Transformers Assignment

Transformers use both Oersted's Principle and Faraday's Principle. Refresh yourself on these two principles.

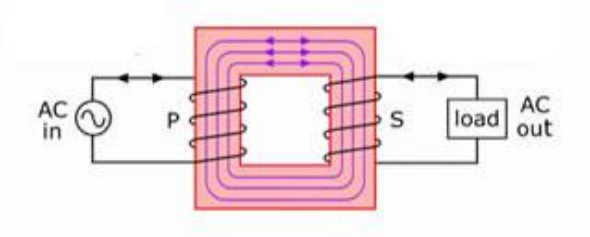
Oersted's Principle:

Faraday's Principle:

RECALL

Oersted's principle and Faraday's principle complement each other. Using an electric AC current in the primary coil creates a magnetic field in the coil (Oersted's Principle) and the changing magnetic field in the electromagnet induces current flow (Faraday's Principle) in the secondary coil. The current and voltage produced in the secondary coil is related to the number of turns, N, on the primary and secondary sides (N_p and N_s).

Power dissipated on both sides must be identical we find the relationship for transformers to be:



Transformer Equation:

$$\frac{V_p}{V_s} = \frac{I_s}{I_p} = \frac{N_p}{N_s}$$

Power: $P = VI = I^2R$

Step-Up Transformers

1. What happens to V_s if $N_s > N_p$? What happens to I_s in this situation?

Step-Down Transformers

2. What happens to V_s if $N_s < N_p$? What happens to I_s in this situation?

THINKING

3. Why is it that when the voltage is increased the current decreases? And vice-versa? Think about the power on both sides. Explain in terms of energy conservation as well.

PROBLEMS

1. A transformer has a primary voltage of 20 V. The number of turns of wire on the primary coil is 300 and there are 2000 turns on the second coil. What is the secondary voltage? Is this a step-up or step-down transformer?
2. A transformer is intended to plug into a standard 120 V outlet and provide power for a 4 V cell phone charger. If the primary coil has 1200 turns, how many turns are required on the secondary side of the transformer? Is this an example of a step-up or step-down transformer?
3. A 12 V AC source is converted to 120 V AC. What is the turns ratio for this transformer. If the converter is used to run an stereo at 120 V consuming 60 W, what is the primary current?
4. A transformer has 200 turns on its primary side and 800 turns on its secondary side. The transformer is used to power an electric motor that requires 3 A at 650 V. What is the potential difference and current on the primary side of the transformer?
5. A step-up transformer with 100 primary turns and 400 secondary turns is used to create a current of 3 A at a voltage of 15 V. Find
   a) The turns ratio
   b) the primary current and voltage
   c) the power delivered to the primary and secondary side
   d) the resistance of the load on the output side.
6. A step-down transformer has 800 turns on its primary side and 20 turns on its secondary side. It was found that the voltage across the primary side is 500 V. It was also measured that the current across the secondary side was 4 A. Calculate the voltage across the secondary side, the current in the primary side and the power dissipated in this transformer.

MAKING CONNECTIONS

Electricity is transmitted to your home in a number of steps. There are six stages (and 4 transformers): generating station, transmission lines, transformer station, substation, pole (neighbourhood transformer), home. Electricity is generated at the station at 24kV and then transformed to 500 kV in the transmission lines, the voltage is then dropped to 44 kV at the transformer station, the down to 4.0 kV at the substation and then down to 240 V at the neighbourhood transformer for use in you your home.

a) What type of transformer (step-up or step-down) is used in each voltage step? Calculate the turns ratio for each of the 4 transformers.

b) Why is it necessary to transmit the electricity at 500kV (high-voltage)? Think back to the power equation $P = VI = I^2R$.