PLANNING OF ELECTRICAL DISTRIBUTION NETWORKS

M.SC. THESIS

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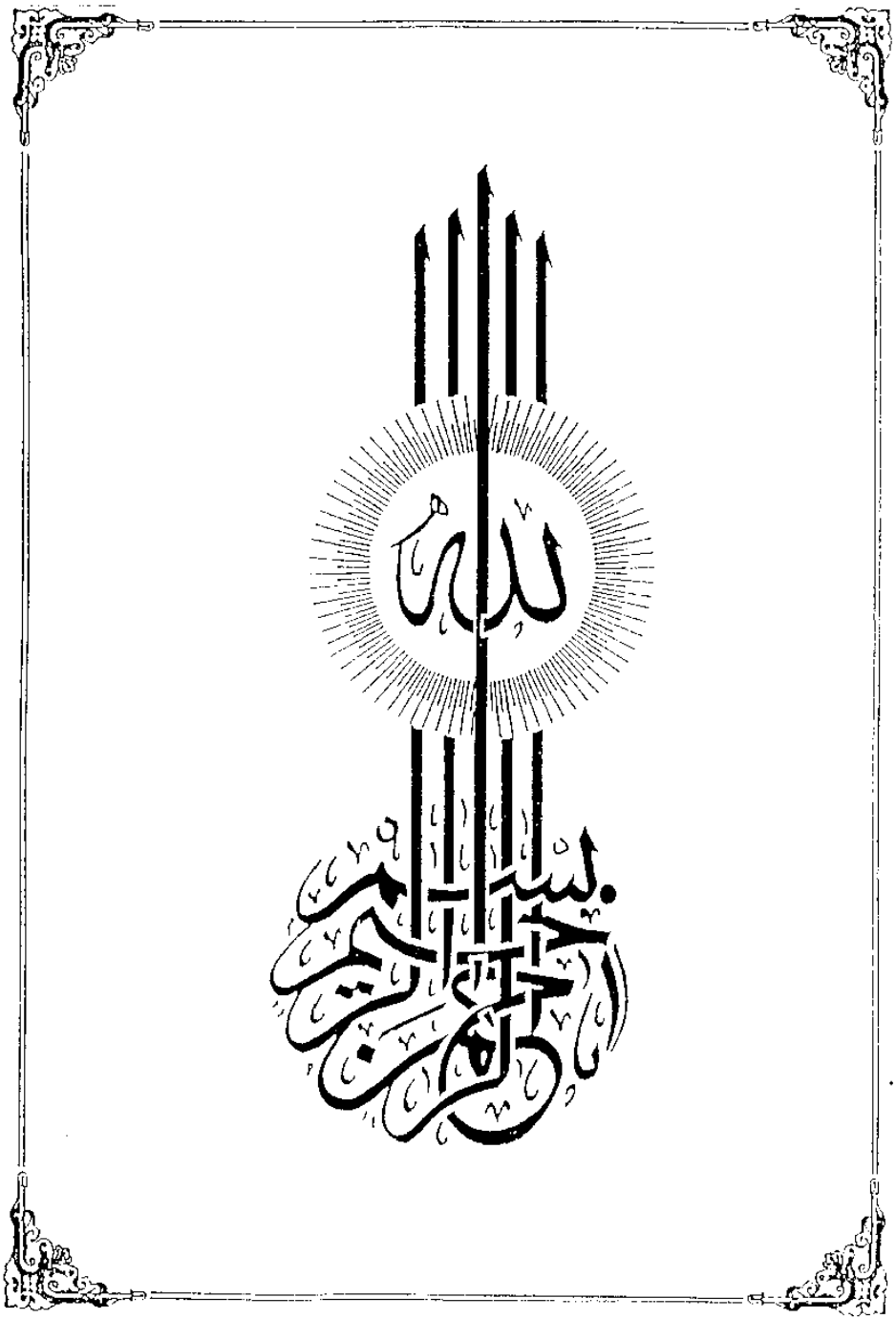

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S U M M A R Y
OF THE MASTER DEGREE THESIS
T I T L E D
"PLANNING OF ELECTRICAL DISTRIBUTION NETWORKS"

The demand of the electric energy has been developed in Egypt from $0,929 \times 10^9$ KWH in the year 1952 to $6,895 \times 10^9$ KWH in 1973. Further, it was increased to $17,235 \times 10^9$ KWH in 1981, and jumped to approach $29,119 \times 10^9$ KWH at the end of the year 1986. Thus, the annual rate of increase is as high as 14% which is considered a very high rate compared to the international rates.

Since, this high amount of electric energy is conducted to consumers via the distribution networks at both medium and low voltages, the planning of new distribution networks and/or expansion of the present networks have received special interest from electrical power engineers, planners and investigators. The development of the planning of the networks to meet the future demand on the bases of optimal technical and economical concepts is, thus, of prime importance.

Further, as the investment as well as the high energy losses costs are main factors affecting the planning and design of the networks, need calls strongly for continuous studies such as present.

Therefore, this thesis presents an investigated method for the optimal planning and design of new distribution networks and/or networks' expansion. These methods took into consideration the practical operational solutions under normal and emergency conditions. Three alternative schemes are included in the study. Load flow and short circuit computer programs have been used to check the power flow, power losses, and voltage profiles.

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Further, a generalized objective cost function of a composite distribution network has been developed - for the first time - taking all affecting factors.

It has been applied on the various schemes using a developed computer program. Differentiation between the various schemes could thus be achieved on economical and technical bases.

Hence, the thesis comprises introduction and five chapters. The first chapter is devoted to the principles of electrical distribution system planning, while the second chapter comprises the system analysis of the investigated distribution systems, equivalent configurations and data.

Further, Chapter Three is devoted to cost function, models, parameters involved and data assembly for its computation.

Furthermore, Chapter Four presents the development of an integrated and more realistic cost function taking all affecting factors into consideration. Investigations of the factors and parameters affecting cost function computation are also included. Applications on various schemes of a composite distribution system are presented.

Finally, Chapter Five presents the main conclusions, recommendations, and suggestions for future investigations.

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I N T R O D U C T I O N.

The electric power system includes generating, transmission, and distribution systems. Generally, the sum of the capital investment of generation and distribution facilities is over 80 percent of the total system investment. The economic importance of the distribution system requires a careful engineering planning, design, construction, and good performance of operation and maintenance.

The integrated distribution system, from the engineering point of view, includes the subtransmission circuits, primary substations, distribution points, main primary feeders, distribution transformers (kiosks), primary feeder sections, secondary circuits, and customer service connections.

As far as the Egyptian electric distribution system is concerned, the statistics of the data collected over about 10 years proves that the demand of the electric energy has been highly increased. The annual rate of its increase reached about 14% which is considered a very high rate compared to the international rates.

Therefore, the electric power engineers, planners,and investigators recently pay a careful attention and special interest to the planning of either new distribution networks or expansion of the present networks. Thus, the elaboration and development of the planning of the distribution networks to meet the demand required by the land use, has gained a prime interest and importance.

Further, the objective of the distribution system planning - as known - is started from the demand loads required by the secondary connections (customers) till the bulk power substations. Furthermore, the investment for the different components as well as the energy losses costs are main factors affecting the planning and design of the distribution networks.

Hence, for the system planning, it is essential to assure that the growing demand for electricity can be satisfied by distribution system additions which are both technically adequate and acceptably economical.

The above considerations call strongly for continuous efforts of researchersand engineers to develop reliable concepts and rules for distribution system planning. Unfortunately, previous investigations

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dealing with the economics of the distribution system when planning disregarded several factors that should have been included in the suggested cost functions. Moreover, previous investigations have considered over simplified configurations disregarding the practical schemes of composite distribution systems. This is believed to yield misleading results in many events on distribution system planning.

This has called strongly for the present work that investigates methods for the optimal planning and design of new distribution networks and/or networks' expansion. These methods took into consideration the practical operational solutions under normal and emergency conditions. Three alternative schemes are included in the study. Load flow and short circuit computer programs have been used to check the power flow, power losses, and voltage profiles.

Further, a generalized objective cost function of a composite distribution network has been developed - for the first time - taking all affecting factors.

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CHAPTER I

PRINCIPLES OF ELECTRICAL DISTRIBUTION SYSTEM PLANNING

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