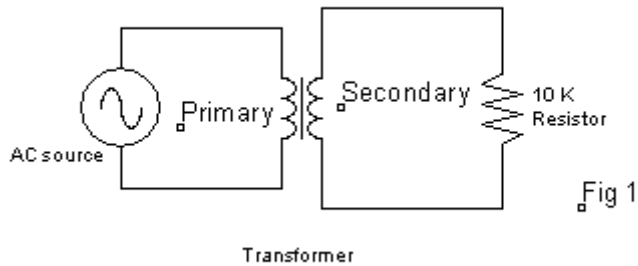


Basic Electronic Part 18

by
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Suppose we have an inductor with an AC source connected to it. This AC source will cause a changing magnetic field to exist around the inductor. If we place another inductor close enough to the first inductor so that the changing magnetic field will intersect the coils in the second inductor, then the magnetic field will induce a voltage across the second inductor. We say the two coils have mutual inductance. When two coils are arranged so that a changing current through one induces a voltage in the other we have a transformer. Transformers can have more than two coils.

In a transformer, one inductor has the input signal applied across it. This is called the primary winding. This primary winding induces a voltage across one or more secondary windings. These secondary windings provide an output voltage to other parts of a circuit. In this sense, a transformer transfers energy from one part of a circuit to another part. Note that there is no direct connection between the two parts of the circuit.



To insure good energy transfer between the two coils we try to maximize the mutual inductance between them. One way to accomplish this is to have most of the magnetic field of the primary coil cutting through the secondary coil. We can accomplish this by winding the transformer inductors on a single form, or core. The core is often made from iron, powdered iron or ferrite materials. These core materials will make the magnetic field stronger. Another factor that increases the magnetic field is higher voltage on the primary because this increases the current flowing in the primary winding. The field is also stronger when there are more turns of wire in the coil.

Suppose we have a transformer with the same number of turns in the secondary as there are in the primary. If we apply 120 volts ac to the primary, the output voltage of the secondary will be 120 volts ac. The voltage induced by the changing magnetic field is proportional to the number of turns on the inductor. For example, if a primary winding has 500 turns and a secondary winding has 250 turns, then the output voltage will be half the input voltage. Therefore, a primary voltage of 120 volts ac will produce 60 volts ac in the secondary. Similarly, if the primary has 500 turns and the secondary has 1000 turns, then an input of 120 volts ac will produce 240 volts ac on the secondary.

We can express this mathematically as follows:

$$\frac{N_p}{N_s} = \frac{E_p}{E_s},$$

where N_p is the number of turns on the primary winding,

N_s is the number of turns on the secondary winding,

E_p is the primary voltage, and

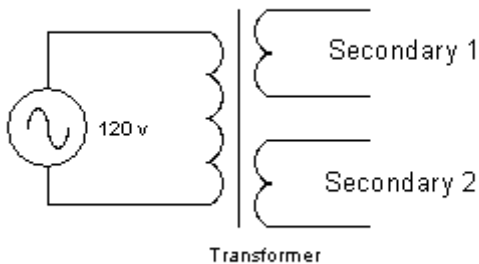
E_s is the secondary voltage.

This will allow us to design a transformer to produce any desired voltage. For example, if we want a transformer that will produce 12 volts ac from a 120 volt ac source, we solve the above equation for E_s to get

$$E_s = E_p \frac{N_s}{N_p}$$

Since $E_p = 120$ volts ac and we want $E_s = 12$ volts ac, then the ratio of secondary turns to primary turns must be $\frac{1}{10}$. If the primary consists of 1000 turns, then the secondary must have 100 turns.

Now consider the transformer below with 120 volts ac applied to the primary.



If the primary winding consists of 500 turns, secondary 1 consists of 1000 turns, and secondary 2 consists of 250 turns, what is the output of secondary 1 and secondary 2?