to maintain a certain level of temperature and humidity in **an** enclosure. This is done with the help of electro-mechanical systems. In Indian context when we say 'air conditioning', we generally mean cooling but sometimes in cold climate heating is also required. You must have seen many buildings where a box like equipment is fitted on the windows - called the air

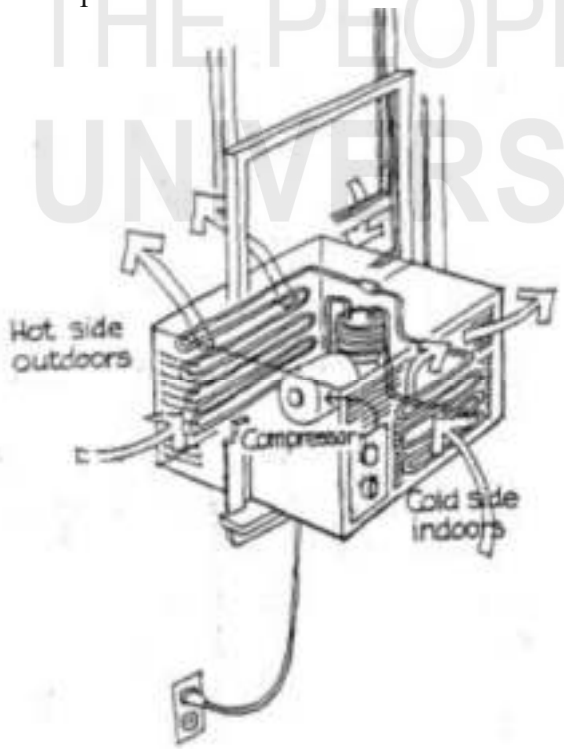


Figure 4.9: Window Air Conditioner

conditioner. These are the window type air conditioners shown in Figure 4.9, used to air condition or cool a room. Sometimes, more than one such units are used if a room is large. But if large spaces or an entire building has to be air conditioned - we use central air conditioning system (Figure 4.10).

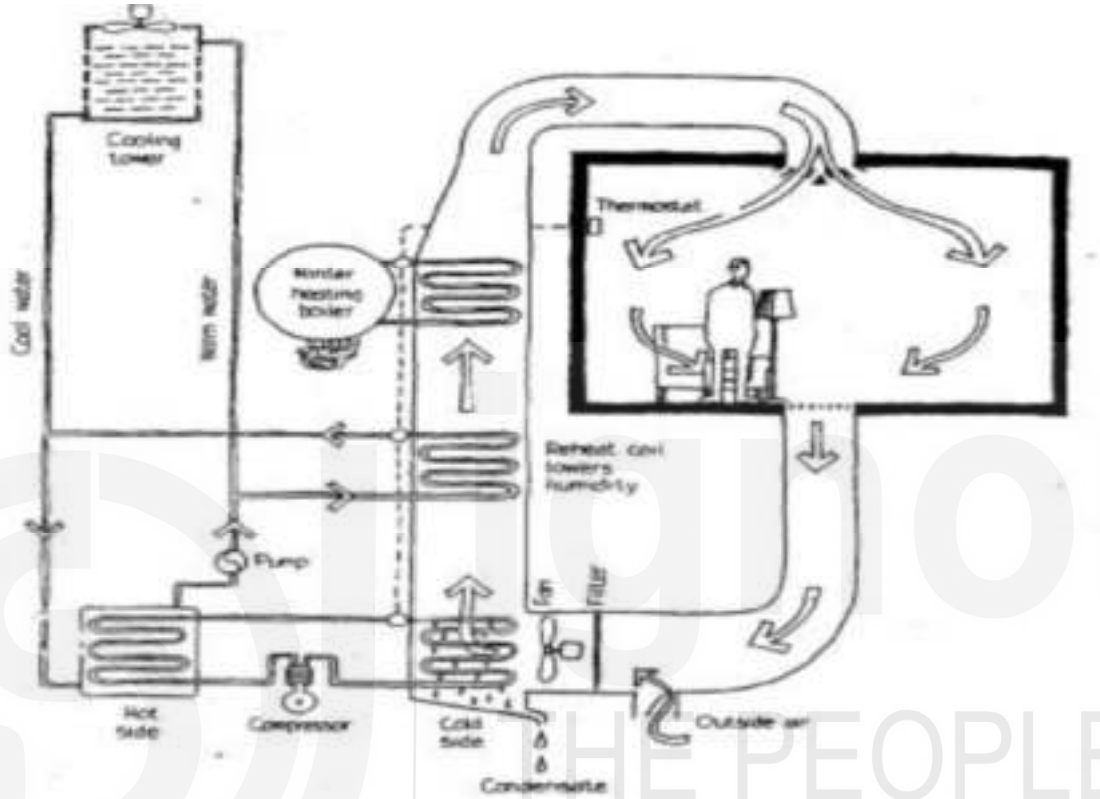


Figure 4.10: Schematic of a Simple Air Conditioning System

Any air conditioning system works on the principle of taking outside air and blowing it through filters and cooling or heating elements (as the case may **be)** and conveying it through ducts or directly to spaces to be air conditioned. It will also have a provision for the return of room air to get re-circulated through system. The temperature control

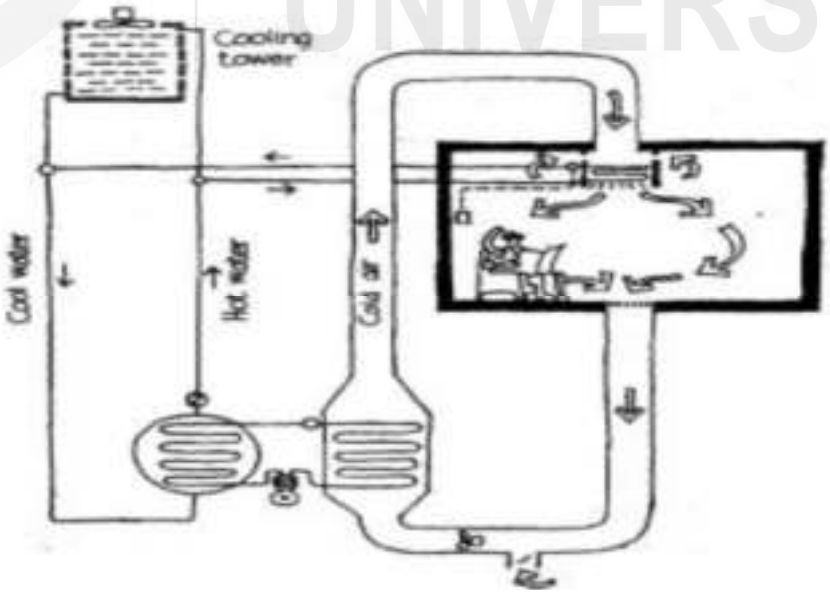


Figure 4.11: Schematic of Single Duct Air Conditioning System

is achieved with the help of thermostats. Figure 4.11 shows the general working of single duct air conditioning system.

Some other types of air conditioning devices including heating and cooling device and an evaporating cooling device are shown in Figure 4.12(a) and (b) respectively.

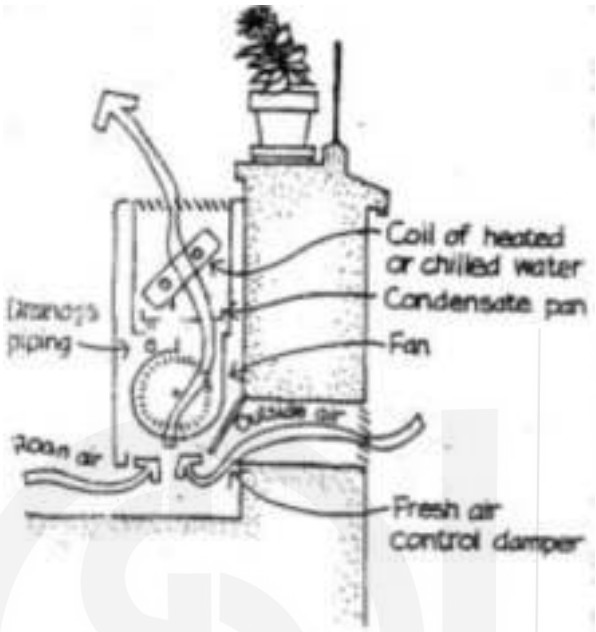


Figure 4.12(a): Heating and Cooling Devices

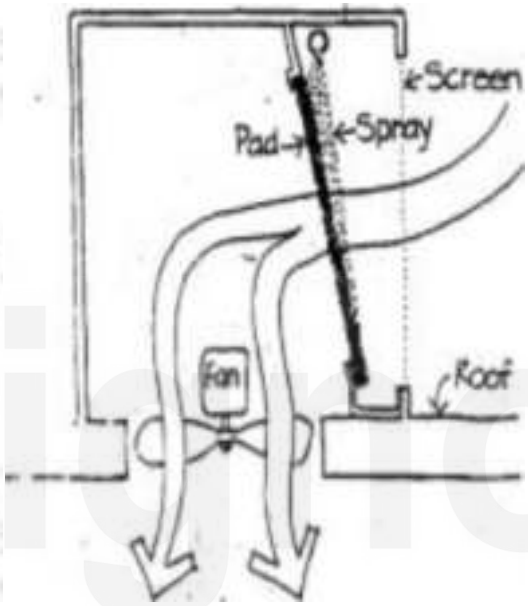


Figure4.12 (b): Evaporating Cooling Device

4.5.4 Fire Protection for Buildings

Uncontrolled fire is a deadly and destructive occurrence in human civilization. A forest fire is dangerous enough but when a fire occurs in a building, the danger is compounded in many ways. A building supplies fuel for accidental fire.

A natural first step would be to prevent fire in the first place. Fire often starts from the cooking or heating stoves or electrical short circuiting. It is therefore important to place the sources of fire in such rooms from where it may not spread. If the electrical work is clone properly it will eliminate short circuiting. Apart from brick and concrete, many other materials are used in a building. It is important that all building materials are as much fire retardant as possible.

The buildings should be so designed that in case a fire breaks out in any part, it should not spread to other parts. It should also be possible for the inhabitants of the other parts to quickly evacuate the building. Adequate firefighting devices should be provided at places in the form of fire extinguishers and water hydrants. In case of tall buildings, the design should be such that all the floors are accessible from outside for rescue work. In many cities, large buildings or complexes have to be passed by the fire authorities.

We have seen how there are various types of services which are essential to make a building function properly. Telecommunication System, TV Networking, Electronic Security System and

many others can also be cited. It is very important that at the time of planning as well, as at the time of execution of building all the necessary services should be properly planned and provided.

Check your Progress-III

1. What are the various fitments used in a building water supply system?

2. Write short notes on:
   i. Gully Trap
   ii. Sanitary Fittings
   iii. Septic Tank
   iv. Air-conditioning

4.6 SUMMARY

We have seen in this unit that there are many functional aspects of design which are necessary to incorporate for efficient working of a building. We have dealt with the climatic aspects. How building provides us comfort in different climatic conditions. There are many ways in which a building can provide comfort by efficient planning as well as conserving energy. Many types of services are required to make the buildings usable for us, e.g. water supply, drainage, electrical supply etc. All these services require careful planning and execution. Architecture, therefore, does not only involve buildings that are good to look at but also work efficiently to provide the wellbeing to the inhabitants.