QUIZ – ANSWER KEY

QUIZ NO: 94

TOPIC: ELECTRICAL ENGINEERING

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1. The essential condition for parallel operation of two single-phase transformer is that they should have the same ?

   [A] KVA Rating

   [B] Turn Ratio

   [C] Polarity

   [D] All of the above

   Answer: D

   Explanation:-

   Parallel operation of transformers

   There are a number of requirements that must be satisfied before two or more single-phase transformers can be 'paralleled -i.e. before they can be connected in parallel with each other, in order to supply the same load. These requirements are

   1. Same voltage ratio (turns ratio)
   2. Similar percentage impedance
   3. Similar kVA rating
   4. Same polarity

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Same voltage ratio:- If two single-phase transformers with different voltage ratios (or turns ratios) are connected in parallel across a common primary voltage, then their secondary voltages will obviously be different. Under 'no-load' conditions (i.e. with no load connected), this will result in a circulating current between the loop formed by the two secondary windings. As the impedance of a transformer's windings is low, this circulating current can be quite high, resulting in unnecessarily high I^2R losses.

Similar percentage impedance:- A transformer's percentage impedance can be determined by short-circuiting the secondary winding with an ammeter, and gradually increasing the primary voltage until rated current flows in the secondary. The percentage impedance is then simply the ratio of that particular primary voltage to the rated primary voltage, expressed as a percentage.

So, for example, if a particular transformer has a percentage impedance of, say, '5%', then it would take just 5% of the rated primary voltage to cause 100% of the rated secondary current to flow through the short-circuited secondary winding.

For unequal ratings, the numerical (ohmic) values of their impedances should be in inverse proportion to their ratings to have current in them in line with their ratings. A difference in the ratio of the reactance value to the resistance value of the per-unit impedance results in a different phase angle of the currents carried by the two paralleled transformers; one transformer will be working with a higher power factor and the other with a lower power factor than that of the combined output. Hence, the real power will not be proportionally shared by the transformers.

Similar kVA rating:- Transformers with different kVA ratings will share the load more-or-less in proportion to those ratings (i.e. with each transformer carrying roughly its own share of the load), providing their voltage ratios are identical and their percentage impedances are close. However, it is generally recommended that the kVA-rating of any two transformers should never differ by more than a ratio of 2:1.

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Same Polarity:- The 'polarity' of a transformer describes the instantaneous direction of the potential difference induced across the secondary terminals of that transformer, relative to that across the primary terminals.

The transformers should have the same polarity: The transformers should be properly connected with regard to their polarity. If they are connected within correct polarities then the two EMFs, induced in the secondary windings that are in parallel, will act together in the local secondary circuit and produce a dead short circuit.

2. A transformer has negative voltage regulation when its load power factor is ?

[A] Lagging

[B] Leading

[C] Unity

[D] Any of the above

Answer: B

Explanation:-

Voltage regulation is the change in secondary terminal voltage from no load to full load at a specific power factor of load and the change is expressed in percentage.

E2 = no-load secondary voltage

V2 = full load secondary voltage

Voltage regulation for the transformer is given by the ratio of change in secondary terminal voltage from no load to full load to no load secondary voltage.

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Voltage regulation = E2–V2E2

It can also be expressed as,

Regulation = I2R02cosφ2±I2X02sinφ2E2

Regulation depends on the leakage impedance of the transformer and on the power factor of the load.

- At leading power factors, regulation is usually negative; that is, the voltage at the secondary terminals of a transformer is larger at full load than it is when the load is disconnected.
- In such cases, the equipment connected to a transformer's secondary may be subjected to higher than rated voltages.
- This may occur when the power-factor-correction capacitor banks remain on the network while the plant operates at a reduced load.
- Also, note that for the leading power factor, if the magnitude of the phase angle ϕ is high, the magnitude of I2X02sinφ may become greater than that of I2R02cosφ2. The regulation then becomes negative.

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3. The main purpose of performing short circuit test in a transformer is to measure it's ___________

[A] Copper loss

[B] Core loss

[C] Insulation Resistance

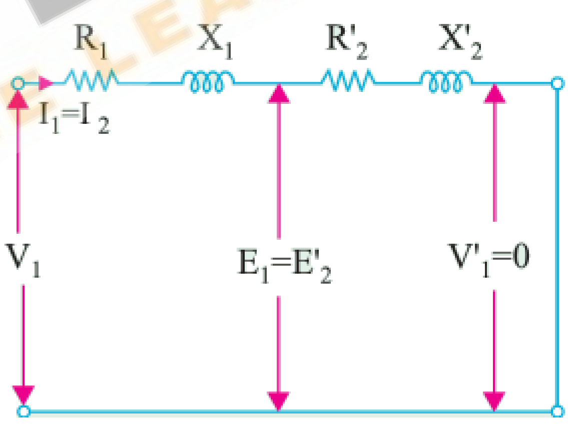
[D] Total loss

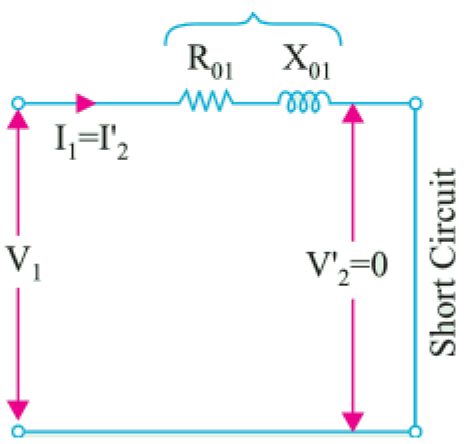
Answer: A

Explanation:-

Short circuit or Impedance test

Short circuit test or Impedance test is performed to determine
⇒ Copper loss at full load
⇒ Equivalent impedance (Z_{o1} or Z_{o2})
⇒ Leakage reactance (X_{o1} or X_{o2})





- The figure shows the circuit diagram for conducting the short-circuit test on a transformer. One of the windings of the transformer is

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short-circuited through an ammeter, while a low voltage is applied to the other winding.

- The applied voltage is slowly increased until full load current flows in this winding. The full load current will then flow in the other winding also.
- Normally the applied voltage is hardly 5 to 7 percent of the rated voltage of this winding. As such the flux established in the core will be quite small and so the iron losses occurring under this condition is negligible.
- Thus, the reading indicated by the wattmeter connected in the circuit gives the full load copper losses of the transformer.

4. Which winding in a transformer has more number of turns?

[A] Secondary winding

[B] primary winding

[C] High voltage winding

[D] Low voltage winding

Answer: C

Explanation:-

- The number of turns on the primary and secondary windings depends upon their respective voltages.
- **A high-voltage winding has far more turns than a low-voltage winding.**
- On the other hand, the current in a high-voltage winding is much smaller, enabling us to use a smaller size conductor.
- The result is that the amount of copper in the primary and secondary windings is about the same.
- If a transformer has more turns in the secondary winding than in the primary winding, the secondary voltage is higher than the primary voltage and it is a step-up transformer.

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- If a transformer has more turns in the primary winding than in the secondary winding, the primary voltage is higher than the secondary voltage. This means that the voltage has been decreased, or "stepped down."

5. The friction loss in a transformer is ?

   [A] 20%

   [B] 0%

   [C] 50%

   [D] more than 50%

   Answer: B

   Explanation:-

The transformer is a static device that is used to transfer electric power from one circuit to another without changing its frequency. The main function of a transformer is to raise as lower the voltage in a circuit with a corresponding decrease or increase in current at the same frequency. It works on the principle of Faraday's law of Electromagnetic induction. Transformers have no moving parts, rugged and durable in construction.

Since operation does not involve rotation of any armature, field system, or commutator, rotational, friction loss. and windage losses do not occur and its efficiency is thus high.

For electrical 'power' purposes, i.e. transformers operating at 50 or 60 Hz, iron cores are essential and iron losses will occur. Winding copper losses are also present when current is supplied, nonetheless, the transformer is the most efficient of electrical machines and has a full-load efficiency of 95.5% for units of 5 kVA and 97.5% for units up to 1 MVA may be achieved.

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6. In an auto transformer, the primary and secondary are______coupled power of ?

[A] Electrically only

[B] Magnetically only

[C] Both electrically & magnetically

[D] None of the above

Answer: C

Explanation:-

An autotransformer is a type of transformer that uses a single tapped winding rather than the two separate and electrically isolated windings used by mutual transformers. Because autotransformers don't have separate windings, unlike mutual transformers there is no electrical isolation between the primary and secondary circuits.

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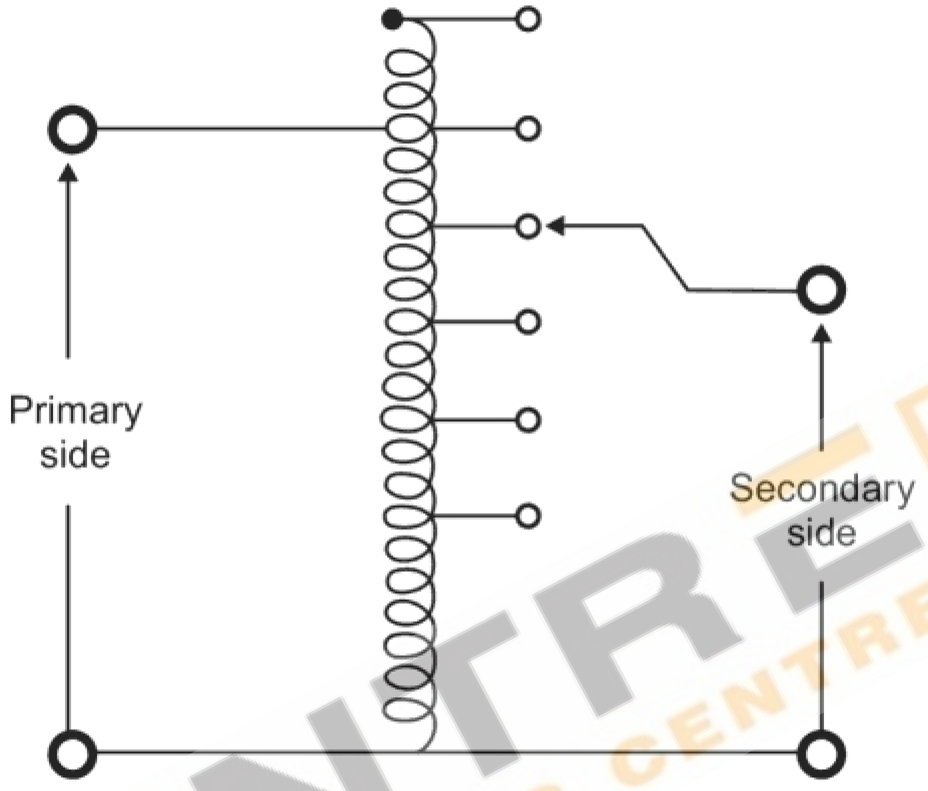

- **Therefore the primary is electrically connected to the secondary, as well as magnetically coupled to it.**
- The alternating current applied between the input points will induce a flow of magnetic flux around the core.
- This magnetic flux will link with all the turns forming the coil, inducing a voltage into each turn of the winding.
- Since the volts-per-turn is the same in both windings, each develops a voltage in proportion to its number of turns.
- In an autotransformer, part of the current flows directly from the input to the output, and only that part is transferred.

Where electrical isolation between the primary and secondary windings is unimportant, the use of an autotransformer has a number of advantages over a mutual transformer.

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- With only one winding, the volume of copper required in its manufacture can be lower than for a mutual transformer.
- There are no secondary copper losses, so autotransformers are more efficient than a corresponding mutual transformer.

7. The size of the transformer core mainly depends on ___________?

   [A] Frequency

   [B] Area of core

   [C] Flux density of core

   [D] Both frequency and area of core

Answer: D

Explanation:-

From emf equation of transformer;

E=4.44fNAB

Where;
E= Voltage
f= frequency
A= Area of the core
N= number of turns
B =magnetic flux density

In general, we can say;

A = E/(4.44fNB)

- For the constant value of E, N, B if we increase F, then the Area of the core will decrease means the size of the transformer will reduce.

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- The Frequency is inversely proportional to the A-area of the Transformer. As the Frequency is High, the Size and Weight of the Transformer of the same power Rating can be reduced.
- Higher frequency implies faster MMF variations with time hence higher emf is inducted on coils, then for same voltage lower core area is needed or lower number of turns, in any case, lower volume.

The flux is proportional to the ratio of voltage/frequency. The higher the frequency lower is the flux in the transformer and vice versa. So, at higher frequencies the operating flux in the transformer core is low. That means there is no point in using a lot of magnetic material in the core to handle that flux which reduces the size of a transformer.

But if we operate a transformer at low frequencies the build has to be a big one. Large flux would need a larger core thus increasing the size of a transformer.

8. A single-phase 100 kVA, 1000 V / 100 V, 50 Hz transformer has a voltage drop of 5% across its series impedance at full load. Of this, 3% is due to resistance. The percentage regulation of the transformer at full load with 0.8 lagging power factor is ?

   [A] 4.8
   [B] 6.8
   [C] 8.8
   [D] 10.8

Answer: A

Explanation:-

Given that,

Voltage drop across series impedance (% Z) = 5%

Voltage drop due to resistance (% R) = 3%

Power factor = 0.8 lagging

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We know that,

$X=(5)2-(3)2 = 4\%$

Voltage regulation = $\%R \cos \varphi \pm \%X \sin \varphi$

+ve is for lagging loads

-ve is for leading loads

Voltage regulation = $(3)\ (0.8) + (4)\ (0.6) = 4.8\%$

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9. A 2 kVA transformer has an iron loss of 150 W and a full load copper loss of 250 W. The maximum efficiency of the transformer will occur when the total loss is ?
    - [A] 500 W
    - [B] 400 W
    - [C] 300 W
    - [D] 275 W

    Answer: C

    Explanation:-

    The efficiency of a transformer will be maximum when copper losses are equal to iron losses. Iron losses include both hysteresis and eddy current losses.

    Copper losses = 250 W

    Iron losses = 150 W

    At maximum efficiency, copper losses = 150 W

    Total losses = 150 + 150 = 300 W

10. In a transformer, the core loss is found to be 46 W at 50 Hz and is 80 W at 70 Hz, both losses being measured at the same peak flux density. The hysteresis loss and eddy current loss at 60 Hz is ?
    - [A] 11 W, 20 W
    - [B] 30 W, 45 W
    - [C] 16 W, 30 W
    - [D] 22 W, 40 W

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Answer: D

Explanation:-

Core loss = Eddy current loss + Hysteresis loss

$= K_e f^2 + K_c f$

At 50 Hz, Pc = 46 watt

$46 = K_e (50)^2 + K_h \times 50$……… 1

At 70 Hz, Pc = 80 watt

$70 = K_e (70)^2 + K_h \times 70$…………. 2

From equation (1) and (2),

Ke = 0.0111

Kh = 0.363

Now at 60 Hz,

$P_e = K_e \times 60^2$

$= 0.0111 \times 3600 = 39.96 \cong 40$ Watt

$P_h = 0.36306 \times 60$

$= 21.78 \cong 22$ Watt

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