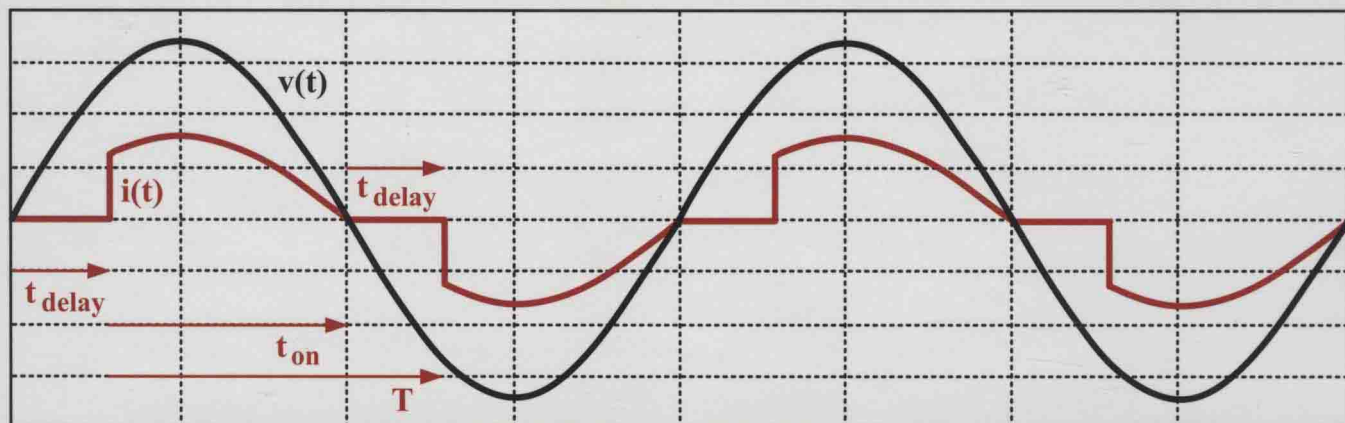


Second Edition

Power Quality in Power Systems and Electrical Machines



Mohammad A. S. Masoum
Ewald F. Fuchs



POWER QUALITY IN POWER SYSTEMS AND ELECTRICAL MACHINES

Second Edition

MOHAMMAD A.S. MASOUM

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POWER QUALITY IN POWER SYSTEMS AND ELECTRICAL MACHINES

PREFACE

The increased use of power electronic components within the distribution system and the reliance on renewable energy sources which have converters as interface between the source and the power system lead to power quality problems for the operation of machines, transformers, capacitors and power systems. The subject of power quality is very broad by nature. It covers all aspects of power system engineering from transmission and distribution level analyses to end-user problems. Therefore, electric power quality has become the concern of utilities, end users, architects and civil engineers as well as manufacturers. The book is intended for undergraduate or graduate students in electrical and other engineering disciplines as well as for professionals in related fields. It is assumed that the reader has already completed electrical circuit analysis courses covering basic concepts such as Ohm's, Kirchhoff's, Ampere's and Faraday's laws as well as Norton and Thevenin equivalent circuits and Fourier analysis. In addition, knowledge of diodes and transistors and an introductory course on energy conversion (covering energy sources, transformers, simple control circuits, rudimentary power electronics, transformers, single- and three-phase systems as well as various rotating machine concepts such as brushless DC machines, induction and synchronous machines) is desirable.

This book has evolved from the content of courses given by the authors at the University of Colorado at Boulder, USA, the Iran University of Science and Technology at Tehran, Iran, and the Curtin University at Perth, Australia. The book is suitable for both electrical and non-electrical engineering undergraduate and postgraduate students. It has been particularly written for students or practicing engineers who want to teach themselves through the inclusion of 135 application examples with solutions and 115 problems at the end of each chapter dealing with practical applications. 924 references are given in this book: mostly journal and conference papers as well as national and international standards and guidelines. The International System (SI) of units has been used throughout with some reference to the American/English system of units.

Power quality of power systems affects all connected electrical and electronic equipment, and is a measure of deviations in voltage, current, frequency, temperature, force, and torque of particular supply systems and their components. In recent years there has been considerable increase in nonlinear loads, in particular distributed loads such as computers, TV monitors and lighting. These draw harmonic currents which have detrimental effects including communication interference, loss of reliability, increased operating costs, equipment overheating, electrical machine, transformer and capacitor failures, and inaccurate power metering. This subject is pertinent to engineers involved with power systems, electrical machines, electronic equipment, computers and manufacturing

equipment. This book helps readers to understand the causes and effects of power quality problems such as nonsinusoidal wave shapes, voltage outages, harmonic losses, origins of single-time events such as voltage dips, voltage reductions, and outages, along with techniques to mitigate these problems. Analytical as well as measuring techniques are applied to power quality problems as they occur in existing systems based on central power stations and distributed generation mainly relying on renewable energy sources.

It is important for each power engineering student and professional who is active in the area of distribution systems and renewable energy that he/she knows solutions to power quality problems of electrical machines and power systems: this requires detailed knowledge of modeling, simulation and measuring techniques for transformers, machines, capacitors and power systems, in particular fundamental and harmonic power flow, relaying, reliability and redundancy, load shedding and emergency operation, islanding of power system and its voltage and frequency control, passive and active filtering methods, and energy storage combined with renewable energy sources. An intimate knowledge of guidelines and standards as well as industry regulations and practices is indispensable for solving power quality problems in a cost-effective manner. These aspects are addressed in this book which can be used either as a teaching tool or as a reference book.

In this second edition of the book, we have included Chapter 11 of the first addition in Chapter 9 “The Roles of Filters in Power Systems and Unified Power Quality Conditioners” and added new Chapter 11 “Power Quality Solutions for Renewable Energy Systems” relating power quality solutions to renewable energy systems and sources.

Key features:

- Provides theoretical and practical insight into power quality problems of machines and systems.
- 135 practical application (example) problems with solutions.
- 115 problems at the end of each chapter dealing with practical applications.
- 924 references mostly journal and conference papers as well as national and international standards and guidelines.

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