**BASIC ELECTRICITY and ELECTRONICS**

**ASSIGNMENT**

**COSC SECTION-2**

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**Time**

The first experiments with electrical conduction characteristics were conducted by Stephen Gray in the 17th century, which marked the emergence of capacitors. Dutch scientist Pieter van Musschenbroek created the first capacitor in 1745, known as the "Leyden jar." It consisted of a glass container with metal foil linings that developed opposite polarity charges when a high voltage was applied, creating an electric field.

In the 19th century, Michael Faraday introduced the use of a solid dielectric substance in capacitors. His design included two metal plates separated by a mica coating, which served as the dielectric to prevent current flow between the plates. Elihu Thomson later developed the ceramic capacitor, utilizing ceramic as the dielectric material. Ceramic capacitors remain popular and widely used to this day.

The 20th century saw the creation of the electrolytic capacitor by Samuel Ruben. These capacitors found their applications in power supplies, audio equipment, and computers. The construction of capacitors is relatively simple yet crucial. They consist of two conductive plates spaced apart by a dielectric substance. The plates are typically made of metals like tantalum, copper, or aluminum, while the dielectric material can be a solid, liquid, or gas.

**Construction of Capacitors**

Capacitors can be manufactured in various shapes and sizes to suit different applications. For instance, electrolytic capacitors often have a cylindrical shape with two leads for connections. Ceramic capacitors are available in different forms, including disc, chip, and tubular shapes.

During construction, the dielectric material is sandwiched between the conductive plates. The plates and dielectric are carefully selected based on the desired characteristics of the capacitor. The plates are typically chosen for their high surface area to maximize capacitance. Various methods, such as etching, coating, or winding metal foils, can be used to achieve this.

The dielectric material plays a crucial role in the capacitor's performance. It provides insulation between the plates and determines the capacitance and other electrical properties. Common dielectric materials include ceramics (used in ceramic capacitors), plastics (such as polyester and polypropylene capacitors), and electrolytes (found in electrolytic capacitors).

In the case of electrolytic capacitors, the dielectric is formed by a layer of oxide on one of the conductive plates, while a liquid or gel electrolyte fills the space between the plates. The electrolyte enables the flow of current through the capacitor.

Some capacitors are constructed with multiple plates and alternating layers of dielectric material to increase their capacitance. These are known as multilayer capacitors or stacked capacitors.

The capacitance of a capacitor is influenced by the size of the plates, the distance between them, and the dielectric material used. Capacitance increases with larger plate area and decreases with greater plate separation. The choice of dielectric material is significant as it affects the energy storage capacity. Dielectric materials with a high dielectric constant, such as mica, have a larger energy storage capacity, while those with a low dielectric constant, like air, have a lower capacity.

**Application of Capacitors**

Capacitors have a wide range of applications across various electronic devices and circuits. They are versatile components that play a crucial role in enhancing the performance and functionality of modern electronics. Here are some of the most common applications of capacitors:

1. **Energy Storage:** Capacitors can be used as energy storage devices. They are particularly useful in situations where a brief burst of energy is required. For example, in cameras, capacitors are often used to provide a high-energy discharge for the flash, enabling quick and powerful illumination for capturing images in low-light conditions. Similarly, in flash drives and solid-state drives (SSDs), capacitors are employed to ensure data integrity by providing sufficient power during sudden voltage fluctuations or power interruptions, allowing the system to complete write operations and prevent data loss or corruption.
2. **Noise Filtering:** Capacitors are widely used for noise filtering applications. Unwanted electrical noise, interference, or disturbances can degrade the performance of audio and video equipment. Capacitors act as filters by attenuating certain frequencies and passing others, effectively removing unwanted signals and improving the overall signal quality. In audio systems, capacitors are commonly used in crossover networks to separate different frequency ranges and direct them to the appropriate speakers. In video equipment, capacitors are utilized to stabilize and filter the power supply, ensuring a clean and consistent voltage for optimal picture quality.
3. **Circuit Tuning:** Capacitors are essential components for tuning circuits. By selecting capacitors with specific values, circuits can be precisely tuned to operate at desired frequencies or respond to particular signals. This feature is particularly important in radio and television applications, where capacitors are employed in various stages of the circuit to filter out unwanted frequencies and amplify desired ones. Capacitors, in conjunction with inductors and resistors, are key components in electronic filters, such as low-pass, high-pass, band-pass, and notch filters, which are widely used in communication systems to isolate and extract specific frequency ranges.
4. **Power Factor Correction:** Capacitors play a vital role in power factor correction. In AC power systems, the power factor represents the efficiency of energy usage. Capacitors are used to correct the power factor by storing and releasing reactive power to compensate for the lagging or leading currents caused by inductive or capacitive loads, respectively. Power factor correction capacitors are widely employed in industrial and commercial settings to improve power quality, reduce energy losses, and avoid penalties imposed by utilities for poor power factor.
5. **Voltage Regulation and Smoothing:** Capacitors are used for voltage regulation and smoothing in power supplies. They are incorporated into voltage regulator circuits to stabilize voltage levels, suppress voltage spikes, and reduce ripple in DC power sources. By storing and releasing charge, capacitors help maintain a constant voltage output and provide a steady and clean source of power for electronic devices.
6. **Oscillators and Timing Circuits:** Capacitors are utilized in oscillator circuits and timing circuits. In oscillator circuits, capacitors, along with inductors and resistors, determine the frequency of the generated waveform. Timing circuits, on the other hand, utilize capacitors in combination with resistors to control the timing intervals for various applications such as electronic timers, pulse generators, and delay circuits.
7. **Sensors and Measurement Devices:** Capacitors find applications in sensors and measurement devices. They are used in sensor circuits to store charge, modify signal waveforms, and control the sensitivity of the sensor. Capacitors are also utilized in precision measurement devices, such as oscilloscopes and multimeters, to calibrate and stabilize voltage references, ensuring accurate measurements.

In conclusion, capacitors have numerous applications in modern electronics, ranging from energy storage and noise filtering to circuit tuning and power factor correction. Their versatility and ability to store and release electrical energy, along with their capacity to filter signals and tune circuits, make them indispensable components in various industries. As electronic technologies continue to advance, capacitors will remain a crucial element in the design and functionality of innovative electronic devices.