



**OPTIMIZATION OF THE PERFORMANCE OF GRID-  
CONNECTED WIND-DRIVEN DOUBLE-FED  
INDUCTION GENERATOR**

By

**Ayman Mohamed Abdalsamie Abdalhaliem**

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
In Partial Fulfillment of the  
Requirements for the Degree of  
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In  
**Electrical Power and Machines Engineering**

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
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Under the Supervision of

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Title of Thesis:

Optimization of the Performance of Grid-Connected Wind-Driven Double-Fed Induction Generator

Key Words:

DFIG; wind ; induction generator ; turbine ; control

Summary:

A complete study of the effect of injecting the rotor of the double fed induction generator with a voltage that is variable in both magnitude and phase angle which resulted in optimization of the performance of the double fed induction generator to achieve the point of maximum power extracted from wind and one of two options, either obtaining minimum losses or operating at a preset power factor value. A comparison has been conducted between the double fed induction generator performance using the employed control strategies and the single fed induction generator.

# Acknowledgments

To my Advisors Prof. Dr. Adel Shaltout and Prof. Dr. Hussein Abdel-khalek Attia thank you for the great support.

To my father words cannot describe how grateful I am for your endless support in every aspect of my life, thank you.

# Dedication

To my Father the man I owe everything  
To my Mother without you this would have never happened  
To my wife thank you for your patience

I wish I made you all proud....

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# List of Symbols

$C_T$	Thrust coefficients
$C_Q$	Torque coefficients
$C_P$	Power coefficients
$E_s$	Internal Voltage, V
$F_T$	Thrust force, newton
$I_r$	Rotor Current, A
$I_e$	Magnetizing current, A
$I_s$	Stator current, A
$P_m, P_r$	Power extracted from wind, W
$P_e$	Electrical Power generated, W
$P_{core}$	Core losses, W
$P_{cu}$	Copper losses, W
$P_{loss}$	Total power losses
$P_V$	The power in the wind, W
$Pf_s$	Stator Power factor
$Pf_r$	Rotor Power factor
$Q_s$	Stator Reactive power
$Q_r$	Rotor Reactive power
$R$	Turbine blades radius, m
$R_1, R_s$	Stator Resistance
$R_2, R_r$	Rotor resistance
$R_m$	Core loss resistance
$R_{ms}$	Real (resistive) component of $Z_{ms}$
$R_T$	Thevinin's equivalent circuit resistance
$s$	Slip speed
$T$	Torque, N.m
$V$	Wind speed, m/s
$V_1, V_s$	Stator terminal Voltage, V
$V_t$	Thevinin's equivalent circuit voltage, V
$V_r$	Rotor Voltage, V
$V_t$	Thevinin's equivalent circuit voltage, V
$X_1, X_s$	Stator Reactance, Ohm
$X_2, X_r$	Rotor reactance, Ohm
$X_m$	Magnetizing reactance, Ohm

$X_T$	Thevinin's equivalent circuit reactance, Ohm
$Z_{ms}$	The equivalent series impedance of the parallel combination $R_m$ and $X_m$ , Ohm
$T$	Torque, N.m
$\beta$	Pitch angle, Degree
$\lambda$	Tip-speed ratio
$\rho$	Air density, Kg/m <sup>3</sup>
$\Omega_r$	mechanical angular speed of the turbine, rad/s
$\psi_s$	Stator voltage phase angle, degree
$\phi_s$	Stator current phase angle, degree
$\Psi_r$	Rotor voltage phase angle, degree
$\Phi_r$	Rotor current phase angle, degree
$\eta$	efficiency

# List of Abbreviations

<b>DFIG</b>	Double fed induction generator
<b>SFIG</b>	Single fed Double induction generator
<b>IG</b>	Induction generator
<b>AC</b>	Alternating Current
<b>FSIG</b>	Fixed-Speed induction-generators
<b>SCR</b>	Silicon controlled Rectifier
<b>I/P</b>	Input
<b>CAD</b>	Computer aided design
<b>m/c</b>	Machine