Question: Justify: the current in an inductor and voltage across a capacitor cannot change instantaneously.

Answer:

1. **Inductor Current**:

The fundamental principle governing an inductor is **Faraday's Law of Induction**, which states that the voltage across an inductor is proportional to the rate of change of current through it:

$$V_L = L\frac{di}{dt}$$

Where:

- V_L is the voltage across the inductor.
- L is the inductance.
- dI/dt is the rate of change of current through the inductor.

If the current were to change instantaneously (instantaneous change means slope of di/dt would be infinite), di/dtwould be infinite, resulting in an infinite voltage across the inductor, which is physically impossible. Therefore, the current through an inductor cannot change instantaneously; it must change gradually over time.

2. **Capacitor Voltage**:

A capacitor stores energy in the form of an electric field, and the relationship between the charge Q on a capacitor and the voltage V_C across it is given by:

$Q = C{\cdot}V_C$

where:

- Q is the charge stored in the capacitor.
- C is the capacitance.
- V_c is the voltage across the capacitor.

The current I_C flowing into the capacitor is related to the rate of change of charge:

$$I_C = \frac{dQ}{dt} = C\frac{dV_C}{dt}$$

If the voltage across a capacitor were to change instantaneously, dV_C/dt would be infinite, resulting in an infinite current I_C, which is not feasible in real circuits. Hence, the voltage across a capacitor cannot change instantaneously; it must change gradually as the capacitor charges or discharges.

The inability of the current in an inductor and the voltage across a capacitor to change instantaneously is due to the physical constraints dictated by their governing differential equations.

Instantaneous changes would require infinite voltages or currents, which are impossible in real-world circuits. Therefore, these quantities must change smoothly over time.