Declaration

I hereby declare that the work presented in this Thesis titled **"Enhancement of Wind Energy Penetration Levels In Rural Grid By Power Quality Mitigation Using DSTATCOM Controlled by Adaptive Algorithms"** submitted to the Indian Institute of Technology Jodhpur, India in partial fulfilment of the requirements for the award of the degree of **Doctor of Philosophy**, is a bonafide record of the research work carried out under the supervision of **Prof. Abdul Gafoor Shaik**. The contents of this Thesis in full or in parts have not been submitted to, and will not be submitted by me to any other Institute or University in India or abroad for the award of any degree or diploma.

Gajendra Singh Chawda
P15VSS006

Certificate

This is to certify that the thesis titled **"Enhancement of Wind Energy Penetration Levels In Rural Grid By Power Quality Mitigation Using DSTATCOM Controlled by Adaptive Algorithms"**, submitted by **Gajendra Singh Chawda (P15VSS006)** to the Indian Institute of Technology Jodhpur, India for the award of the degree of **Doctor of Philosophy**, is a bonafide record of the research work done by him under my supervision. To the best of my knowledge, the contents of this report, 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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List of Symbols

Symbol	*Description*
i^*_{gpabc}, i^*_{gqabc}	Reference active and reactive currents
i_{gabc}, i^*_{gabc}	Sensed and reference grid currents
W_{wind}	Wind Feed forward weight component
u_{tpabc}, u_{tqabc}	Active and reactive voltage unit templates
v_t, v_{tn}	Sensed and reference terminal voltage
v_{dc}, v^*_{dc}	Sensed and reference DC-link voltage
v_{de}, v_{te}	Voltage errors of PI controllers
W_{pabc}, W_{qabc}	Active and reactive weights of load current
W_{sp}, W_{sq}	Active and reactive updated total weights
W_p, W_q	Active and reactive averaged weights
I_p, I_q	Active and reactive loss components
i_{Labc},i_{wabc},i_{cabc}	Load, wind and compensating currents
v_{Labc},v_{wabc},v_{cabc}	Load, wind and compensating voltages
P_g,P_w	Grid and wind active powers
Q_g,Q_D	Grid and DSTATCOM reactive powers
Z_g,PF_g	Impedance and power factor of grid
v_{dcw},W_{rw}	Wind DC-bus voltage and rotor speed
μ and τ	Convergence factors
i^*_{pabc}, i^*_{qabc}	Reference active and reactive currents
W_{pabc}, W_{qabc}	Active and reactive weights of load current
W_{Lpa}, W_{Lqa}	Average active and reactive weights
C_{dc}, C_f	DC-link capacitor and ripple filter capacitor
S_{cc}	Short circuit power capability of system

S_p	Total installed rated power of WE sources
L_f, R_f	Interfacing inductor and resistor
D_1-D_4	Adaption delays
i_{gTHD}	Total harmonics distortion of grid current
v_{gTHD}	Total harmonics distortion of grid voltage

List of Abbreviations

Abbreviation	*Full form*
3P4W	Three Phase Four Wire
3P3W	Three Phase Three Wire
ABT	Admittance Based Theory
ACA	Adaptive Control Algorithm
ADALINE	Adaptive Linear Element
ALMS	Adaptive Least Mean Square
ALMF	Adaptive Least Mean Fourth
ANF	Adaptive notch filter
ANFIS	Adaptive Neuro-Fuzzy Inference System
ARLS	Adaptive Recursive Least Square
BESS	Battery Energy Storage System
CCA	Conventional Control Algorithm
CIGRE	International Council on Large Electric Systems
DFACTS	Distributed Flexible AC Transmission System
DFIG	Double-Fed Induction Generator
DLMF	Delayed Least Mean Fourth
DLMS	Delayed Least Mean Square
DSP	Digital Signal Processing
DSSSC	Distributed Static Synchronous Series Compensator
DSSC	Distributed Static Series Compensator
DSTATCOM	Distribution Static Compensator
DSVC	Distributed Static VAr Compensator
DTCSC	Distributed Thyristor Controlled Series Compensator

DVR	Dynamic Voltage Restorer
EPLL	Enhanced Phase-Locked Loop
FC	Fuel Cell
FLC	Fuzzy Logic Controller
FPGA	Field Programmable Gate Array
GSC	Grid Side Converter/Built-in Converter
HCC	Hysteresis Current Controller
ICCT	Indirect Current Control Theory
IGBT	Insulated Gate Bipolar Transistor
IPQC	Interline Power Quality Compensator
IRPT	Instantaneous Reactive Power Theory
ISOs	Independent System Operators
LMF	Least Mean Fourth
LMS	Least Mean Square
LPF	Low Pass Filter
NL	Non-Linear Load
PCC	Point of Common Coupling
PF	Power Factor
PI	Proportional–Integral
PID	Proportional Integral Derivative
POI	Point of Interconnection
PLL	Phase Locked Loop
PQ	Power Quality
PMSG	Permanent Magnetic Synchronous Generator
PWM	Pulse Width Modulation
RE	Renewable Energy
RES	Renewable Energy Source
RLS	Recursive Least Square

RSC	Rotor Side Converter
RSGA	Reference Signal Generation Algorithm
SAPF	Shunt Active power Filter
SCR	Short Circuit Ratio
SEIG	Self-Excited Induction Generator
SMC	Sliding Mode Controller
SOGI	Second Order Generalized Integrator
SPV	Solar Photo-Voltaic
SPWM	Sinusoidal Pulse Width Modulation
SRFT	Synchronous Reference Frame Theory
SyRG	Synchronous Reluctance Generator
THD	Total Harmonic Distortion
TDD	Total Demand Distortion
UPQC	Unified Power Quality Conditioner
VFFRLS	Variable Forgetting Factor RLS
VSC	Voltage Source Converter
VSLMS	Variable Step LMS
WE	Wind Energy
WECS	Wind Energy Conversion System
WES	Wind Energy Source
X/R	Ratio of Reactance and Resistance