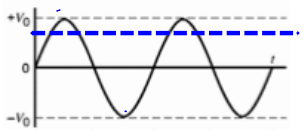
The output of an AC generator is an emf that varies sinusoidally with time.

V_0 = peak/max voltage I_0 = peak/max current

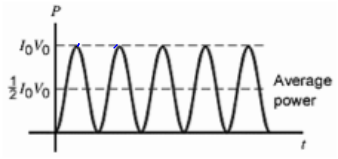


$V = V_0 \sin(\omega t)$

$I = I_0 \sin(\omega t)$

$\omega = 2\pi f$

The power output of an AC generator



$P = IV$

$P = I_0 \sin(\omega t) V_0 \sin(\omega t)$

$P = I_0 V_0 \sin^2(\omega t)$

Maximum Power

$P_{max} = I_0 V_0$

Average Power

$P_{avg} = \frac{1}{2} P_{max}$

$= \frac{1}{2} I_0 V_0$

$= I_0/\sqrt{2} \cdot V_0/\sqrt{2}$

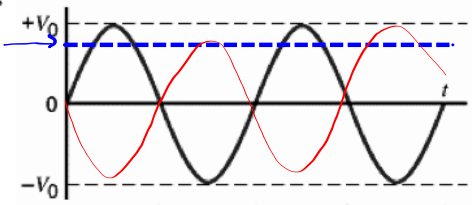
RMS Values

$I_{rms} = I_0/\sqrt{2}$

$V_{rms} = V_0/\sqrt{2}$

Root-Mean-Squared values (RMS): The rms value of an alternating current (or voltage) is that value of the direct current (or voltage) that dissipates power in a resistor at the same rate.

1. In the USA, most household voltage is stated as "120 V at 60 Hz." This is the root-mean-square voltage and the frequency of the AC voltage. Calculate the maximum voltage and mark V_o, V_{rms}, on the graph. 120



$V_0 = V_{rms} \cdot \sqrt{2}$

$= 170V$

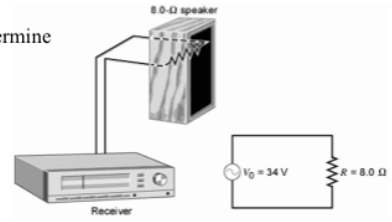
2. In Europe, the "mains electricity" is rated at 230 V. What is the peak household voltage in Europe?

Rating:

rms values are given as the AC values to be used in calculations, as if they were DC values

Formula: $R = \frac{V_0}{I_0} = \frac{V_{rms}}{I_{rms}}$

1. A stereo receiver applies an AC voltage of 34 V rms to a speaker. The speaker behaves approximately as if it has a resistance of 8.0 Ω, as the circuit figure indicates. Determine



a) the maximum voltage,

$V_0 = V_{rms} \cdot \sqrt{2} = 48\text{V}$

b) the rms current,

$I_{rms} = \frac{V_{rms}}{R}$

$= 4.25\text{A}$

c) the average power for this circuit.

$P_{avg} = \frac{1}{2} P_{max} = \frac{1}{2} I_0 V_0 = \frac{1}{2} I_0^2 R = \frac{1}{2} V_0^2 / R$

$= I_{Rms} V_{Rms} = I_{Rms}^2 R = V_{Rms}^2 / R$

Rms

2. A 100 W light bulb is designed to operate from a 120 VAC mains. Determine:

a) the maximum power of the light bulb

200W

b) the maximum current drawn by the bulb

1.2A

$I_0 V_0 = P_{max}$

170V 200W

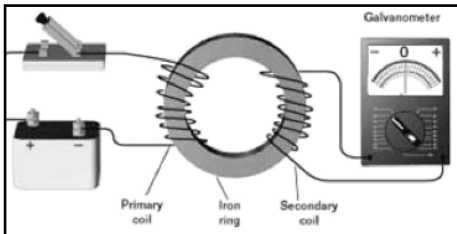
3. A maximum alternating voltage of 170 V is applied across a 50 Ω resistor. Determine:

a) the maximum current through the resistor

3.4 A

b) the average power dissipated by the resistor

290W



Faraday's Induction Ring

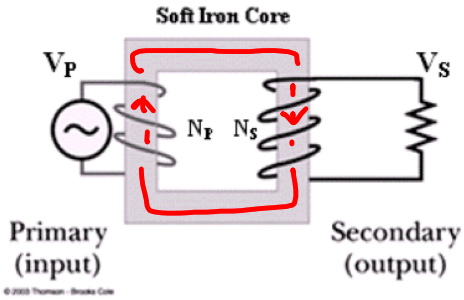
According to Michael Faraday's original experiment that first produced electromagnetic induction, an emf and current were only induced in the secondary coil when the switch in the primary coil was being opened or closed, that is, when the current in the primary coil was changing (increasing or decreasing).

No emf or current was induced in the secondary coil while the switch was stationary in the open or closed position, that is, when the current was steady or off.

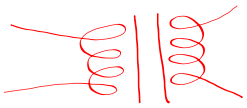
Therefore, emf can only be induced in the secondary coil when the magnetic field from the current in the primary coil is building up or dying down, that is, while the magnetic flux is changing.

Transformer: a device that increases or decreases AC voltage

Structure and operation of a transformer



Your Turn



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1. An alternating potential difference (V_P) applied across the primary coil creates an alternating current in the primary coil.
2. This creates an alternating magnetic field (time-changing flux) in the primary coil.
3. The soft iron core concentrates the magnetic flux from the primary coil and links it with the secondary coil.
4. The time-changing flux in the secondary coil induces a secondary alternating emf (V_S).

Transformer formula

$\mathcal{E}_P = N_P \frac{\Delta\Phi}{\Delta t}$

$\mathcal{E}_S = N_S \frac{\Delta\Phi}{\Delta t}$

$\frac{\mathcal{E}_P}{\mathcal{E}_S} = \frac{N_P}{N_S}$

Step-Up Transformer:

$N_S > N_P$

$V \uparrow$

Step-Down Transformer:

$N_P > N_S$ $V \downarrow$