

## Chapter 1

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# BASIC PRINCIPLES FOR ELECTRIC MACHINE ANALYSIS

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### 1.1 INTRODUCTION

There are several basic concepts that must be established before the analysis of electric machines can begin. The principle of electromechanical energy conversion is perhaps the cornerstone of machine analysis. This theory allows us to establish an expression of electromagnetic torque in terms of machine variables, generally the currents and the displacement of the mechanical system. Other principles that must be established are (1) the derivation of equivalent circuit representations of magnetically coupled circuits, (2) the concept of a sinusoidally distributed winding, (3) the concept of a rotating air-gap magnetomotive force (MMF), and (4) the derivation of winding inductances. The above-mentioned basic principles are presented in this chapter, concluding with the voltage equations of a 3-phase synchronous machine and a 3-phase induction machine. It is shown that the equations, which describe the behavior of alternating-current (ac) machines, contain time-varying coefficients due to the fact that some of the machine inductances are functions of the rotor displacement. This establishes an awareness of the complexity of these voltage equations and sets the stage for the change of variables (Chapter 3), which reduces the complexity of the voltage equations by eliminating the time-dependent inductances.

### 1.2 MAGNETICALLY COUPLED CIRCUITS

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