Basic Electrical Engineering (TEE 101)

Lecture 47: Auto-Transformer

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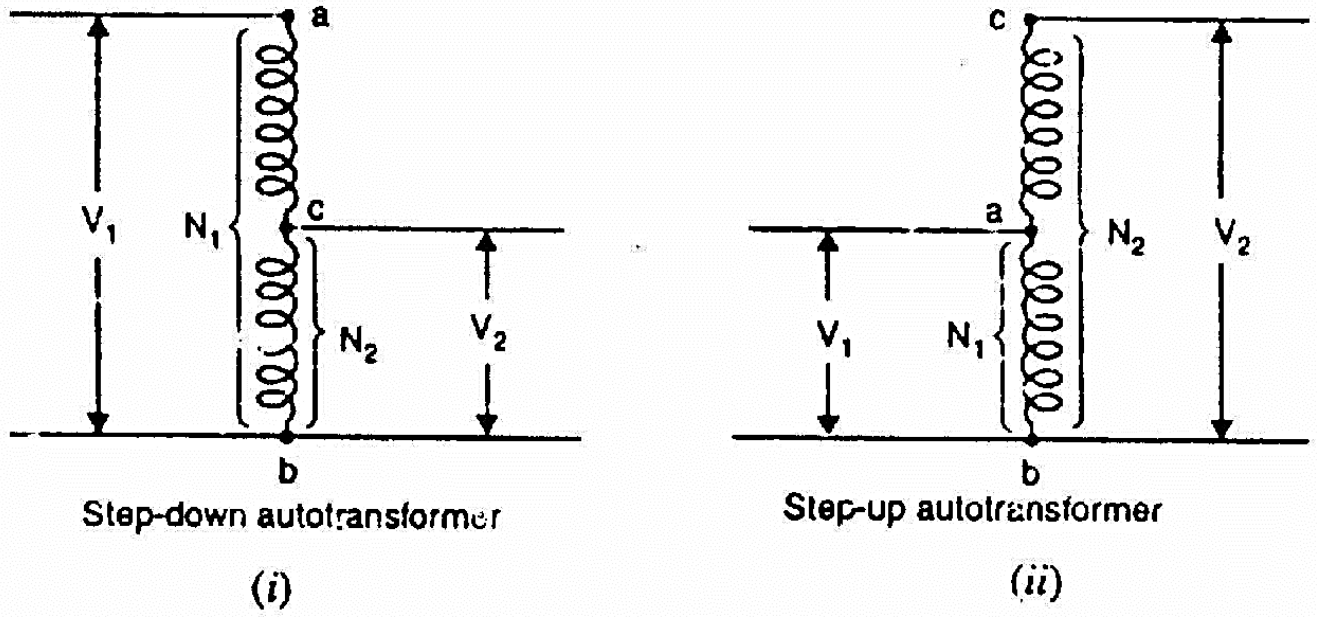
Content

This lecture covers:

- **Introduction to Autotransformer**
- **Theory of Autotransformer**
- **Advantages/Disadvantages of Autotransformer**
- **Applications of Autotransformer**

Auto Transformer

- *A transformer in which part of the winding is common to both the primary and secondary circuits is known as an* **auto-transformer.**



The ***working principle of autotransformer*** and construction is similar to that of conventional two winding transformers.

However, it differs in the way in which the primary and the secondary are inter-related.

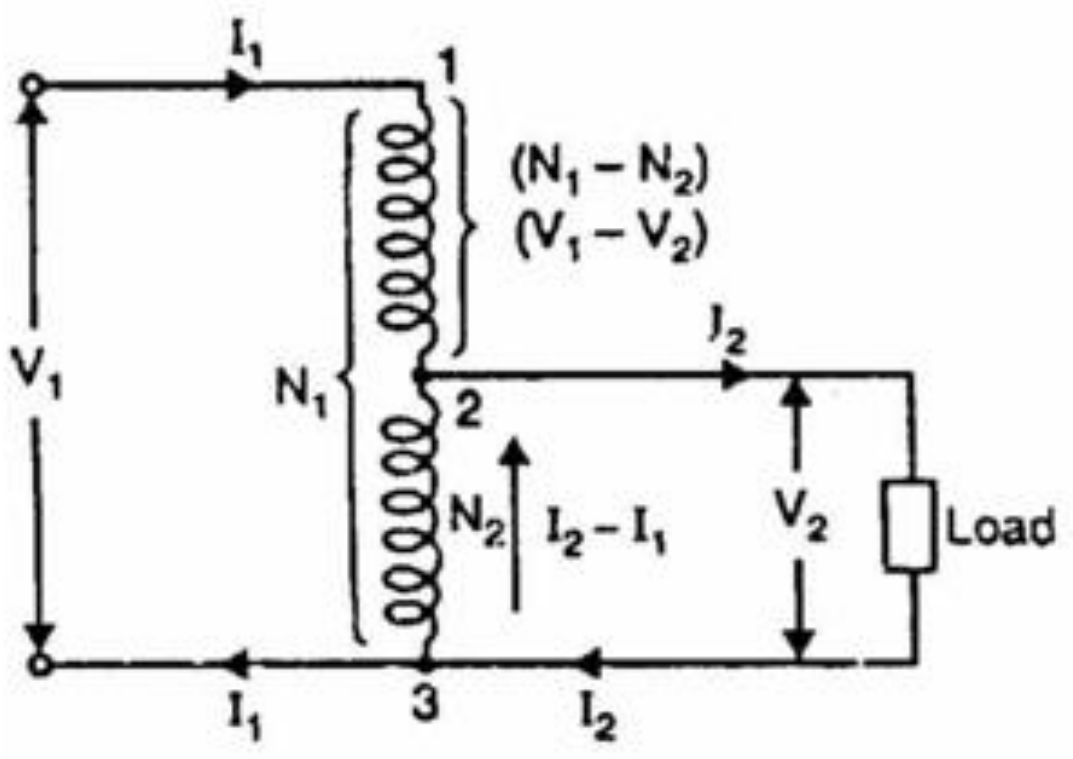
In a two-winding transformer, primary and secondary are only magnetically linked by a common core but are completely insulated from each other.

But in the case of an auto transformer windings are connected electrically as well as magnetically.

The same auto transformer can be used as a step-down or a step-up transformer.

Theory of Autotransformer

- Winding 1-3 - N_1 turns - primary winding
- winding 2-3 - N_2 turns - secondary winding
- Input current is I_1
- Output current is I_2
- Portion 1-2 of the winding has $N_1 - N_2$ turns and voltage across this portion of the winding is $V_1 - V_2$.
- The current through the common portion of the winding is $I_2 - I_1$.



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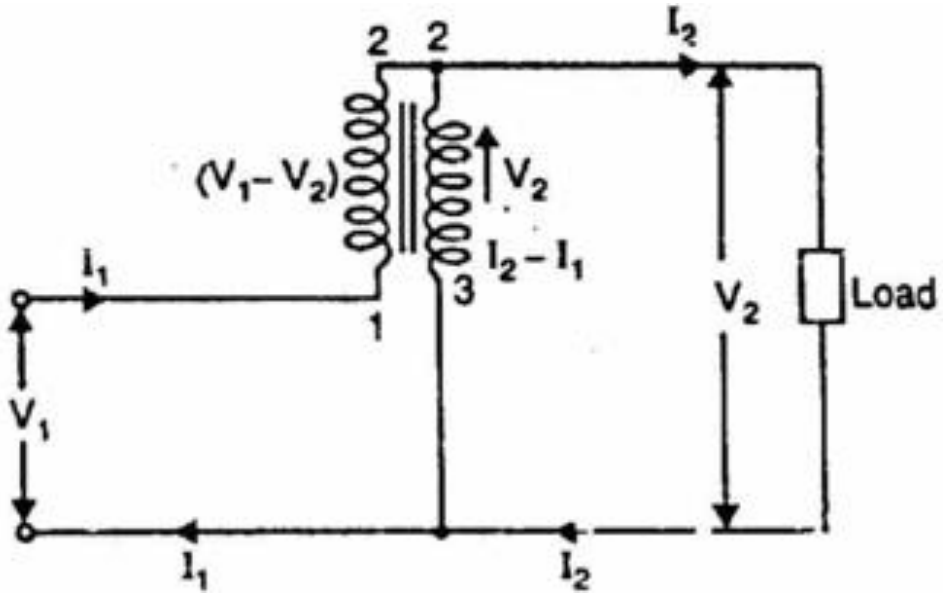
Theory of Autotransformer

The equivalent circuit of the autotransformer.



From this equivalent circuit, we have,

$$\frac{V_1 - V_2}{V_2} = \frac{N_1 - N_2}{N_2}$$

$$(N_1 - N_2)V_2 = (V_1 - V_2)N_2$$

$$V_2N_1 - V_2N_2 = V_1N_2 - V_2N_2$$

$$V_2N_1 = V_1N_2$$

$$\frac{N_2}{N_1} = \frac{V_2}{V_1} = K$$

Output of Autotransformer

Output *apparent* power $= V_2 I_2$

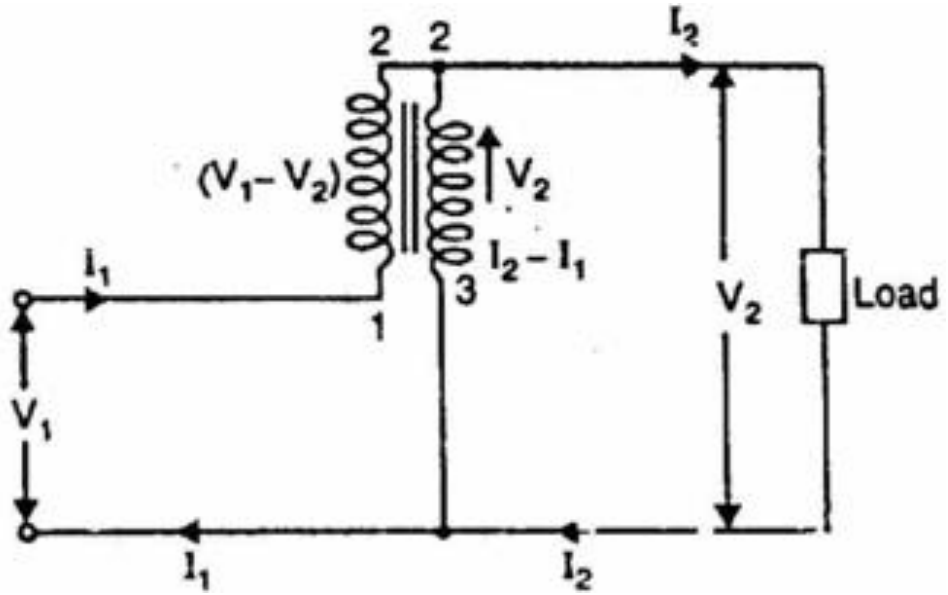
Apparant *power transferred* inductively

$= V_2(I_2 - I_1) = \mathrm{K}.V_1\left(\frac{I_1}{K} - I_1\right)$

$= \mathrm{K}.V_1 I_1\left(\frac{1}{K} - 1\right)$

$= \mathrm{K}.V_1 I_1\left(\frac{1-K}{K}\right) = V_1 I_1(1-K)$

$= Input \times (1-K)$



$$\text{Apparant power transferred conductively} = \text{Input} - \text{Input} \times (1 - K)$$

$$= \text{Input}[1 - (1 - K)] = Input \times K$$

- Suppose the input power to an ideal autotransformer is 1000 W and its voltage transformation ratio K = 0.25. Then,

$$\text{Apparant power transferred inductively} = \text{Input} \times (1 - K)$$
$$= 1000 \times (1 - 0.25) = 750\ W$$

$$\text{Apparant power transferred conductively} = \text{Input} \times K = 1000 \times 0.25$$
$$= 250\ \text{W}$$

Advantages and Disadvantages of Auto Transformer

Advantages: An auto-transformer entails the following *advantages* :

(*i*) Higher efficiency

(*ii*) Small size

(*iii*) Lower cost

(*iv*) Better voltage regulation when compared with a conventional two-winding transformer of the same rating.

Disadvantage:

- The secondary winding is not insulated from the primary winding.
- If an auto transformer is used to supply low voltage from a high voltage and there is a break in the secondary winding, the full primary voltage comes across the secondary terminal which is dangerous to the operator and the equipment. So the auto transformer should not be used for interconnecting high voltage and low voltage systems.
- Used only in the limited places where a slight variation of the output voltage from input voltage is required.

Applications of Auto Transformer

- Used as a starter to give up to **50 to 60%** of full voltage to the stator of a squirrel cage induction motor during starting.
- Used to give a small boost to a distribution cable, to correct the voltage drop.
- Used as a voltage regulator
- Used in power transmission and distribution system and also in the audio system and railways.

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Thank You