DESIGN AND DEVELOPMENT OF INDUCTION MACHINE DRIVE FOR PERFORMANCE OPTIMIZATION

A THESIS

submitted by

ANSHUL KUMAR MISHRA

for the award of the degree

of

MASTER OF SCIENCE

(By Research)

SCHOOL OF COMPUTING AND ELECTRICAL ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY MANDI

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Declaration by the Research Scholar

This is to certify that the thesis entitled "**DESIGN AND DEVELOPMENT OF INDUCTION MACHINE DRIVE FOR PERFORMANCE OPTIMIZATION**", submitted by me to the Indian Institute of Technology Mandi for the award of the degree of Master of Science by Research is a bonafide record of research work carried out by me under the supervision of **Dr. Bharat Singh Rajpurohit**. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

Mandi 175001
Date: Signature of Research Scholar

THESIS CERTIFICATE

This is to certify that the thesis titled **DESIGN AND DEVELOPMENT OF INDUCTION MACHINE DRIVE FOR PERFORMANCE OPTIMIZATION**, submitted by **Anshul Kumar Mishra**, to the Indian Institute of Technology Mandi, for the award of the degree of **Master of Science By Research**, is a bonafide record of the research work done by him under my supervision. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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ABSTRACT

KEYWORDS: *Induction Motor Model, Air-gap Flux Density, Space-Harmonics Winding and Slot Harmonics, Harmonics Inductance Torque Ripple, Multivariable Optimization, Nelder-Mead Simplex Algorithm.*

Now a day a major portion of electric drives include induction motor for mechanical output due to its simple construction and high performance in all physical conditions. Due to wide range of mechanical load profiles, application specific electric drive design became necessary. Design process for any electric drive consists of three main parts, converter design, controller design and electrical machine design. In the modern technological era, any design activity is always followed by the modeling of the device to be designed. This is necessary for the parameter impact determination on the response of the device. Mathematical modeling of an electrical machine is all about to mimic the real machine through a set of voltage, current and dynamics equations subjected to some initial conditions. This work focuses on the approach of induction machine design through targeted variable optimization. Overall work has been completed in three sections.

First section is the modeling of induction motor to forecast the impact of design parameters on the output torque response. A qualitative and analytical approach has been adopted to consider the effect of slots and winding harmonics on the developed electromagnetic torque. Chronological illustration of winding harmonics and modified winding function approach builds up the self and mutual inductance matrices which are the key parameters used as intermediate dependency between input and output variables. An iterative algorithmic approach has been used to solve these six voltage current differential equations along with two motor dynamics equations which determine the response of the induction motor. Model has been excited with sinusoidal input only to demonstrate the effect of winding and slot harmonics on the output torque.

Second section of the work goes for optimization. With purely sinusoidal excitation, the torque response of induction motor model has adequate amount of ripple in it. These ripples are the function of machine design parameters. In this multivariable optimization, torque ripple has been used as the objective function with winding design parameters as the targeted variables. A

simple Nelder-Mead Simplex optimization algorithm has been used for local optimization in the cyclic search space. Applied algorithm has the advantage of minimum computational resources and minimum time to complete the optimization. Obtained variables after ripple minimization have been subjected to design feasibility check. Optimized variable values have been rounded off to nearest feasible values after feasibility check. The optimized design variables have been verified for torque response with the mathematical model described in section one. Effect on power factor and efficiency has been analyzed. With this new design has been finalized and its comparison with existing machine has been done for performance verification.

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