CHAPTER 8: GENERATION OF ELECTRICITY

8.1 GENERATION OF ELECTRICAL ENERGY

1. A generator is a device that converts mechanical energy into electrical energy.
2. For a generator to produce electrical energy (electricity), the coil of wires in the generators rotates within a magnetic field by a turbine.
3. Energy sources such as fossil fuels, running water and nuclear fuels are sources of energy used to provide kinetic energy to rotate the turbines.
4. The generators are used in the various types of power stations.

<u>VARIOUS TYPES OF POWER STATIONS</u>

1. **THERMAL POWER STATION**
   a. Natural gas, diesel or coal is burnt to produce heat energy.
   b. This heat energy is used to convert water into steam.
   c. The steam rotates the steam turbine which drives the generator to produce electrical energy.
   d. Energy changes involves:
   Chemical energy → heat energy → kinetic energy → electrical energy

2. **NUCLEAR POWER STATION**
   a. Nuclear reactions release a huge amount of heat, which is used to convert water into steam.
   b. The steam is used to rotate the steam turbine.
   c. The turbine rotates the generator to produce electrical energy.
   d. Energy changes involves:
   Nuclear energy → heat energy → kinetic energy → electrical energy

3. **HYDROELECTRIC POWER STATION**
   a. Running water flows from a dam rotates the water turbine.
   b. The rotating turbine will in turns drives the generator that produces electrical energy.
   c. Energy changes involves:
      Potential energy ⟶ kinetic energy ⟶ electrical energy

<u>ALTERNATIVE SOURCES OF ENERGY</u>

1. Solar energy
2. Biomass fuel

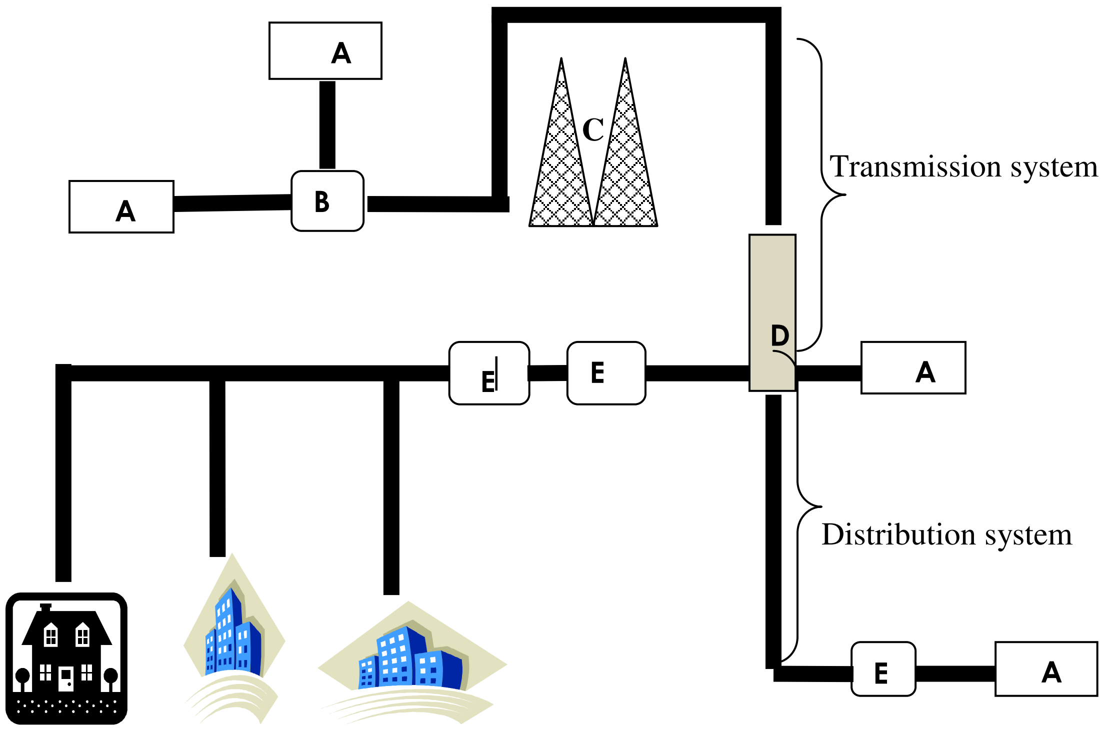
8.2 TRANSFORMERS

1. A transformer is a device that changes the voltage of an alternating current.
2. It is made up of a soft iron core with a coil of insulated wire on both sides of the core.
3. When alternating current is flowing through the primary coil, a changing magnetic field is created continuously.
4. This changing magnetic field induces an alternating voltage in the secondary coil.
5. Primary coil – receives input voltage,
   Secondary coil – produces output voltage.
6. The voltage produced (output voltage)can either increases or decreases, depends on:
   i. The input voltage
   ii. The number of turns of the primary and secondary coil.
7. In a transformer, the voltage is larger on the side with more turns (wire coil).
8. Types of transformers: (i) Step -up transformer (ii) Step- down transformer
9. Differences between step-up and step-down transformer

Step-up transformer	Step-down transformer
a. Input is less than output	Input is more than output
b. Number of turns in the primary coil is less than that in the secondary coil	Number of turns in primary coils is more than that in the secondary coil.

8.3 ELECTRICAL ENERGY TRANSMISSION AND DISTRIBUTION SYSTEM

1. The components involved in the electrical power transmission and distribution system are
    a. Power station
    b. Step-up transformer station
    c. National Grid Network
    d. Step-down transformer
    e. Substation
2. The generators at a power station produce alternating current with a voltage of 11kV or 25kV.
3. This current enters a transformer station. Here, the voltage is raised to 132kV or 275kV using a step-up transformer.
4. The alternating current then flows through a network of transmission cables called the National Grid Network.
5. Then it enters into a regional control and switching zone. Here, the electrical power is controlled before it is sent where and when it is needed. It is also allowing some stations and lines to be shut down without cutting off power supply.
6. From this zone, the alternating current flows through a series of step-down transformers and switching zones at the main substation and its branches before distributing to consumers.
7. Figure below shows the electrical energy transmission and distribution system



KEY –
A – Power Station
B – Step-up transformer
C – National Grid Network
D – Step-down transformer
E – Substation

8.4 ELECTRICAL ENERGY SUPPLY AND WIRING SYSTEM IN HOMES

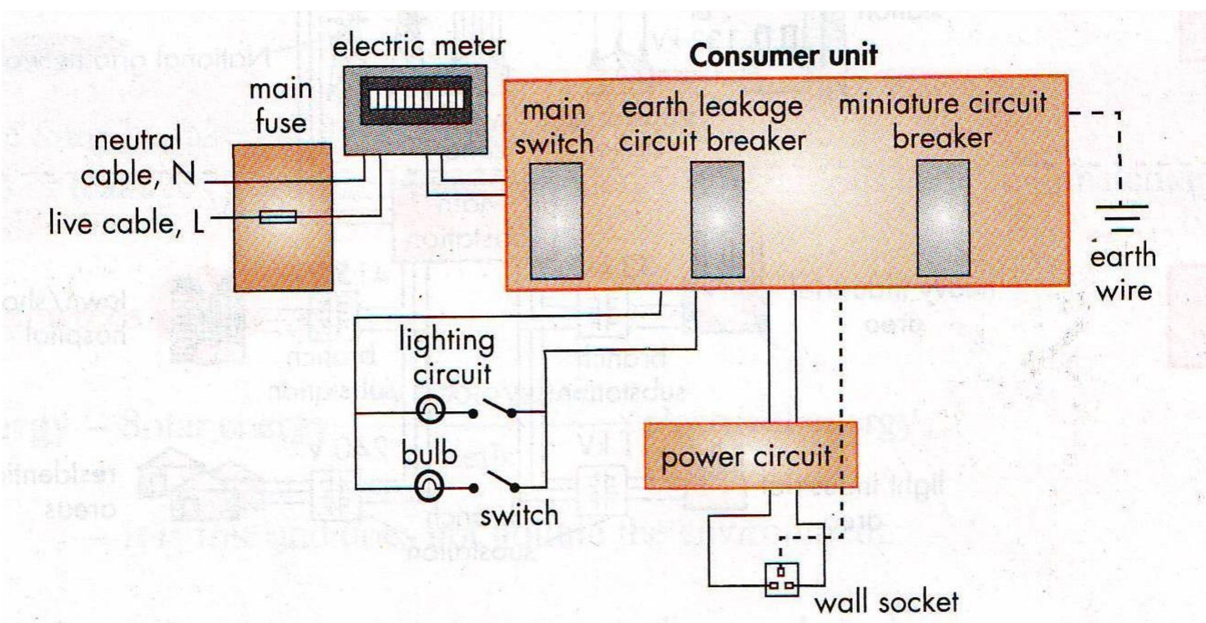
1. Alternating current with a voltage of 240 V is supplied to our homes by the live wire.
2. Current is returned to the substation by the neutral wire.
3. Types of electrical wiring system:
   a. Single- phase wiring   b. Three- phase wiring
4. Wiring in a 3-pin plug involves:

Type of wire	International colour code
Live	Brown
Neutral	Blue
Earth	Yellow with green stripes

5. The components in the electrical wiring system at home and their functions are shown in the following.

PART	FUNCTION
Fuse box	Protects a house circuit from damage caused by a large current or overloading.
Main switch	Controls the amount of current which flows through the circuit into the house.
Circuit breaker	Breaks the circuit by springing out or tripping its switch when the current flowing through it exceeds its rating.
Live wire	Carries current at a voltage of 240V from the local substation to home.
Neutral wire	Returns the current from homes to substations.
Earth wire	Connects an appliance directly to earth as a safety measure.
Electric meter	Records the amount of electrical energy that has been used.

6. Figure below shows the wiring system in homes.



8.5 COST OF USING ELECTRICAL ENERGY

1. Power is the rate of using energy.
2. The S.I. unit for power is watt (W) or joules per second.

$$\text{Electrical power (W)} = \frac{\text{Electrical energy used (J)}}{\text{time taken (S)}}$$

3. Electrical appliances are normally marked with the power and voltage rating.

$$\text{electrical power} = \text{voltage X current}$$

4. The unit commonly used for electrical energy is the kilowatt-hour [kWh].

$$\text{Cost of electrical energy used} = \text{electrical energy used in units x cost per unit}$$

8.6 FUNCTIONS OF FUSE AND EARTH WIRE

1. Types of fuse: (a) Cartridge fuse (b) Replaceable fuse
2. The rating of a fuse is the value of the maximum current that is allowed to flow through the fuse without causing its fuse wire to melt.
3. Some common ratings of fuses are 1A, 2A, 3A, 5A, 10A and 13A.
4. A fuse functions as a safety device to protect the wiring and appliance against excessive current flow.
5. The fuse has a slightly higher rating than the magnitude of current which flows in the appliances.

$$\text{Current (I)} \quad \frac{\text{power (W)}}{\text{voltage (V)}}$$

6. When excessive current flows in a circuit, the fuse will melt and break the circuit.
7. The earth wire connects the metal part of electrical appliances to the earth. It carries the leaked current from the appliance to earth.

8.7 THE IMPORTANCE OF SAFETY PRECAUTIONS IN THE USE OF ELECTRICAL ENERGY

Safety Precautions in the Use of Electrical Energy

1. Do not overloaded electrical sockets
2. Replace old wires with worn out insulations with new wires
3. Do not touch electrical appliances or switches with wet hand
4. Do not poke anything into an electric socket
5. In case of an electrical fire
   - switch off the main switch
   - use a powder fire extinguisher to put out the fire
   - call the fire brigade
6. In case of a person getting an electric shock,
   - switch off the main switch
   - use an insulator such as wood, rubber or plastic ti separate the person from the source of electric shock
   - never touch the person with your bare hands
   - give first aid to the victim
   - send the victim to the hospital.

8.8 CONSERVING ELECTRICAL ENERGY

- Steps to conserve electrical energy
  - (a) Turn off the lights that are not in use
  - (b) Use fluorescent lamps which are more efficient in lightning
  - (c) Iron all your clothes at one time
  - (d) Keep the refrigerator away from heating appliances such as ovens and do not open refrigerator door often.
  - (e) use energy-efficient electric appliances in homes and offices