Induction Motors

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Induction Motors

One of the most common electrical motor used in most applications which is known as induction motor. This motor is also called as asynchronous motor because it runs at a speed less than its synchronous speed. An asynchronous motor type of an induction motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor can therefore be made without electrical connections to the rotor as are found in universal, DC and synchronous motors. An asynchronous motor's rotor can be either wound type or squirrel-cage type. Three-phase squirrel-cage asynchronous motors are widely used in industrial drives because they are rugged, reliable and economical. Single-phase induction motors are used extensively for smaller loads, such as household appliances like fans. Although traditionally used in fixed-speed service, induction motors are increasingly being used with variable-frequency drives (VFDs) in variable-speed service.

Key features:

- Explores induction motors, their drives and power electronic control bringing together current thinking, simulation and practice with established models and performance.
- Topics are logically arranged according to the course outline of the subject.
- The use of simple language to facilitate a better understanding of each chapter.
- Illustrative examples of varying difficulties, wherever needed, are presented to enhance the interest of students.
- The provision of knowledge check test for each chapter is given at the end of chapter to strengthen the learning process of students.
- Case Study, Role Model, Keywords, and Examples are also provided to enrich the knowledge of students.

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3. Video Lecture of each chapter, which explains each topic in detail with examples, animations, images and text and makes it easy to understand the topics in easier, simpler and better way.
4. Huge Database of Interactive Assessments for each chapter, which is also printable
5. Further reading and learning links for each topic
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8. Review Questions for each chapter are also given in the DVD, which are also printable

The DVD is also a useful tool for teachers to teach with digital resources in classroom and do a great job of illustrating skills and techniques that are otherwise difficult to explain.

ISBN 978-1-68095-505-7

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Authored and Edited by 3G E-learning LLC, USA

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ISBN: 978-1-68095-505-7

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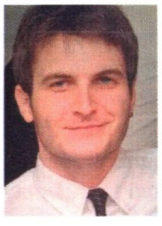

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PREFACE

One of the most common electrical motor used in most applications which is known as induction motor. This motor is also called as asynchronous motor because it runs at a speed less than its synchronous speed. An asynchronous motor type of an induction motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor can therefore be made without electrical connections to the rotor as are found in universal, DC and synchronous motors. An asynchronous motor's rotor can be either wound type or squirrel-cage type. Three-phase squirrel-cage asynchronous motors are widely used in industrial drives because they are rugged, reliable and economical. Single-phase induction motors are used extensively for smaller loads, such as household appliances like fans. Although traditionally used in fixed-speed service, induction motors are increasingly being used with variable-frequency drives (VFDs) in variable-speed service.

Content Coverage

Chapter One begins with the basic concept of induction motor. Applications of induction motor are also highlighted. *Chapter Two* presents the fundamentals of vector control along with theory and principles of field orientation control. Single phase induction motors and its types are illustrated in *Chapter Three*. *Chapter Four* describes the construction and characteristics of three phase induction motor. In *Chapter Five,* methods for starting and speeding control are discussed. It also draws on braking of three phase induction motor. *Chapter Six* focuses on inverter-fed induction motor drives. Torque speed characteristics constant v/f operation as well as cycloconverter drives are too explained.

The following are the salient features of the book:

- Explores induction motors, their drives and power electronic control bringing together current thinking, simulation and practice with established models and performance.

- Topics are logically arranged according to the course outline of the subject.
- The use of simple language to facilitate a better understanding of each chapter.
- Illustrative examples of varying difficulties, wherever needed, are presented to enhance the interest of students.
- The provision of knowledge check test for each chapter is given at the end of chapter to strengthen the learning process of students.
- Case Study, Role Model, Keyword, and Examples are also provided to enrich the knowledge of students.

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CHAPTER 1

INTRODUCTION TO INDUCTION MOTOR

LEARNING OBJECTIVES

After studying this chapter, you will be able to

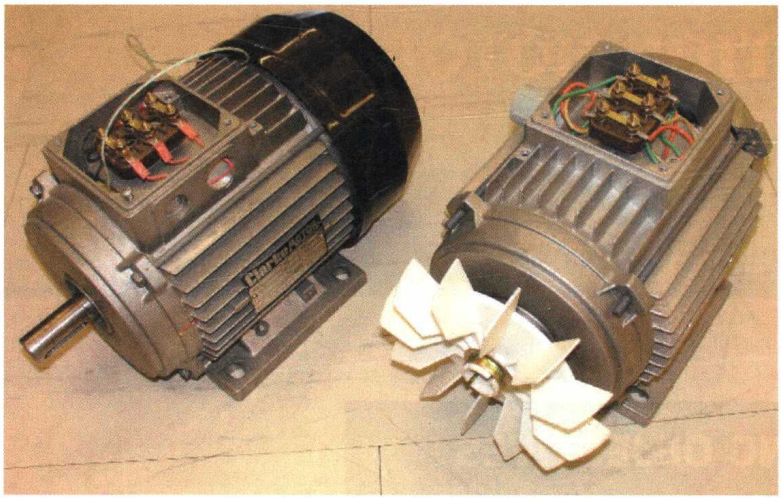
1. Describe the basic concept of induction motor
2. Explain the applications of induction motor

INTRODUCTION

An induction motor is a motor that provides power. It owes its name to the way it operates. Alternating current (AC) voltages are induced by the magnetic and rotating field of the stator in the rotor circuit. An induction motor is constructed with elements of copper, steel, and aluminum. While this makes them more expensive than universal motors, it also increases their quality and durability.

The construction of an induction motor is almost identical to the construction of a three-phase synchronous motor. It consists of a rotor that is manufactured from a laminate cylinder with a slotted surface. The windings in these slots can be one of three types: a squirrel-cage winding, a slip ring rotor, or a solid core rotor.

A squirrel-cage winding is made of copper bars that span the length of the rotor. They are connected at each end through a ring. The rotor bars are skewed and not straight in order to reduce noise.



Slip-ring rotors do not contain the bars found in squirrel-cage rotors. Instead, they contain windings that are connected to slip rings. If the slip rings are shortened, it causes the rotor to behave much in the same way as squirrel-cage rotors. Solid-core rotors induce the current needed to rotate and are made from solid steel.

Inductor motors are slower than universal motors and have a lower start-up torque. The speed of the motor is controlled by the number of windings in their stator and by the supply of voltage. In order to induce voltage, the speeds of the rotor and the rotating magnetic field in the stator must differ; otherwise, the magnetic field will not move relative to the rotor and no voltage or current will be induced.

Their slower speed contributes to their longevity as well as their consistent and reliable use. They are not prone to out as universal motors are. Induction motors also are usually very quiet.

Almost all table saws are fitted with an induction motor. The appropriate size motor depends on the saw. While smaller saws would use a motor between 1 and 5 horsepower, larger saws need fan-cooled induction motors. This is designed for continuous use and they are designed in a way that they are sealed against dust.

An induction motor is able to drive at a constant speed. Their three-phase construction produces a motor that generally is easy to start as it requires no extra equipment. These motors are heavier than universal motors which make them an ideal solution for use on a table saw. Their weight makes them more stable and helps to reduce vibration.

Typically, an induction motor requires fewer amps per horsepower and will have a higher resale value. They are, for many, the preferred choice of motor thanks to their

rugged construction and the ability to control their speed. Also, they do not require brushes as do universal motors. Because of this, they generally are easier to control.

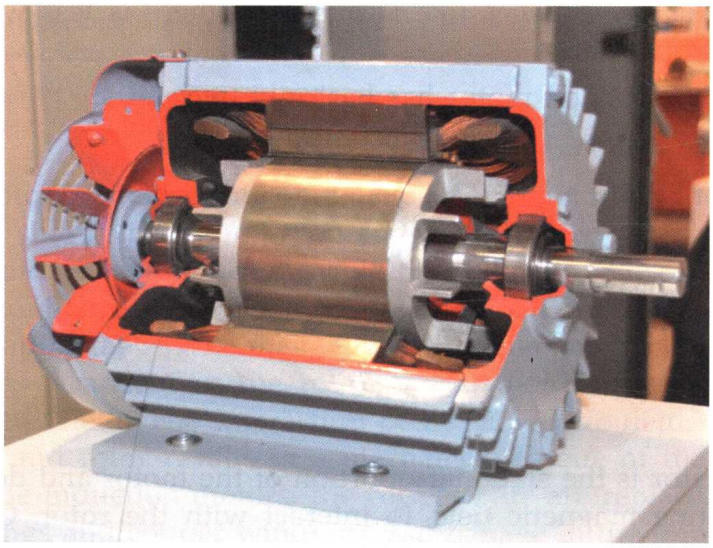
1.1 BASIC CONCEPT OF INDUCTION MOTOR

An **induction motor** (IM) is a type of asynchronous AC motor where power is supplied to the rotating device by means of electromagnetic induction. It is an electromechanical energy conversion device which runs on AC supply. It is one of the most common motor found in invariably all industries and in domestic households too.

An electric motor converts electrical power to mechanical power in its rotor (rotating part). There are several ways to supply power to the rotor. In a DC motor this power is supplied to the armature directly from a DC source, while in an induction motor this power is induced in the rotating device. An induction motor is sometimes called a rotating transformer because the stator (stationary part) is essentially the primary side of the transformer and the rotor (rotating part) is the secondary side. Induction motors are widely used, especially polyphase induction motors, which are frequently used in industrial drives.

KEYWORD

Induction motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding.



A motor with only armortisseur windings is called an induction motor. An induction motor is the most modest electrical machine from constructional point of view, in the majority of the cases. Induction motor works on the principle of induction where electro-magnetic field is induced into the rotor when rotating magnetic field of stator cuts the stationary rotor. Induction machines are by far the most common type of motor used in industrial, commercial or residential settings. It is a three phase AC motor. Its characteristic features are:

- Simple and rugged construction
- Low cost and minimum maintenance
- High dependability and sufficiently high proficiency
- Needs no additional starting motor and necessity not be synchronized

DID YOU KNOW?

Electromagnetic induction was first discovered by Michael Faraday, who made his discovery public in 1831. It was discovered independently by Joseph Henry in 1832.

1.1.1 Basic parts of an Induction Motor

An induction motor is a type of electric motor that converts electric power into rotary motion. An induction motor uses the principle of electromagnetic induction to cause the rotor to turn. **Electric current** is supplied to the stator, which induces a magnetic field that rotates. The rotating magnetic field interacts with the rotor, inducing current in the rotor. The interaction of the two magnetic fields results in a torque, turning the rotor within the motor casing. Because the induction motor does not use brushes like DC motors, there is less wear of the internal parts.

An induction motor has basically two parts:

- Stator
- Rotor
- Shaft
- Bearings
- Casing

Stator

The stator is the stationary portion of the motor and delivers a rotating magnetic field to interact with the rotor. One or more copper windings make up a "pole" within the **stator**,

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