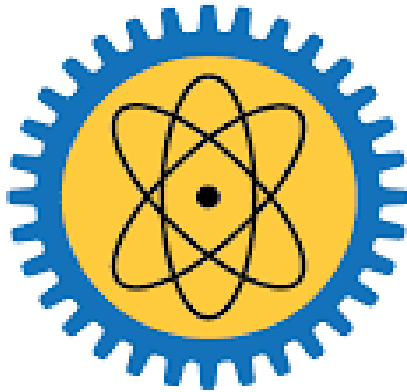




**BUSITEMA
UNIVERSITY**
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FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING

**DESIGN AND SIMULATION OF A POWER QUALITY
IMPROVEMENT SYSTEM FOR MEDIUM/LOW-VOLTAGE
DISTRIBUTION NETWORKS: A CASE STUDY OF KIGEZI
HIGHLAND TEA FACTORY, UGANDA**

BY

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*A final year project report submitted to the faculty of engineering in partial fulfillment
of the requirement of the award of the degree of Bachelor of Science in Electrical
Engineering of Busitema University*

MAY 2025

DECLARATION

I, NIZEYIMANA ALEX, do hereby declare that this report written in partial fulfillment of the requirement of the award of the degree of Bachelor of Science in Electrical Engineering of Busitema University is my own authentic work and the content of this document has never been submitted to any institution of higher education except where due reference is made.

NIZEYIMANA ALEX

Signature:..... Date:.....

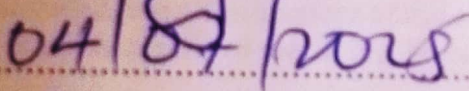
APPROVAL

This is to certify that this project report on **Design and simulation of a power quality improvement system for medium and low voltage distribution networks: A case study of KIGEZI Highland Tea Factory in Southwestern Uganda** was compiled and completed by **NIZEYIMANA ALEX** under the guidance and supervision of my university supervisors.

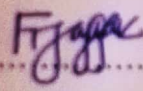
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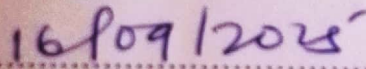
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LIST OF PRINCIPAL SYMBOLS AND ABBREVIATION

UAPF	Universal Active Power filter
DSTATCOM	Distributed Static Compensator
DVR	Dynamic Voltage Restorer
CPD	Custom Power Device
DG	Distributed Generation
DER	Distributed Energy Resources
VSC	Voltage Source Controller
LV	Low Voltage
THD	Total Harmonic Distortion
UPQC	Unified Power Quality Compensator
PCC	Point of Common Coupling
OLTC	Online Tap Changer
V	Instantaneous voltage
i	Instantaneous current
P	Real power
Q	Reactive power
R	Resistance
L	Inductance
C	Capacitance
Z	Impedance
PQ	Power Quality

ABSTRACT:

Power quality disturbances such as harmonic distortion, voltage fluctuations, and poor power factor pose significant challenges to industrial processes, especially in rural and semi-urban areas of Uganda where power infrastructure is limited. The Kigezi Highland Tea Factory, a key agro-industrial facility, experiences frequent operational inefficiencies and equipment failures due to these power quality issues. This project presents the design and simulation of a **Universal Active Power Filter (UAPF)** aimed at improving the power quality of the factory's **low-voltage distribution network**.

The proposed system was modeled using **MATLAB/Simulink** and incorporated a **Proportional-Integral (PI) controller** for regulating the DC-link voltage and a **Hysteresis Current Controller (HCC)** for real-time harmonic current compensation. A nonlinear load, representative of the factory's actual operational conditions, was simulated to assess the system's performance. Simulation results demonstrated a significant reduction in **Total Harmonic Distortion (THD)** from 19.18% to 4.9%, improved power factor from, and effective balancing of phase currents.

The findings confirm that the UAPF, when equipped with appropriate control strategies, can effectively mitigate power quality problems in industrial low-voltage networks. The system offers a scalable and adaptable solution for similar industrial facilities across Uganda, contributing to more reliable and efficient energy use.

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