**BCT 2202 – Lecture 7**

# **Sources of electrical energy**

## **Introduction**

There are many types of energy such as

1. electrical energy,
2. mechanical energy,
3. thermal energy,
4. light energy, and
5. wind energy.

Electricity is produced from nuclear power plants, hydroelectric plants, wind farms, and sunlight. Fans, lights, televisions, washing machines, and refrigerators all require electricity to operate. Sources that generate electricity are called electrical power sources. Electrical energy is stored in batteries and capacitors. Electric energy sources are classified into conventional (thermal power plants) or alternative (renewable) sources.

## **Thermal Power Plants**

Large amounts of fossil fuels are burned every day in thermal power plants to produce electricity. It is called a thermal power plant as electrical energy is generated using thermal energy. It is much easier to transmit electrical energy than to transport coal or petroleum over long distances. So, thermal power plants are installed near coal or oil fields.

## **Alternative and renewable energy sources**

Alternative energy refers to energy sources which could replace coal, gas and oil, all of which increase the atmospheric carbon when burned as fuel. Renewable energy implies that it is derived from a source which is automatically replenished or one that is not depleted as it is used.

### **Solar energy**

Solar energy is one of the most resourceful sources of energy for the future. The reason for this is that the total energy received each year from the sun is around 35 000 times the total energy used by man. However, about one third of this energy is either absorbed by the outer atmosphere or reflected back into space. Solar energy could be used to run cars, power plants and spaceships. Solar panels on roofs capture heat in water storage systems. Photovoltaic cells, when suitably positioned, convert sunlight to electricity.

### **Wind power**

Wind power is another alternative energy source that can be used without producing by-products that are harmful to nature. As wind flow crosses the blades of the windmill, it is forced to rotate and can be used to generate electricity. Like solar power, harnessing the wind is highly dependent upon weather and location. The average wind velocity of Earth is around 9 m/s, and the power that could be produced when a windmill is facing a wind of 4.5 m/s is around 50W.

### **Hydroelectricity**

Hydroelectricity is achieved by the damming of rivers and utilising the potential energy in the water. As the water stored behind a dam is released at high pressure, its kinetic energy is transferred onto turbine blades and used to generate electricity. The system has enormous initial costs but has relatively low maintenance costs and provides power quite cheaply.

### **Tidal power**

Tidal power utilises the natural motion of the tides to fill reservoirs which are then slowly discharged through electricity-producing turbines.

### **Geothermal energy**

Geothermal energy is obtained from the internal heat of the planet and can be used to generate steam to run a steam turbine which, in turn, generates electricity. Drilling 3 miles from the surface of the Earth, a temperature of 100◦C is encountered; this is sufficient to boil water to run a steam-powered electric power plant. Volcanic features called geothermal hotspots are found all around the world. These are areas which transmit excess internal heat from the interior of the Earth to the outer crust which can be used to generate electricity.

# **Electrical measuring instruments and measurements**

Tests and measurements are important in designing, evaluating, maintaining, and servicing electrical circuits and equipment. To detect electrical quantities such as current, voltage, resistance or power, it is necessary to transform an electrical quantity or condition into a visible indication. This is done with the aid of instruments (or meters) that indicate the magnitude of quantities either by

1. the position of a pointer moving over a graduated scale (called an analogue instrument)
2. the form of a decimal number (called a digital instrument).

The digital instrument has become the instrument of choice in recent years. Computer-based instruments are rapidly replacing conventional test equipment. The virtual storage test instrument and digital storage oscilloscopes are the most common used instruments today.

## **Analogue instruments**

All analogue electrical indicating instruments require three essential devices:

1. A deflecting device. A mechanical force is produced by the current or voltage which causes the pointer to deflect from its zero position.
2. A controlling device. The controlling force acts in opposition to the deflecting force and ensures that the deflection shown on the meter is always the same for a given measured quantity.
3. A damping device. The damping force ensures that the pointer comes to rest in its final position quickly and without undue oscillation.

## **Electronic instruments**

Electronic measuring instruments have a much higher input resistance and can handle a much wider range of frequency. The digital voltmeter (DVM) provides a digital display of the voltage being measured. Advantages of a DVM over analogue instruments include:

1. higher accuracy and resolution,
2. no observational or parallex errors
3. and a very high input resistance, constant on all ranges.

### **The ohmmeter**

An ohmmeter is an instrument for measuring electrical resistance. A simple ohmmeter circuit is shown in Figure 1.

Diagram

Description automatically generated

Figure 1

In the ohmmeter the energy necessary for operation is supplied by a self-contained source of voltage, such as a battery. Initially, terminals XX are short-circuited, and R adjusted to give ful scale deviation (f.s.d.) on the milliammeter. If current I is at a maximum value and voltage E is constant, then resistance is at a minimum value. Thus f.s.d. on the milliammeter is made zero on the resistance scale. When terminals XX are open circuited no current flows and is infinity, .

### **Multimeters**

Instruments are manufactured that combine a moving coil meter with a few shunts and series multipliers, to provide a range of readings on a single scale. Such instruments are called multimeters (universal instruments or multirange instruments). A particular range may be selected either using separate terminals or by a selector switch. Only one measurement can be performed at a time. Digital Multimeters (DMM) are now almost universally used, because of their accuracy, resolution, ruggedness, reliability, and safety. These instruments measure DC currents and voltages, resistance and continuity, AC currents and voltages, temperature, and much more.

### **Wattmeters**

A wattmeter is an instrument for measuring electrical power in a circuit. Figure 2 shows typical connections of a wattmeter used for measuring power supplied to a load.

Diagram

Description automatically generated

Figure 2

The instrument has two coils:

1. a current coil, which is connected in series with the load, like an ammeter.
2. a voltage coil, which is connected in parallel with the load, like a voltmeter.

### **The oscilloscope**

The oscilloscope is basically a graph-displaying device. It draws a graph of an electrical signal, showing how signals change over time. From the graph it is possible to:

1. determine the time and voltage values of a signal.
2. calculate the frequency of an oscillating signal.
3. find out how much of a signal is DC or AC.
4. tell how much of the signal is noise and whether the noise is changing with time.

Oscilloscopes are indispensable for anyone designing or repairing electronic equipment. They are available in both analogue and digital types.

1. **Analog oscilloscopes**

An analogue oscilloscope works by directly applying a voltage being measured to an electron beam moving across the oscilloscope screen. The voltage deflects the beam up or down proportionally, tracing the waveform on the screen. This gives a picture of the waveform. Analogue oscilloscopes are often preferred when it is important to display rapidly varying signals in real time.

1. **Digital oscilloscopes**

A digital oscilloscope samples the waveform and uses an analogue to digital converter to convert the voltage being measured into digital information. It then uses this digital information to reconstruct the waveform on the screen. Digital oscilloscopes can process the digital waveform data or send the data to a computer for processing. Also, they can store the digital waveform data for later viewing and printing.