FINAL YEAR PROJECT REPORT

OPTIMIZED DESIGN OF SINGLE PHASE INDUCTION MOTOR

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(OPTIMIZED DESIGN OF SINGLE PHASE INDUCTION MOTOR)

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Regards :

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CHAPTER 1

ABSTRACT

This thesis presents a design methodology and software design tool, which are useful for the design of induction motors and synchronous generators. A user or designer specifies performance requirements and the system synthesizes a set of design parameters which meet those specifications. Optimization may also be performed by the designer with respect to any performance parameter, while keeping other requirements within specified limits.

Electric machine design is in general a "hard" problem, and most designers rely on their knowledge, experience, and intuition to design new motors or modify existing ones.
Most of the problems encountered can be traced to non-linearity, coupled equations, categorical variables, and presence of multiple objectives. Analysis of given design variables to compute performance parameters are comparatively easier using circuit equation analysis routines. The converse (synthesis process), where we need to generate a set of design variables matching certain performance criteria, is a much harder problem. This is also the more common problem in a design scenario. We propose a two-step methodology to generate designs matching user requirements, and perform optimizations.

In the first step of our methodology, a Monte-Carlo based statistical approach is proposed to circumvent the aforementioned problems. The n-dimensional design space is first reduced to a smaller sub-space which is more likely to contain the desired solutions. A multivariate normal distribution is used to characterize this sub-space. Several designs are generated within this sub-space which allows a user to evaluate multiple design possibilities. All of these designs meet user requirements.

These designs are then also used as starting points for further optimization, in the second step of our methodology. A statistical function approximation tool called MARS (Multivariate Adaptive Regression Spines) is used to "map" the relations between inputs and every performance variable. This map is then used during the optimization process for obtaining function values and gradients at all locations. A non-linear programming algorithm is used to perform all optimizations. Ideas from multiple objective optimization literatures are used to account for multiple performance variables.

The proposed methodology is implemented in an industrial strength software system which allows a firm to perform multiple scenario analyses, automate the design process, perform optimizations, shorten development lead times, and react fast to customer requests.

Several examples using industrial strength circuit analysis routines are presented, and their results analyzed.

Even though this approach is applied to the case of induction motors, and synchronous generators, it is believed that the methodology is sufficiently general, and would be applicable to many design situations.

There are probably more single-phase ac induction motors in use today than the total of all the other types put together.

It is logical that the least expensive, lowest maintenance type of ac motor should be used most often. The single-phase ac induction motor fits that description.

Unlike poly phase induction motors, the stator field in the single-phase motor does not rotate. Instead it simply alternates polarity between poles as the ac voltage changes polarity.

Voltage is induced in the rotor as a result of magnetic induction, and a magnetic field is produced around the rotor. This field will always be in opposition to the stator field (Lenz's law applies). The interaction between the rotor and stator fields will not produce rotation, however. The interaction is shown by the double-ended arrow in figure 4-10, view A. Because this force is across the rotor and through the pole pieces, there is no rotary motion, just a push and/or pull along this line.

There are several types of single-phase induction motors in use today. Basically they are identical except for the means of starting. Once they are up to operating speed, all single-phase induction motors operate the same.

Chapter 2
INTRODUCTION

2.1 Background

Electric motors and generators are referred to as electric machines. Electricians are most frequently concerned with electric motors, due to their extensive application.

The electric motor must be one of man's most useful inventions. In the manufacturing industries they are used in large numbers, to drive lathes, drilling and milling machines, augers, conveyors, cranes, hoists, lifts, fans and steel rolling equipment. In the process industries they are used to pump liquids and gases. They are used in transport to start engines, operate windscreen wipers, open and close windows and power electric vehicles. In domestic situations, they are used in washing machines, clothes dryers, cookers, fridges, freezers, vacuum cleaners, food mixers, audio / video equipment, cameras, clocks etc.

Electric motors are popular because they are compact, reliable, and cheap, need little attention, and are convenient to use. They can be provided in a wide range of sizes and can be designed to have different characteristics for various applications. Also, there is a readily available supply of electricity. The electric motor may be regarded as an energy converter. It is supplied with electrical energy and provides mechanical energy as an output.

There are AC motors and DC motors. There are a number of different types of motor under each heading. They may be classified by their power rating. This may be given in Watts or Horsepower. One Horsepower is the equivalent of 746 Watts. Power ratings range from a few watts, such as those used in electric clocks, through to a few kilowatts, such as those used in domestic, agricultural and light duty industrial situations, to large motors in the order of tens of megawatts. These are used in heavy duty industrial situations such as mining, quarrying and cement plants. Motors are also classified by the way in which their windings are interconnected.

Motors are classified depending on the environment in which they are intended to be used. For example, very high temperature locations, damp locations, dust laden locations and explosive locations.

The basic requirement of an electric motor is that it should provide rotational drive. The motor is fixed in position and drives a mechanical system directly or via gears, belts etc.

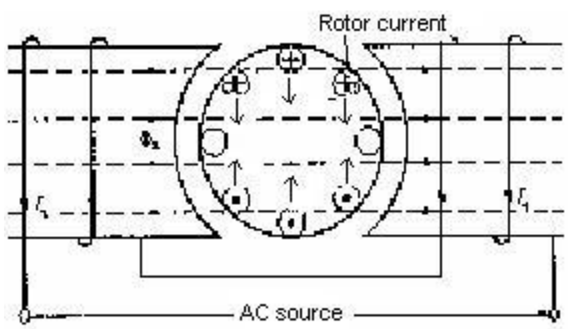
Motors depend for their operation on the interaction between two magnetic fields. Electric current, flowing through windings consisting of copper wire produce both of these magnetic fields. Some small motors use permanent magnets to produce one of the magnetic fields.

2.2 Overview of Project

An induction or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is induced by electromagnetic induction from the magnetic field of the stator winding. An induction motor therefore does not require mechanical commutation, separate-excitation or self-excitation for all or part of the energy transferred from stator to rotor, as in universal, DC and synchronous motors. An induction motor's rotor can be either wound type or squirrel-cage type.

Three-phase squirrel-cage induction motors are widely used in industrial drives because they are rugged, reliable and economical. Single-phase induction motors are used extensively for smaller loads, such as household appliances like fans. Although traditionally used in fixed-speed service, induction motors are increasingly being used with variable-frequency drives (VFDs) in variable-speed service. VFDs offer especially important energy savings opportunities for existing and prospective induction motors in variable-torque centrifugal fan, pump and compressor load applications. Squirrel cage induction motors are very widely used in both fixed-speed and VFD applications.

Single-phase induction motors are the most familiar of all electric motors because they are used in home appliances, businesses, and small industries. In general, they are employed when three-phase power is not available. Single-phase induction motors are usually two-pole or four-pole, rated at 2 hp or less, while slower and larger motor can be manufactured for special purposes. They are widely used in domestic appliances and for a very large number of low power drives in industry. The single phase induction motor resembles, three-phase, squirrel-cage motor except that, at full speed, only a single winding in the stator is excited.
In a single-phase motor we have only a single field winding excited with alternating current; therefore, it does not have a revolving field like three-phase motors. Thus, it does not self-starting. Several methods have been devised to initiate rotation of the squirrel-cage rotor and the particular method employed to start the motor will designate the specific type.



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