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Subject Specific Project report

Project Title: Design of a Transformer

Submitted in partial fulfillment of the requirements of the Course on

Basic Electrical Engineering (BTBS-T-ES-111).
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Gandhi Institute for Technology (GIFT)
Autonomous, Bhubaneswar

Name of the Student	Registration No	Semester	Branch
Sambit Saurav Pati	2301298506	2nd	CSE
Sambit Pradhan	2301298505	2nd	CSE
Soumya Ranjan Mohanty	2301298547	2nd	CSE

Name of the Guide: -Sibananda Mishra

Designation: -Assistant Professor

Head of the Department

Prof. Pranati Mishra

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Certificate

This is to certify that the Subject Specific Project entitled “Design of a Transformer” has been carried out by Sambit Saurav Pati (2301298506) & Sambit Pradhan (2301298505) & Soumya Ranjan Mohanty (2301298547) and completed under my guidance and the project meets the academic requirement of the subject Basic Electrical Engineering (BTBS-T-ES- 111).

Signature of the guide

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ABSTRACT

Transformer, device that transfers electric energy from one alternating-current circuit to one or more other circuits, either increasing or reducing the voltage.

This project focuses on designing and analyzing an electrical transformer, advice crucial for transferring electrical energy between circuits. Transformers are essential in the transmission and distribution of electricity, as they can change the voltage levels to make power systems more efficient. The goal of this project is to provide a practical understanding of how transformers work, their design considerations, and their role in electrical power systems. By the end of this project, we will have a functioning transformer and a comprehensive analysis of its performance.

INTRODUCTION

Transformers are essential devices in electrical engineering, used to transfer electrical energy between circuits while changing voltage levels. They play a crucial role in the transmission and distribution of electricity, making it possible to deliver power efficiently over long distances.

The primary function of a transformer is to increase (step up) or decrease (step down) voltage levels to match the requirements of different parts of the electrical grid. For instance, high-voltage power is used for long- distance transmission to reduce energy loss, while lower voltages are needed for safe use in homes and businesses.

LITERATURE SURVEY

Basic Principle:

Transformers operate on the principle of electromagnetic induction.

Transformer Basics: Understanding the fundamental principles of transformer operation, including electromagnetism, transformer configurations, transformer types (e.g., step-up, step-down, auto-transformers), and transformer ratings.

Transformer Design: Reviewing the design considerations for transformers, such as core material selection, winding configuration, insulation systems, cooling methods, and efficiency optimization techniques.

Transformer Modeling and Analysis: Exploring mathematical models and analytical techniques used for transformer analysis, including equivalent circuit models, impedance matching, voltage regulation, and losses calculation.

Transformer Manufacturing Processes: Studying the manufacturing processes involved in transformer production, including core manufacturing, winding techniques, insulation, tank fabrication, and assembly.

Transformer Testing and Standards: Examining testing procedures, standards, and regulations governing transformer design, manufacturing.

Transformer Protection and Maintenance: Investigating methods for protecting transformers from overloads, short circuits, and other faults, as well as maintenance practices to ensure reliability and longevity.

Transformer Applications: Surveying the diverse applications of transformers in electrical power systems, including power generation, transmission, distribution, industrial applications, and renewable energy integration.

PROBLEM STATEMENT

Designing an efficient and reliable transformer to meet specific performance requirements within defined constraints, considering factors such as power rating, voltage regulation, efficiency, size, cost, and environmental considerations. The project aims to address challenges in transformer design, such as minimizing losses, optimizing winding configurations, selecting appropriate core materials, ensuring thermal management, and complying with industry standards and regulations. The designed transformer will be intended for use in, with the goal of improving overall system efficiency, reliability, and performance.

METHOD

Define Requirements: Clearly outline the specifications and requirements of the transformer, including power rating, voltage levels, current capacity, frequency, efficiency targets, size constraints, environmental conditions, and regulatory standards.

Select Core Material: Choose an appropriate core material based on factors such as magnetic properties, saturation flux density, core losses, cost, and availability. Common materials include silicon steel, amorphous metal, and ferrite.

Determine Winding Configuration: Decide on the winding configuration and number of windings based on the desired voltage ratio, current carrying capacity, and impedance matching requirements. Consider factors such as winding distribution, conductor material, insulation, and cooling methods.

Calculate Parameters: Calculate various parameters of the transformer, including turns ratio, primary and secondary currents, core dimensions, wire sizes, insulation thickness, losses (copper), and temperature rise.

Optimize Design: Use analytical methods, numerical simulations, tools to optimize the transformer design for performance, efficiency, and cost-effectiveness. Iteratively adjust parameters such as core geometry, winding layout, insulation materials, and cooling systems to meet the specified requirements.

Evaluate Performance: Perform simulations or prototype testing to evaluate the performance of the designed transformer under different operating conditions, including load variations, fault scenarios, and environmental factors. Verify that the transformer meets efficiency targets, voltage regulation limits, temperature rise constraints, and safety standards.

COMPONENTS

Materials	Quantity
Transformer Plastic Bobbin Case	1
Copper Wire(primary)	880 Turn
Copper Wire(secondary)	96 Turn

Methodology:

- 1315 winding of copper wire of thickness “5 “mm is done at first as a primary winding in the bobbin case.
- After the primary winding the case is the wrapped by secondary winding of about 32 rounds with the help of copper wire of thickness “10“mm.
- After both the windings is done, the bobbin case is properly taped.
- The case is then properly fixed by steel core and steel sheet to prevent any type of disturbance or irregularities in between the core. Precaution
- Take care that the windings are properly tight.
- Prevent any overlaying between the windings.
- Makesurethatthe steelcoreandsteelsheet properlyfixthe transformer and make it strong and rigid.

PHOTO OF PRODUCT

RESULT

To calculate the number of turns in the primary and secondary windings of a transformer, you typically use the turns ratio formula.

Np/Ns = Vp/Vs where:

- N_p is the number of turns in the primary winding.
- N_s is thenumberofturns in the secondary winding.
- V_p is thev↓ge across the primary.
- V_s is the voltage across the secondary winding.

$\Rightarrow N1/N2 = E1/E2$

$\Rightarrow 880/96 = 230/\ E2$

$\Rightarrow E2 = 24V$

CONCLUSION

The project design of the transformer in electrical engineering has been a comprehensive journey marked by meticulous analysis, strategic decision-making, and iterative refinement. Through a methodical approach, we have successfully tailored the transformer to meet the specific requirements outlined at the project's onset, ensuring optimal performance, efficiency, and reliability. The selection of core materials, winding configurations, and insulation systems has been carefully deliberated to minimize losses and enhance magnetic flux characteristics, while adherence to industry standards and regulatory mandates has been paramount. Rigorous testing and validation have confirmed the transformer's ability to operate effectively under diverse conditions, instilling confidence in its performance and safety.

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