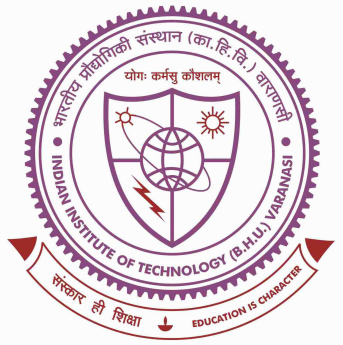
Design and Development of Multi-Output Multi-level Converter for Multi-Motor Drives



A thesis submitted in partial fulfillment of the requirements

for the award degree

Doctor of Philosophy

by

Dhawal Dwivedi

DEPARTMENT OF ELECTRICAL ENGINEERING

Indian Institute of Technology

(Banaras Hindu University), Varanasi

Varanasi-221005

INDIA

Roll No: 21081005

October 2025

Certificate

It is certified that the work contained in this thesis entitled **"Design and Development of Multi-Output Multi-level Converter for Multi-Motor Drives"** by **Dhawal Dwivedi** has been carried out under my supervision and that it has not been submitted elsewhere for a degree.

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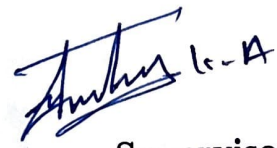

Supervisor

Dr. Chinmaya K A

Assistant Professor

Dept. of Electrical Engg.

IIT(BHU), Varanasi

Uttar Pradesh, INDIA.

Declaration

I, **Dhawal Dwivedi**, certify that the work embodied in this thesis titled **"Design and Development of Multi-Output Multi-level Converter for Multi-Motor Drives"** is my own bonafide work and has been carried out by me under the supervision of **Dr. Chinmaya K A** from July-2021 to July-2025, at the Department of Electrical Engineering, Indian Institute of Technology (Banaras Hindu University), Varanasi (UP).

To the best of my knowledge, it is an original work, both in terms of research content and narrative, and has not been submitted elsewhere, in part or in full, for a degree. Further, due credit has been attributed to the relevant state-of-the-art and collaborations with appropriate citations and acknowledgments, in line with established norms and practices.

Dhawal

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(Dhawal Dwivedi)

Roll No. 21081005

Dept. of Electrical Engg.

IIT(BHU), Varanasi

Uttar Pradesh, INDIA.

Date: 09/10/25

Place: Varanasi

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It is certified that the above statement made by the student is correct to the best of our knowledge.

K. A

Dr. Chinmaya K A

(Supervisor)

Signature of Head of Department

Prof. R. K. Singh

आचार्य एवं विभागाध्यक्ष / PROFESSOR & HEAD
विद्युतीय अभियांत्रिकी विभाग /Department of Electrical Engineering
भारतीय प्रौद्योगिकी संस्थान/Indian Institute of Technology
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Dedicated to family.

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Abbreviations

ANPC	Active Neutral Point Clamped
B2B	Back To Back
CHB	Cascaded H-Bridge
CMOM	Cascaded Multi-Output Multilevel
CF	Common Frequency
C5L-ANPC	Conventional Five-level Active Neutral Point
CFLS-MLI	Conventional Five-Level Stacked MLI
DF	Different Frequency
DFC-ANPC	Dual Flying Capacitor Active Neutral Point Clamped
DP	Different Phase
DOC	Dual-Output Converter
EV	Electric Vehicle
ESR	Equivalent Series Resistance
FCS	Finite Control Set
FC	Flying Capacitor
FLSDO	Five-Level Stacked Dual Output

5LDO-ANPC	Five-level Dual-Output Active Neutral Point
IM	Induction Motor
IGBT	Insulated-Gate Bipolar Transistor
IPD-PWM	In-Phase Disposition Pulse-Width Modulation
MOSFET	Metal–Oxide–Semiconductor Field-Effect Transistor
MPC	Model Predictive Control
M-CDOM	Modified Cascaded Dual-Output Multilevel
M-CMOM	Modified Cascaded Multi-Output Multilevel
NPC	Neutral-Point Clamped
NPP	Neutral-Point Piloted
PD-PWM	Phase Disposition Pulse-Width Modulation
PMSM	Permanent Magnet Synchronous Motor
PO	Parallel Output
PV	Photovoltaic
PWM	Pulse-Width Modulation
RES	Renewable Energy Sources
RMS	Root Mean Square
SVM	Space Vector Modulation
TLDO-ANPC	Three-Level Dual-Output Active Neutral-Point Clamped
3PPMLI	Three-Phase Three-Port Multilevel Inverter
TL-SDOFL	Three-Leg Stacked Dual-Output Five-Level
THD	Total Harmonic Distortion

UPS Uninterruptible Power Supply

WTHD Weighted Total Harmonic Distortion

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