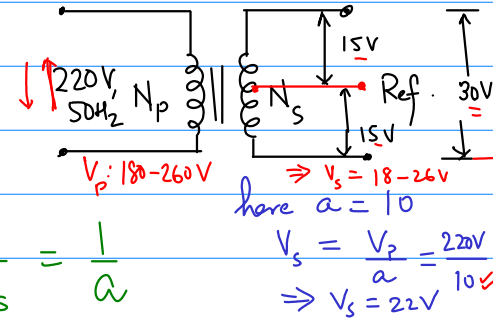


Transformer Taps & Autotransformer

Turn ratio, $a = \frac{N_p}{N_s} = \text{fixed}$



$$\frac{V_p}{V_s} = a \quad ; \quad \frac{I_p}{I_s} = \frac{1}{a}$$

Once, the no. of turns in primary/secondary is fixed.

$a = \text{fixed}$.

So, Tapping of a winding (either primary/secondary) helps in changing the value of turn-ratio 'a'.

... voltage between them. Such an arrangement provides for adjustments up to 5 percent above or below the nominal voltage rating of the transformer.

Example 2-6. A 500-kVA, 13,200/480-V distribution transformer has four 2.5 percent taps on its primary winding. What are the voltage ratios of this transformer at each tap setting?

Solution

The five possible voltage ratings of this transformer are

+5.0% tap	✓ 13,860/480 V	↑ +330	↑ +330
+2.5% tap	13,530/480 V	↑ +330	↑ +330
Nominal rating	13,200/480 V		
-2.5% tap	12,870/480 V	↓ -330	↓ -330
-5.0% tap	12,540/480 V	↓ -330	↓ -330

Diagram of a step-down transformer with a primary winding having five taps (N, -330, -2.5%, -1.25%, 0, +1.25%, +2.5%, +330) and a secondary winding with a 480V output. The diagram is labeled 'step-down transformer'.

$$\begin{aligned} &2.5\% \quad 13,200 \\ &25 \times 13,200 \\ &1000 \\ &330.0 \end{aligned}$$

$$a_N = \frac{13200}{480} = 27.50 \quad \checkmark$$

$$a_+ = \frac{13530}{480} = 28.18 \quad \uparrow$$

$$a_{++} = \frac{13860}{480} = 28.80 \quad \uparrow \uparrow$$

$$a_- = \frac{12,870}{480} = 26.81 \downarrow$$

$$a_{--} = \frac{12,540}{480} = 26.12 \Downarrow$$

- Once the tap is fixed, the turn-ratio is also fixed and one cannot change the tap while the transformer is in operation.
- However, in many applications wherein you require controlled voltage with changing the supply voltage.

For this we use specially designed transformer called Tap changing under load (TCUL) transformer.

— Such transformer (also called voltage regulator) changes its tap automatically whenever there is change in the supply voltage ($\uparrow \downarrow$).

Autotransformer

Whenever change in voltage level is required only by a small amount.

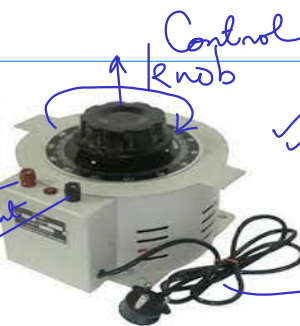
220V
210V

← Gradual
step-down 230V

Gradual step-up.
240V, 245, 250V

0V - 300V

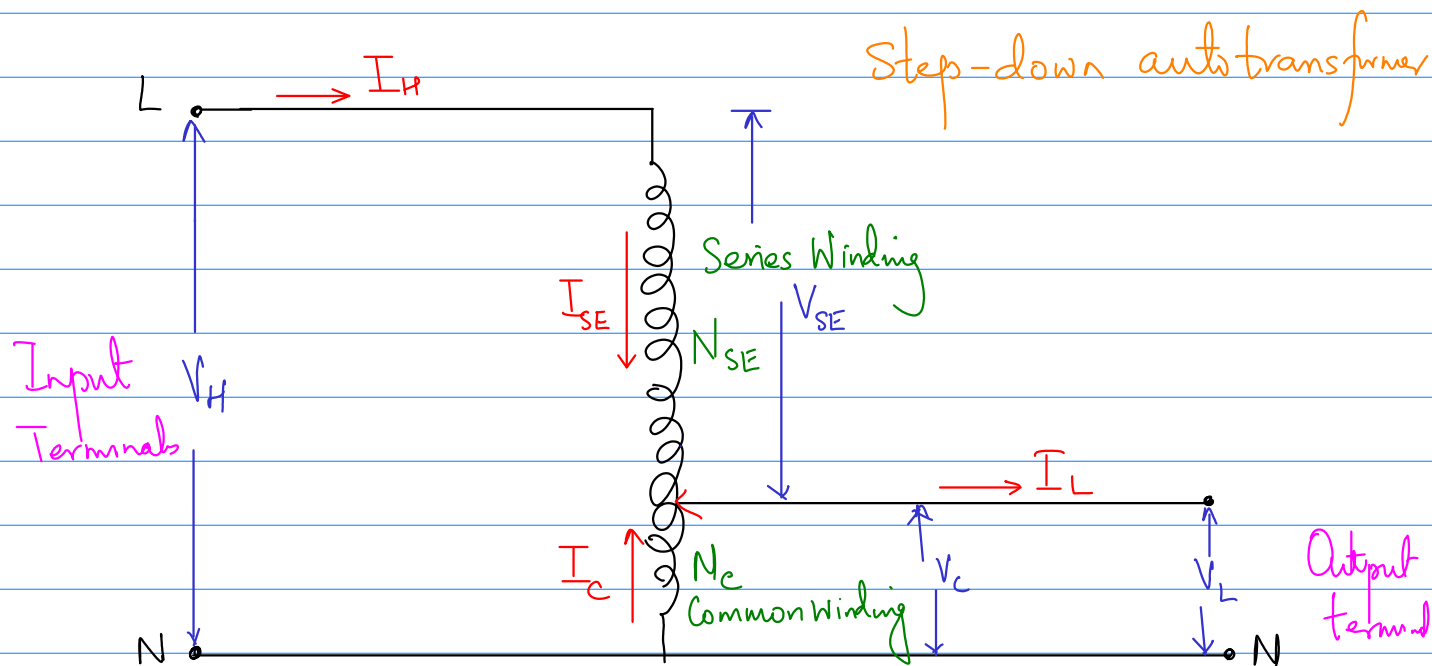
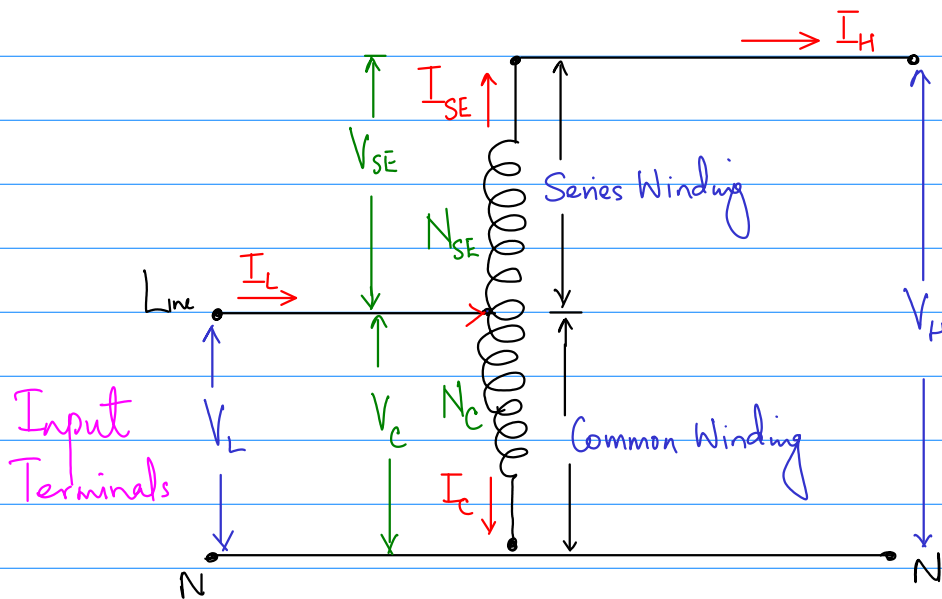
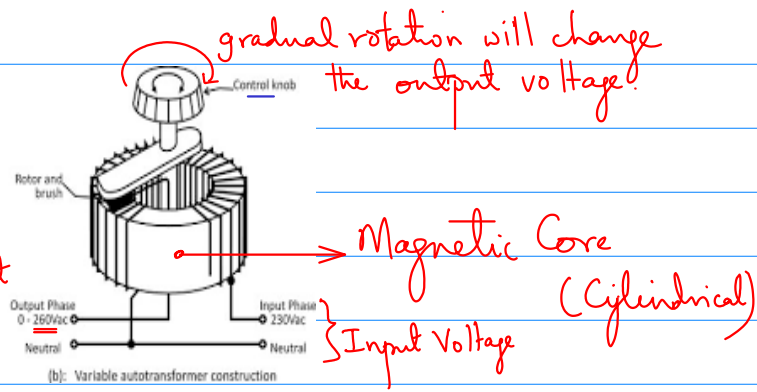
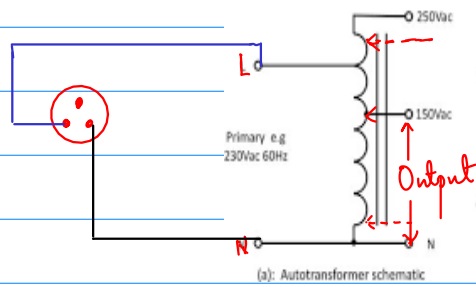
Output
Voltage



Autotransformer

Supply (230V, 50Hz)

Construction:



Important relationships b/w voltages/currents.

1. $\frac{V_C}{V_{SE}} = \frac{N_C}{N_{SE}} = \underline{\text{variable}}$ (depends upon the position of the control knob)

2. $N_C I_C = N_{SE} I_{SE} \Rightarrow \frac{I_C}{I_{SE}} = \frac{N_{SE}}{N_C} = \underline{\underline{\text{variable}}}$

3. Low-voltage terminal : $V_L = V_C$

4. High-voltage terminal : $V_H = V_C + V_{SE}$

5. $I_H = I_{SE}$

6. $I_L = I_C + I_{SE}$

Reference: Section 2.9
