

power systems

M. Ahmad

High Performance AC Drives

Modelling Analysis and Control



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In memory of:

My father, Mr. Mushtaq Ahmad

And

My mother Mrs. Zeenat

Preface

Variable speed is one of the important requirements in most of the electric drives. Earlier dc motors were the only drives that were used in industries requiring operation over a wide range of speed with step less variation, or requiring fine accuracy of speed control. Such drives are known as high performance drives. AC motors because of being highly coupled non-linear devices can not provide fast dynamic response with normal controls. However, recently, because of ready availability of power electronic devices, and digital signal processors ac motors are beginning to be used for high performance drives. Field oriented control or vector control has made a fundamental change with regard to dynamic performance of ac machines. Vector control makes it possible to control induction or synchronous motor in a manner similar to control scheme used for the separately excited dc motor. Recent advances in artificial intelligence techniques have also contributed in the improvement in performance of electric drives.

This book presents a comprehensive view of high performance ac drives. It may be considered as both a text book for graduate students and as an up-to-date monograph. It may also be used by R & D professionals involved in the improvement of performance of drives in the industries. The book will also be beneficial to the researchers pursuing work on sensorless and direct torque control of electric drives as up-to date references in these topics are provided. It will also provide few examples of modeling, analysis and control of electric drives using MATLAB/SIMULINK. An approach applying first principles that will give reader understanding of the basic concepts of high performance ac drives has been used. The main emphasis of the book is on sensorless control of ac drives, as these controlled drives provide high performance at low cost with high reliability.

The book written mainly with the above objectives is divided into seven chapters. The first chapter deals with the basics of electric drives, their requirement in industries and load dynamics. Since the induction machine is the most commonly used ac motor in the drives, its modeling is taken in the chapter 2. Here dynamic model of induction motor in different reference frames have been described. Also state space model of the induction machine used in the simulation is also discussed. In chapter 3, vector control, or field oriented control which transforms the dynamic structure of ac machine into that of separately excited compensated dc motor for both induction and synchronous motor is discussed. Chapter 4 deals

with sensorless control and direct torque control of induction machine. Chapter 5 is dedicated to vector and direct torque control of permanent magnet synchronous motor and brushless dc motor. These motors are now very widely used in industries. In this chapter the model of the PMSM and brushless DC motor are presented along with the control schemes.

Chapter 6 is devoted to Switched Reluctance Motor (SRM) drives. The SRM had its origin in 1850 but has received considerable interest since 1980s. These motors are now finding use in many variable speed drives. The switched reluctance motors have many advantages, e.g. High efficiency, can be designed for ratings from few watts to M watts and can be employed in harsh working environments. In this chapter principle of operation of SR motor, various types of its configurations, equivalent circuit, and design procedure are discussed. Also the modeling, simulation and control of these drives is presented in simple manner. Sensorless operation and control of these drives is also discussed. In chapter 7 multi-phase drives which are now being considered for many applications have been described. Chapter 8 deals with fuzzy logic and application of neural network in the control of high performance drives.

The content of this book and the material has been developed by this author while teaching graduate students in AMU Aligarh and UPM Malaysia. I am also involved in research in the area of high performance drives and multiphase drives. I am thankful to the chairman Department of electrical engineering and the vice-chancellor Aligarh Muslim University for awarding me leave for academic pursuits to write this book. Finally, I am very grateful to my wife Maimoona for the patience and support to carry out this work.

Mukhtar Ahmad
Aligarh

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