

Unit 43: Further Electrical Machines and Drives

Unit code	K/615/1511
Unit level	5
Credit value	15

Introduction

Electric machines are the most common devices used to perform the actuator function in an industrial control loop. They are an indispensable part of engineering processes and are the workhorse in both commercial and industrial applications.

The aim of this unit is to continue developing the skills in the use and application of electrical machines, particularly direct current (DC) and alternating current (AC) drives.

Among the topics included in this unit are: an introduction to electrical machines and drives, and their characteristics, starting and braking, loading conditions, ratings, and their control.

On successful completion of this unit students will be able to explain the operation of different motors used in industry, describe the different types of industrial drives used in various disciplines, assess the importance of electrical machines and their drives for a given industrial application, analyse their performances and suggest appropriate solutions using a variety of possible methods.

Learning Outcomes

By the end of this unit students will be able to:

1. Explore the principles of operation and the characteristics of electrical machines and their industrial applications.
2. Illustrate the fundamentals of power electronics converters used in power processing units for electric drives.
3. Demonstrate the fundamentals of DC drives and their industrial applications.
4. Demonstrate the fundamentals of AC drives and their industrial applications.

Essential Content

LO1 **Explore the principles of operation and the characteristics of electrical machines and their industrial applications**

Principles of operation and characteristics of electrical machines and their industrial applications:

Introduction to electrical machines, concepts of electrical machines and their classification

Principles of operation of DC machines and their characteristics

Principles of operation of three-phase induction machines and their characteristics

Principles of operation of synchronous machines and their characteristics

Introduction to special machines

Simulation using Matlab/Simulink or similar commercially available software

LO2 **Examine the fundamentals of power electronics converters used in power processing units for electric drives**

Fundamentals of power electronics converters used in power processing units for electric drives:

Concepts of electrical drives and their classification

DC to DC converters (Choppers), AC to DC converters (Rectifiers), DC to AC converters (Inverters), AC to AC converters (Cyclo-converters)

Simulation using Matlab/Simulink or similar commercially available software

LO3 Demonstrate the fundamentals of DC drives and their industrial applications

Fundamentals of DC drives and their industrial applications:

Introduction to DC drives and their application to emerging areas such as smart grid and renewable energy sources

Operating modes of DC drives; single-phase drives, three-phase drives, chopper drives, two/four quadrant operation drives

Application; closed loop control of DC drives

Simulation using Matlab/Simulink or similar commercially available software

LO4 Demonstrate the fundamentals of AC drives and their industrial applications

Fundamentals of AC drives and their industrial applications:

Introduction to AC drives and their industrial application such as smart grid and renewable energy sources

Induction motor drives: voltage controls, frequency controls, current controls, voltage, current and frequency control, and closed loop control induction motor

Synchronous motor drives: frequency control and closed loop control of synchronous motor drives

Simulation using Matlab/Simulink or similar commercially available software

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p>LO1 Explore the principles of operation and the characteristics of electrical machines and their industrial applications</p>		<p>D1 Critically evaluate the performance of a given electrical machine using Matlab/Simulink or similar commercially available software to corroborate its performance or otherwise</p>
<p>P1 Discuss the different types of electrical machines and cite their industrial applications</p> <p>P2 Illustrate the principle of operation of electrical machines with the aid of circuit diagrams and waveforms</p> <p>P3 Investigate the construction, operation and characteristics of a given electrical machine</p>	<p>M1 Utilise Matlab and Simulink or similar commercially available software for modelling and simulation of a given electrical machine</p> <p>M2 Analyse the characteristics of a given electrical machine from its equivalent circuits</p>	

Pass	Merit	Distinction
<p>L02 Examine the fundamentals of power electronics converters used in power processing units for electric drives</p>		<p>D2 Critically evaluate the performance of a given converter using Matlab/Simulink software to corroborate its performance or otherwise</p>
<p>P4 Illustrate, with the aid of circuit diagrams and waveforms, the operation of a given uncontrolled or controlled converter (half wave/full wave/three-phase)</p>	<p>M3 Show how Matlab and Simulink or similar commercially available software may be used for modelling and simulation of a given converter</p>	
<p>P5 Illustrate, with the aid of circuit diagrams and waveforms, the impact of resistive and inductive loads on the converter's input and output characteristics</p>	<p>M4 Evaluate the key performance characteristics of a given converter</p>	
<p>P6 Investigate the importance of input and output filters in a given converter</p>		

Pass	Merit	Distinction
<p>L03 Demonstrate the fundamentals of DC drives and their industrial applications</p>		<p>D3 Analyse the impact of DC drives on the operation and performance of an industrial control system</p>
<p>P7 Discuss the operating modes of DC drives and control parameters</p>	<p>M5 Develop an open loop block diagram of a DC motor and derive the relationship between the input and the output of the systems</p>	
<p>P8 Explain the importance of DC drives in industrial applications</p>	<p>M6 Evaluate how DC drive circuits are used to control the speed of DC motors</p>	
<p>P9 Discuss the principle operations of single/three-phase choppers with the aid of circuit diagrams and waveforms</p>		
<p>P10 Illustrate, with the aid of circuit diagrams and waveforms, the implementation of closed loop control of DC drives</p>		

Pass	Merit	Distinction
<p>LO4 Demonstrate the fundamentals of AC drives and their industrial applications</p>		<p>D4 Analyse the impact of AC drives on the operation and performance of an industrial control system</p>
<p>P11 Illustrate the operating modes of AC drives, their control parameters and their importance in industrial applications</p>	<p>M7 Develop an open loop block diagram of an induction motor and derive the relationship between the input and the output of the systems</p>	
<p>P12 Illustrate, with the aid of circuit diagrams and waveforms, the principles of operations of single/three-phase AC drives</p>	<p>M8 Evaluate how AC drive circuits are used to control the speed of induction and synchronous motors</p>	
<p>P13 Review, with the aid of circuit diagrams and waveforms, the implementation of closed loop control of AC drives</p>		

Recommended Resources

Textbooks

HUGHES, A. (2013) *Electric Motors and Drives: Fundamentals, Types and Applications*. 4th Ed. Newnes.

RASHID, M.H. (2004) *Circuits, Devices and Applications*. 3rd Ed. Prentice Hall.

RASHID, M.H. (2001) *Power Electronics Handbooks*. 1st Ed. Academic Press.

Links

This unit links to the following related units:

Unit 21: Electrical Machines