IDENTIFICATION OF SYNCHRONOUS MACHINE MODELS USING POWER SPECTRAL ANALYSIS

BY

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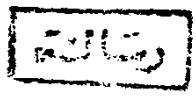

A Thesis Presented

FOR

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Prof. Dr. S.A. Kandil & Dr. Hamdy S. Khalil

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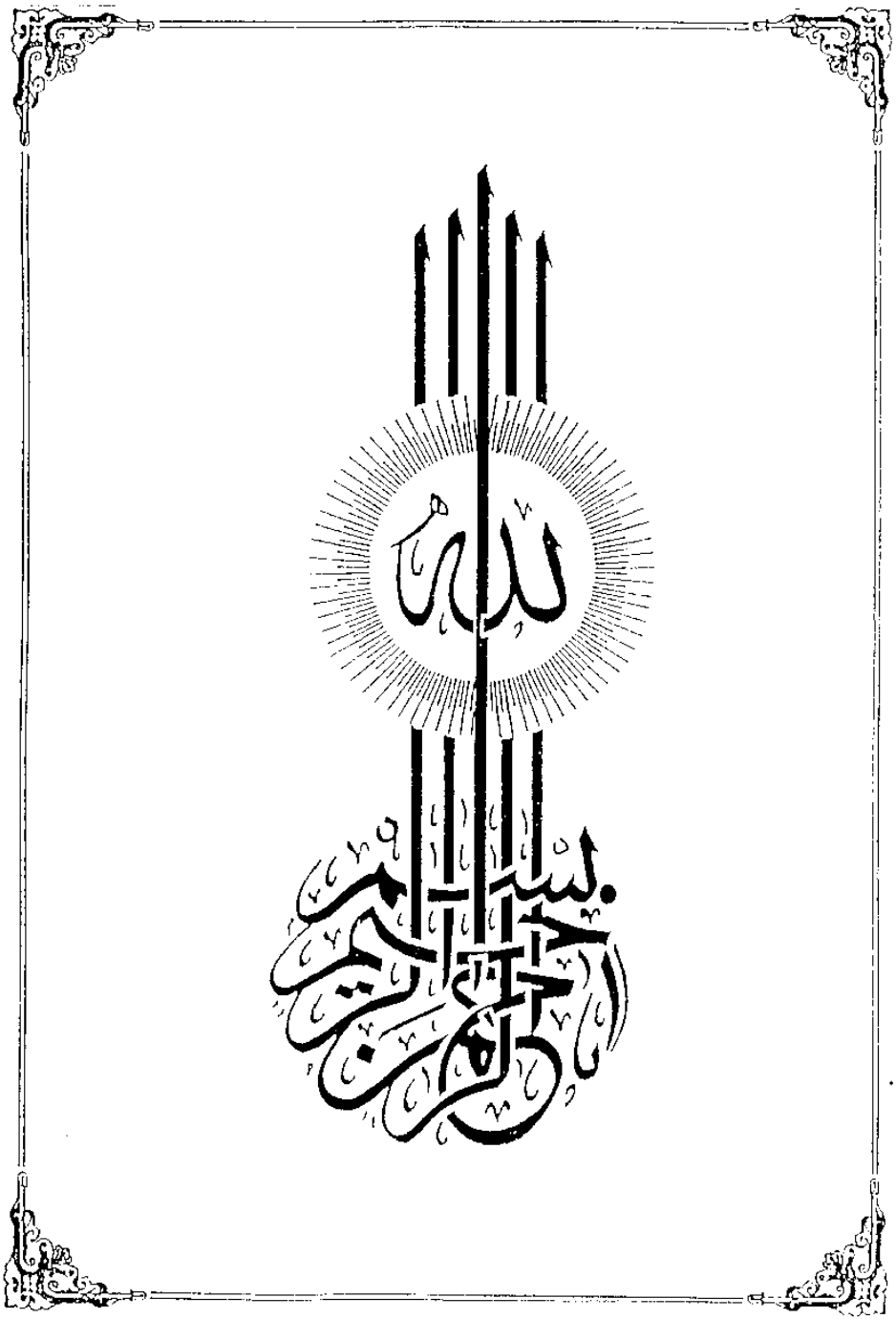
بسم الله الرحمن الرحيم



TO

WALID

AHMED, AMRO,

and

MY WIFE THANAA

EXAMINING COMMITTEE

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Summary of Ph.D. Thesis On

"IDENTIFICATION OF SYNCHRONOUS MACHINE MODELS USING POWER SPECTRAL ANALYSIS"

Submitted by: Eng. Salah El-Din A.H. Emam, B.Sc., M.Sc.
Submitted to: Faculty of Engineering, Ain Shams University.

The investigation of dynamic performance of a power system includes the proper modelling of its generators. Rather simple approaches are needed to make the computational work acceptable, but on the other hand, the choice of the accuracy level to which the model must confirm is an important factor. The main objective of this thesis is to develop and identify the on-line and off-line models of a synchronous machine using a statistical method of identification.

The statistical method of identification is performed through determining the frequency response functions or transfer functions not only by off-line testing but also by on-line testing during normal plant operation, with minimum disturbance. During testing, the traditional forcing functions (ramp, unit step, sinusoidal, etc.) must be large enough to avoid the resulting output response being swamped by the noise signal. On the other hand, these of large traditional signal may drive the system into the nonlinear portion of its characteristics and this would lead to erroneous results. For this reason traditional signals can not be considered good enough for the identification purpose whatever it is on-line or off-line.

The method of identification adopted in this thesis uses a more proper testing signal which is called Pseudo. Random Binary Sequence (PRBS). This signal has random characteristics, and a spectrum as the white noise in the range of frequency of the identified system. The power spectral analysis technique, using the PRDS signal and Fast Fourier transform, is used to determine the synchronous machine models.

The thesis contains six main chapters, other than the nomenclature and three appendices.

Chapter 1 is an introduction, giving the problem to be solved and a review of identification methods and modelling of synchronous machines.

Chapter 2 presents the mathematical theory of power spectral analysis technique and the Fast Fourier Transform (FFT) algorithm.

Chapter 3 is concerned with the generation, analysis, and application of the PRBS signal. The use of this signal and correlation techniques for identification of a simple system consisting of an R-C circuit is explained. The recommendations for using the PRBS signal in power spectral identification are presented.

Chapter 4 gives a survey of the different synchronous machine models. The derivation of the on-line and off-line models of synchronous machine has been developed.

Chapter 5 presents three tests require for the identification of the on-line model and other three tests

for the off-line model. Computer programs based on calculating their output responses and using the power spectral technique, have been developed to compute the frequency response functions of the two models. A comparison between the predicted values of these frequency response functions and those obtained from power spectral analysis is presented. Good agreement between the two sets of results is obtained. A description of the instrumentation techniques required for the experimental identification of the on-line and off-line synchronous machine models is given.

Chapter 6 presents a summary and general conclusions of the thesis.

Appendix A gives, as an example, a list of the computer program developed for the identification of the R-C circuit.

Appendix B presents the per unit system used in the synchronous machine models.

Appendix C gives the state-space representation of the synchronous machine for on-line and off-line models.

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