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**STUDYING THE TURBINE-GENERATOR  
OSCILLATIONS  
A CASE STUDY OF LAKVIJAYA POWER STATION**

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Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

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Thesis/Dissertation submitted in partial fulfilment of the requirements for the degree

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## DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Master thesis under my supervision.

Signature of the supervisors:

Date: 10.05.2024

**Dr. W. D. Prasad**

## **DEDICATION**

My loving parents and my beloved wife who are nourishing and cherishing me and  
to my little adorable sons Ayuk and Anuk.

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## Abstract

The Lakvijaya Power Station located in Narakkaliya, Norochcholai, Sri Lanka plays a crucial role in the nation's energy sector, contributing significantly by almost half of the load to the electricity grid at most of the year. However, similar to any large-scale power facility, it also faces operational challenges, including turbine-generator oscillations. This research study presents a comprehensive study focused mainly on understanding and help mitigating these oscillations for improved operational efficiency and grid stability.

This research inherits a good conjunction of theoretical analysis, numerical simulations, and practical measurements to characterize the nature and causes of turbine-generator oscillations at Lakvijaya Power Station. Through detailed modelling, factors such as turbine multi-stages dynamics, generator response characteristics, speed governor controls, excitation controls, and grid interactions are investigated to identify potential sources of oscillations.

Furthermore, advanced signal processing techniques are applied to real-time operational data to detect and analyze oscillatory patterns. This includes frequency domain analysis and modal analysis with modulation study to pinpoint dominant oscillation frequencies and modes.

The results of this study offer valuable insights for power plant operators, grid operators, and researchers involved in the operation and optimization of large-scale power generation facilities. By detailed in-depth evaluation of turbine-generator oscillations at Lakvijaya power station, this study contribute to the broader country's visionary policy of ensuring reliable and efficient electricity supply in Sri Lanka's energy landscape.

**Keywords:** Lakvijaya Power Station, turbine-generator oscillations, torsional interactions, power plant optimization, grid stability, small-signal assessment.

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## ABBREVIATIONS

<b>Shortened form</b>	<b>Interpretation</b>
AM	Amplitude Modulation
AVR	Automatic Voltage Regulator
BB	Bus Bar
CCE	Cable Connection Enclosure
CEB	Ceylon Electricity Board
CMEC	China Machinery and Engineering Corporation
CT	Current Transformer
CVT	Capacitive Voltage Transformer
D-axis	Direct axis
DS	Disconnect Switch
ERA	Eigen system Realization Algorithm
ES	Earthing Switch
ESPRIT	Estimation of Signal Parameters via Invariance Technique
ET	Excitation Transformer
FES	Fast Earthing Switch
G	Generator
GIS	Gas Insulated Substation
GT	Generator Transformer
HIP	High & Intermediate Pressure
HV	High Voltage

HVDC	High Voltage Direct Current
IEEE	Institute of Electrical and Electronics Engineers
IPB	Isolated Phase Bus
LA	Lightning Arrester
LP	Low Pressure
LV	Low Voltage
LVPP	Lakvijaya Power Plant
LVPS	Lakvijaya Power Station
MT	Main Transformer
NPB	Non-isolated Phase Bus
O&M	Operation and Maintenance
PM	Phase-angle Modulation
PSS	Power System Stabilizer
Q-axis	Quadrature axis
SCC	System Control Centre
SLD	Single Line Diagram
SST	Start-up Standby Transformer
SVC	Static Var Compensator
UAT	Unit Auxiliary Transformer
UKPS	Upper Kotmale Power Station
VD	Vision Device
VT	Voltage Transformer