CERTIFICATE

It is certified that the work contained in the thesis titled, "**Resilient and Robust Control Approaches for Improved Performance in Integrated Power Networks with Uncertainties**", by **Vivek Kumar** has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

It is further certified that the student has fulfilled all the requirements of Comprehensive Examination, Candidacy, and SOTA for the award of Ph.D. Degree.

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I, **Vivek Kumar**, certify that the work embodied in this thesis is my own bonafide work and was carried out by me under the supervision of **Dr. Soumya R. Mohanty** from January-2019 to November 2022, at the Department of Electrical Engineering, Indian Institute of Technology (BHU), Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not wilfully copied any other's work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports, dissertations, theses, etc., or available on websites and have not included them in this thesis and have not cited as my own work.

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

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List of Abbreviations and Symbols

V_{dc}	DC bus voltage
i_{bat}	Battery output current
i_{pv}	PV output current
i_{load}	DC load intake current
i_{dc}	DC current of inverter
C	DC link capacitor
i_{dc}	e_d,e_q Inverter output direct and quadrature voltage
i_{invd}, i_{invq}	Inverter output direct and quadrature current component
V_{cd}, V_{cq}	Direct and Quadrature axis components of filter capacitance voltage
i_d, i_q	Active, Reactive components of inverter output current
R_d	Damping resistance
ω	Fundamental angular frequency
L_1 , L_2	Filter inductance
R_1, R_2	Parasitic resistances of the filter inductances
C_f	Filter capacitance
U_d, U_q	Direct and Quadrature component of grid voltage
P_g	Grid active power sharing
V_{dcref}	DC bus reference voltage
$i_{dref,} i_{qref}$	Reference component of inverter output current
∂	Fractional coefficient
$x, x_e, x_{ref}, x_{e\Delta}$	System states, error states, reference state value and state error deviation
$\mathcal{J}$	System input matrix
S_i, S_{dis}	Sliding surfaces super twisting control and disturbance observer
k_i	Positive sliding mode control gains for i=1,2,3.

k_{pr}	Positive sliding mode control gain for power rate reaching law.
$\lambda_{min}(K_i)$	Minimum eigen value of matrix K_i
U, U_{nom}, U_{int}	Control input, normalized control input and integral control input.
$\mathcal{L}, \mathcal{L}_1, \mathcal{L}_a, \mathcal{L}_A$	Lipschitz coefficients
V	Lyapunov candidate
δ	System input matrix multiplier
T_{ie}	Inter execution time between two consecutive events
$\emptyset, \emptyset_m, \emptyset_{um}$	Matched/Unmatched disturbances
G	Transpose input system matrix
β_{int}	Integral term of super twisting surface
m	Integral Coefficient
v_d	Direct component of reference signal through ETSTSMC
$\|.\|$	Signals second norm
δ	Power angle
ω	Rotor speed concerning the synchronous reference
ω_0	Synchronous speed
H	Inertia constant
P_M	Mechanical power input
D	Damping constant
P_e	Active electrical power output
E_q	Field variable proportional to field flux linkages
T_{do}	d −axis transient open-circuit time constant
x_d	d −axis synchronous reactance
x'_d	d −axis transient reactance
E_{fd}	Equivalent field excitation voltage
E_d	Damper variable proportional to the d −axis damper flux linkages
T_{qo}	q −axis transient open-circuit time constant

x_q	q −axis synchronous reactance
x'_q	q −axis transient reactance
T'_{do}	d −axis sub transient open-circuit time constant
T'_{qo}	q −axis sub transient open-circuit time constant
K_A	Regulator gain
T_A	Regulator time constant
$\mathbb{R}$	Set of real numbers
$(.)^T$	Transpose of a matrix
$(.)^{-1}$	Inverse of a matrix
F'	First-order derivative of a function F
$sign$	Standard signum function
$\|.\|$	Denotes the mode value
$\lambda(.)$	Eigenvalue
I	Identity matrix
$svd(.)$	Singular value of a matrix
max(.)	Maximum value of a signal