Unit 7 - Week 6

Week 6: Assignment

1) A 440/220V transformer rated 100kVA is reconnected as an auto-transformer with voltage ratio of 660/220V. What will be the power rating of the reconnected transformer? ***10 points***

- 100kVA
- 150kVA
- 66.67kVA
- 33.33kVA

Accepted Answers:
150kVA

2) A 110/440V transformer is reconnected as an auto-transformer having voltage ratio 110/550V and loaded with 500kW at unity power factor on the secondary side. What are the line currents? ***10 points***

- Primary Line current = 4545.45A, Secondary Line current = 1136.36A
- Primary Line current = 4545.45A, Secondary Line current = 3636.36A
- Primary Line current = 4545.45A, Secondary Line current = 909.09A
- Primary Line current = 3636.36A, Secondary Line current = 4545.45A

Accepted Answers:
Primary Line current = 4545.45A, Secondary Line current = 909.09A

3) A 15kVA, 400V/200 V, 50 Hz single phase ideal two winding transformer is used to step up a voltage of 400V to 600V by connecting it like an auto transformer. Calculate the maximum kVA that can be handled by the autotransformer without over loading any of the HV and LV coil? ***10 points***

- 30kVA
- 45kVA
- 15kVA
- 30kVA

Accepted Answers:
45kVA

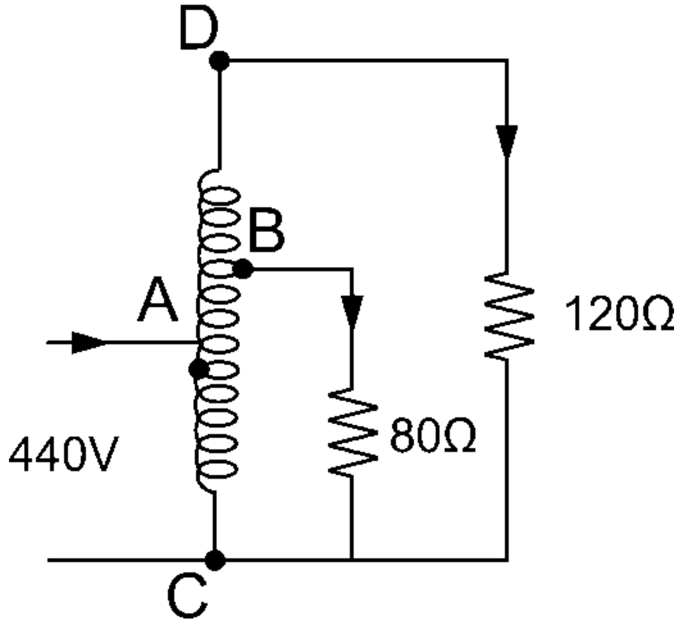
Week 12

4) For the auto-transformer formed in problem -3, how much of the kVA is transferred by electrical conduction when it is operating at maximum kVA without overloading any coils? **10 points**

- 30kVA
- 15kVA
- 45kVA
- 20kVA

Accepted Answers:
30kVA

5) An autotransformer has a coil with total number of turns N_{CD} = 400 between terminals C and D. It has got one tapping at A such that N_{AC} = 200 and another tapping at B such that N_{BA} = 80. Across AC a 440V supply is connected. Two resistive loads of 80Ω and 120Ω are connected across BC and DC respectively. What is the current through 80Ω load? **10 points**



- 5.5A
- 6.8A
- 7.7A
- 8.4A

Accepted Answers:
7.7A

6) Two single-phase loads are connected to 200V two phase supply formed by Scott connected transformers from a 4400V, 3-phase mains. Calculate the current in each line of the 3-phase mains if each load draws 240kW at 0.8 power factor. Neglect losses in the transformers. **10 points**

- 78.72A, 118.08A, 39.36A
- 78.72A, 78.72A, 78.72A, A
- 68.175A, 68.175A, 68.175A
- 118.08A, 118.08A, 118.08A

Accepted Answers:
78.72A, 78.72A, 78.72A, A

7) Two single-phase loads are connected to a 200V two phase supply formed by Scott connected transformers from a 4400V 3-phase mains. Calculate the current in each line of the 3-phase mains if one load takes 300kW at 0.707(lag) pf and the other one 360kW at 0.8(lag). Neglect losses in the transformers. ***10 points***

- 112.5A, 109.5A, 123.5A
- 102.26A, 112.5A, 123.5A
- 102.26A, 109.5A, 54.75A
- 112.5A, 118.6A, 120A

Accepted Answers:
112.5A, 109.5A, 123.5A

8) A potential transformer rated 2000/120 V and a current transformer rated 80/4A are used to measure the voltage and current in a transmission line. If the voltmeter indicates 108 V and the ammeter indicates 1.5 A. Calculate the voltage and current in the line. ***10 points***

- 180V and 30A
- 1800V and 3A
- 1800V and 30A
- 1800 and 300A

Accepted Answers:
1800V and 30A

9) Which of the following transformers cannot be operated with their secondary open circuited? ***10 points***

- Potential Transformer
- Current Transformer
- Pulse Trasnformer
- All of the above

Accepted Answers:
Current Transformer

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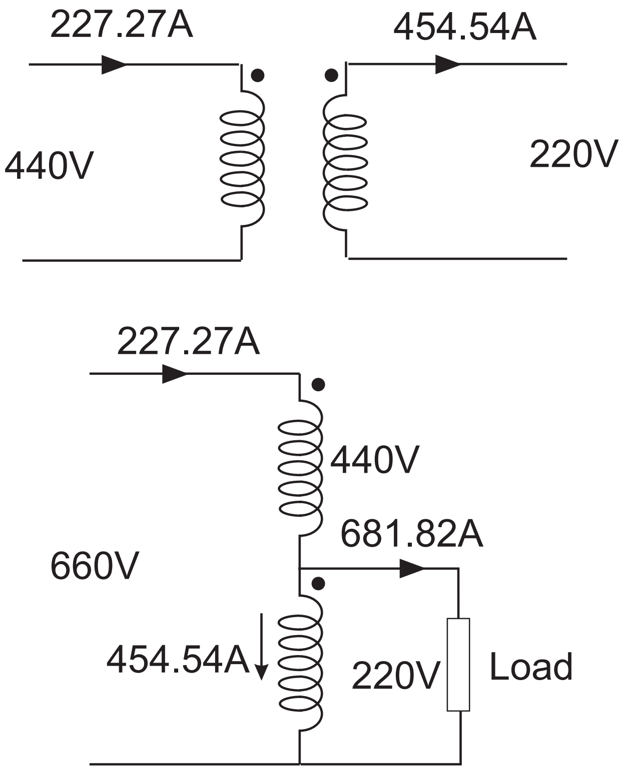
Q1.Solution



Q2.Solution

$$\text{Secondary line current} = \frac{500k}{550} = \mathbf{909.09A}$$
$$\text{Primary line current} = \frac{500k}{110} = \mathbf{4545.45A}$$

Q3.Solution

The transformer has to step up the voltage from 400V to 600V. Hence, the input must be connected to the HV side of the transformer. Then, the induced voltage in the LV side would be 200V. In order to get 600V at the output, the two windings should be connected in additive series. The connection is shown in

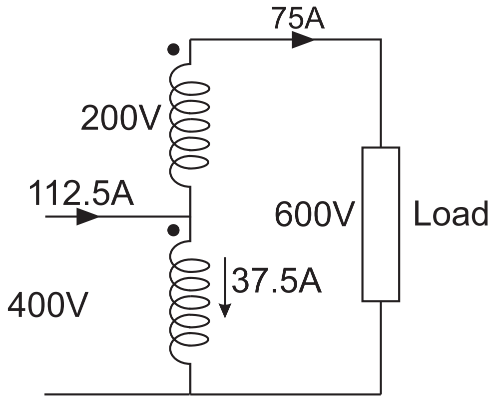


Figure 1:

Fig.1.

$$\text{Now, the rated current of HV side coil} = \frac{15,000}{400} = 37.5A$$
$$\text{The rated current of LV side coil} = \frac{15,000}{200} = 75A$$

Since, the load is in series with the LV side coils, the current drawn by the load should be limited to 75A, in order to avoid overloading of the transformer coils.
Hence, the maximum kVA that can be handled by the transformer without over loading any of the HV and LV side coils is = $600 \times 75 =$ **45kVA**

Q4.Solution

For the transformer in problem.3,

$$\text{The current through the LV coils, when delivering maximum kVA} = 75A$$

$$\text{Current drawn from the supply, when delivering maximum kVA} = \frac{45,000}{400} = 112.5A$$

$$\text{Hence,the current through the HV coils, when delivering maximum kVA } = 112.5 - 75 = 37.5A$$

The relative direction of current in HV and LV side coil currents are shown in Fig.1. The direction of currents are such that, the mmf is balanced in the magnetic circuit always.

$$\text{kVA transferred magnetically} = \text{kVA handled by any of HV or LV side coils}$$

$$= 400 \times 37.5 = 200 \times 75 = \textbf{15kVA}$$

$$\text{kVA transferred electrically} = \text{Total kVA - kVA transferred magnetically}$$

$$= 45kVA - 15kVA = \textbf{30kVA}$$

Q5.Solution

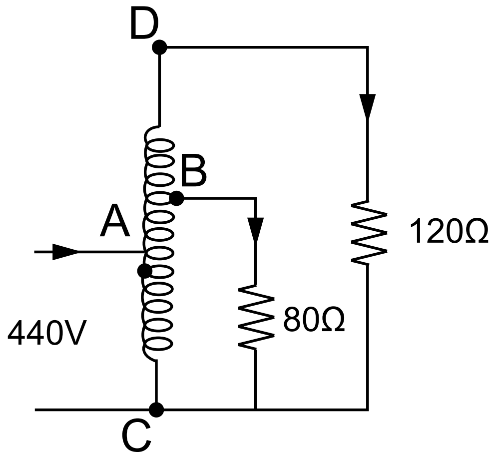


Figure 2:

$$\text{Supply voltage across AC,} \quad V_{AC} = 440V$$

$$\text{Number of turns between A and C,} \quad N_{AC} = 200$$

$$\text{Voltage per turn =} \quad \frac{440}{200} = 2.2V$$

Since, voltage per turn in a transformer remains constant

$$\text{Voltage across } 80\Omega \text{ load =} \quad N_{BC} \times 2.2 = (200 + 80) \times 2.2 = 616V$$

$$\text{Hence, current through } 80\Omega \text{ load =} \quad \frac{616}{80} = \mathbf{7.7A}$$

Q6.Solution

$$\text{Main transformer turns ratio, a =} \quad \frac{200}{4400} = 0.04545$$

$$\text{The secondary side current,} \quad I_2 = \frac{240,000}{200 \times 0.8} = 1500A$$

Both the loads are same, hence, both the load currents are same.

Since, the two phase loads are balanced, the three phase side is also balanced.

$$\text{The primary side current,} \quad I_1 = \frac{2a}{\sqrt{3}} \times I_2 = 78.72A$$

Since, the phase current at the primary side is equal to the line current,

The line current = **78.72A**

Q7.Solution

$$\frac{N2}{N_1} = \frac{200}{4400} = .04545$$

$$\frac{2N_2}{\sqrt{3}N_1} = .053$$

Load currents are,

$$I_a = \frac{300,000}{200 \times 0.707} = 2121.64A; \quad 45^o \text{ lagging}$$

$$I_b = \frac{360,000}{200 \times 0.8} = 2250A; \quad 36.86^o\text{lagging}$$

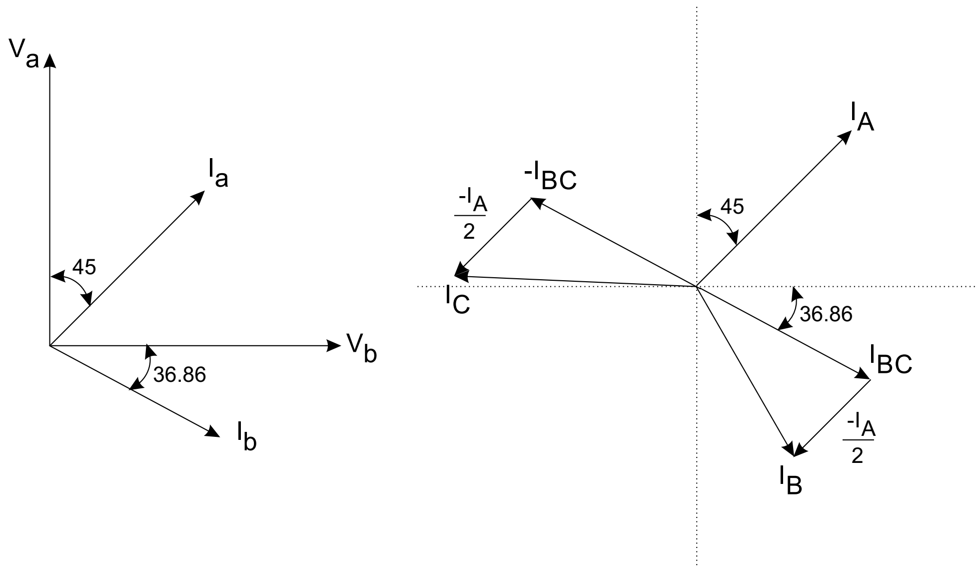


Figure 3:

The phase currents at the 3-phase side are

$$I_A = 2121.64 \times 0.053 = 112.446A$$

$$I_{BC} = 2250 \times 0.04545 = 102.2625$$

From Fig.3, the line currents are given by

$$I_A = \mathbf{112.446\angle - 45}$$

$$I_B = 102.2625\angle - (90 + 36.86) - (0.5 \times 112.446)\angle - 45 = \mathbf{109.5\angle - 157.40}$$

$$I_C = 102.2625\angle(53.14) - (0.5 \times 112.446)\angle - 45 = \mathbf{123.478\angle 79.93}$$

Q8.Solution

The voltage on the line is

$$V = 108 \times \left(\frac{2000}{120}\right) = \mathbf{1800V}$$

The current in the line is

$$I = 1.5 \times \left(\frac{80}{4}\right) = \mathbf{30A}$$

Q9.Solution

Current transformer (CT) cannot be operated with the secondary open. This is because whenever a current is flowing in the primary of the CT, and if there is no current in the secondary MMF balance will not take place. Also this huge current will effectively saturate the core as there is no current in the secondary to counter the flux. Hence the secondary voltage will rise drastically. This can cause damage of insulation or electric shock.

Q10.Solution

$$\text{Turn ratio error} = \frac{|\text{Excitation current}|}{|\text{Actual current in the primary winding}|} \times 100$$

$$\text{Excitation Current} = (15 - 20j) \text{ A} = 25\angle - 53.13 \text{ A}$$

$$|\text{Excitation current}| = 25 \text{ A}$$

$$\text{Actual current in the primary winding} = \text{Current in primary winding - Excitation current}$$

$$= 600 - (15 - 20j) = 585.34\angle 1.96 \text{ A}$$

$$|\text{Actual current in the primary winding}| = 585.34 \text{ A}$$

$$\therefore \text{Current in secondary winding} = \frac{585.34}{300} = 1.95A$$

$$\therefore \text{Actual turns ratio} = 1.95/600 = 3.252 \times 10^{-3}$$

$$\text{Nominal turns ratio} = 1/300 = 3.33 \times 10^{-3}$$

$$\text{Turn ratio error} = \frac{\text{Nominal Turns ratio-Actual turns ratio}}{\text{Actual turns ratio}}$$

$$\frac{3.33 \times 10^{-3} - 3.252 \times 10^{-3}}{3.252 \times 10^{-3}} \times 100 = \mathbf{2.4\ \%}$$