Three-Phase Circuits

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1 Introduction

The study of electronics generally begins with exloring the function and operation of Direct Current (DC) circuits, with skills learned then translated for Alternating Current (AC) circuits. In that translation some students tend to focus more on applying the formulas in problem solving, losing sight of how they were derived. As a result, they may have trouble explaining how AC is generated, how it functions, and why sinusoidal functions are used in the equations.

2 What is AC?

Because current flows in a single direction in DC circuits, the polarity of any terminal stays constant. As the name implies, direction of current flow in AC circuits alternates, and polarity at terminals with it. Figure 1 shows how these values change over time. One full alternation, or period, is marked by the section T; the frequency of an AC value refers to the number of periods per second.

The horizontal axis in Figure 1 can be measured in time, degrees, or radians. One cycle of a sinusoidal wave is 360° or 2π radians. This figure also illustrates phase angle, either as the time delay between two waveforms or as the angle between them. This time difference is also what is being referred to when a waveform is described as either "leading" or "lagging" another. With respect to a reference, a leading waveform is one that is further along in its cycle.
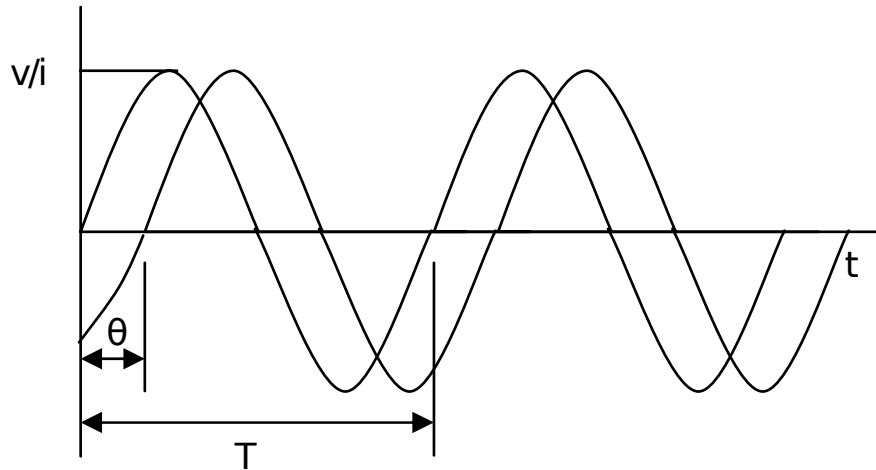
Figure 1: Two Sinusoidal Waves With Phase Difference

3 How is it Generated?

Figure 2 shows a simple model of a three-phase alternator, consisting of a magnetic rotar and stator with three separate sets of coil windings mounted 120° from each other. In accordance with Faraday's law of induction, the relative movement of the magnetic field to the conductors as the shaft rotates an electromotive force (EMF) is created.
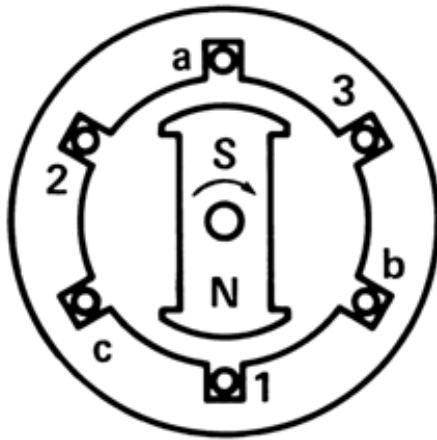
4 Why Use Three-Phases?

5 Heading

6 If needed: Why AC over DC?

Figure 2: Simple Diagram of a Three-Phase Alternator