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FACULTY OF ENGINEERING
ALEXANDRIA UNIVERSITY

ADAPTIVE EXCITATION CONTROL OF A SYNCHRONOUS GENERATOR

THESIS SUBMITTED TO
DEPARTMENT OF ELECTRICAL ENGINEERING
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE

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ALEXANDRIA 1994

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ACKNOWLEDGMENT

The author wishes to express his sincere appreciation to ***Prof. Dr. SAMIR DIGHEIDI*** for his consistent guidance ,assistance and encouragement through the research program..His invaluable suggestions and advice are gratefully acknowledged .

I also wish to express my deep gratitude to ***Prof. Dr. MOHAMED SHAFIK*** for his advice and help.

Special thanks and gratitude are due to ***Dr. HASAN A. YOUSSEF*** . His valuable suggestions and active support helped put everything into perspective.

I extend my thanks to ***Dr. MOHAMED EL-FAHAM*** and ***Dr. EZZ EL-DIN ZAKZOUK*** members of the department of Electrical & Control Engineering at the ARAB MARITIME TRANSPORT ACADEMY .

ALAA KHALIL

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ARABIC PREFACE

LIST OF SYMPOLES

r : stator resistance.

L_d : d-axis stator winding inductance.

L_q : q-axis stator winding inductance.

L_f : field winding inductance.

r_f : field resistance.

l_d : leakage inductance of the d-axis stator winding.

l_q : leakage inductance of the q-axis stator winding.

L_D : d-axis damper winding inductance.

L_Q : q-axis damper winding inductance.

r_D : resistance of the d-axis damper winding.

r_Q : resistance of the q-axis damper winding.

R_e : transmission line resistance.

L_e : transmission line inductance.

x'_d: transient d-axis reactance.

V_∞ : infinite bus voltage.

V_t : generator terminal voltage.

D : damping coefficient.

H : inertia constant.

T_F : stabilizing transformer time constant.

K_F : stabilizing transformer gain.

T_A : regulator time constant.

K_A : regulator gain.

ABSTRACT

This thesis is concerned with the investigation of an adaptive power system controller for a synchronous generator connected to an infinite bus through a double-circuit transmission line. The design of a fixed-gain PID power system stabilizer has been presented, which show that the fixed-gain PID power system stabilizer (PSS) works reasonably well over a medium range of operating conditions. However, the damping may diminish as the generator load changes or the network configuration is altered by faults or other switching conditions. This leads to deterioration in the stabilizer performance. Therefore autotuning stabilizers are required for effective control over a wide range of operating conditions. This can be done using self-tuning regulators (STR) which identify the system under different operating conditions and provide the control action accordingly. simulation of a synchronous generator subject to major disturbances at different operating conditions, including a three-phase short circuit, has been developed to demonstrate the effectiveness of the proposed controller.

A comparative study has been effectuated between a fixed-gain PID power system stabilizer and the proposed adaptive stabilizers, for various changes in the operating conditions. It was shown that the adaptive power system stabilizer can stabilize the synchronous generator for different operating conditions, and it can damp the system oscillations in a short period.

CHAPTER (1)

CHAPTER (1)
INTRODUCTION

Power Systems are inherently nonlinear and undergo a wide range of transient conditions which results in underdamped low frequency speed as well as power oscillations which are difficult to control. Voltage regulators were first designed to keep the voltage at the desired value with varying loads. It was noticed that in some cases the use of voltage regulators led to transient instability and machines had a tendency to oscillate continuously under certain loading conditions. Thus increasing attention has been focused on the effects of excitation control on damping of oscillations. In particular it has been found useful and practical to incorporate stabilizing signals derived from speed, frequency or power, superimposed on the voltage error signal to provide damping. A detailed analysis of damping and synchronizing torques of the synchronous machines with speed as a stabilizing signal is given in [26].

The conventional fixed-gain power system stabilizers are designed for one particular operating condition around which a linearized model is obtained. Usually this operating condition is chosen where the control is mostly needed. Because of the non-linear characteristic properties of the power systems. It is desirable to design the stabilizer parameters to be automatically adjusted according to the system's operating conditions. Adaptive control theory offers techniques for the design of such a device.

Previous Work :

A simulation study has been conducted on a microcomputer based adaptive synchronous machine stabilizer. The adaptive control algorithm tracks the system operating conditions using a least-squares identification technique and the control is calculated by a self-searching pole-shift method [1].