**Lecture-17 AC Circuit – I**

1. **Impedance （阻抗）and admittance （导纳） (lumped element 集总元件)**

* 形状

  描述已自动生成**Resistance -**

with or

* **图表, 箱线图

  描述已自动生成Capacitance -**

🡪

🡪

🡪

* 图片包含 图示

  描述已自动生成**Inductance –**

Inside the coil, there’s no -field (🡪0) in metal,

🡪

🡪

Now let’s define **impedance**: with

1. **(electric motive force 电动势)** from non-electrostatic force

Consider a loop, the total force that a charge feels is denoted as

, where is the electric motive force.

Since , if , there must be something beyond electrostatics.

图示, 示意图

描述已自动生成**Case 1: Faraday’s Law**  **(induce ）**

**Case 2: Lorenz force （motion-induce ）**

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since for static field.

On the other hand, inside metal (no resistance)

**Everything is consistent!**

**Case 3: Chemical battery**

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**Inside battery:**  friction

🡪

**(effect of internal resistance)**

图示, 示意图

描述已自动生成Since ,

Here is a constant. Then can be view as internal resistance .

🡪

1. **Kirchhoff’s rule**
2. **Kirchhoff loop condition**: Consider a loop consisting of a generator and a few lumped elements. We assume no magnetic leaking outside the elements.

The integration path is along the dashed lines. 🡪

图示

描述已自动生成Check the loop generator dashed lines

If neglecting internal resistance of the generator:

1. 卡通人物

   中度可信度描述已自动生成**Kirchhoff node condition:** For each node, the total current sum should be zero.

, pay attention to the positive position.

**\*\*\*Example:**

**图示

描述已自动生成**Consider the left loop: 🡪

Right loop:

🡪

Node condition:

🡪

🡪

**Generally speaking, Kirchhoff Law applies when the wave feature of is not prominent.** i.e. if the wave length , where is the circuit size.

For ,

,

, radio frequency

,

, visible light

\*\*\* In addition, we use the approximation of lumped circuit. We have neglected that circuit itself may carry inductance and capacitance, which we call distributed impedance.

**Condition for Kirchhoff’s Rule**

1. Consider the scale of the entire circuit:

Estimate the contribution from RHS, which is with the period.

The RHS can be neglected if , where is a typical voltage drop across an element. Plug in :

🡪 🡪

Here quantum resistance.

fine-structure constant. – SI

🡪

② The charge accumulation on a node is at the order of , which cannot exceed the order of with the effective capacitance of the entire circuit.

Since = 🡪

is negligible, if , where is a typical current.

It means

Since and define

🡪 Kirchhoff’s Law is applicable under the condition:

**Example:**

**\*\*\*For a daily life circuit** (), ,

We have , there should be no problem.

**\*\*\***But if consider a **power system** at , even that , but the typical resistance/impedance: this is an importance constraint.

**\*\*\* For a typical FM radio frequenc**y **circuit** ,

A typical radio size 🡪 .

The application of Kirchhoff’s Law requires