Faculty of Engineering

Cairo University

PRIMARY FREQUENCY CONTROL FOR WIND TURBINE

By

Abdulhameed Shueai Hassan Alsharafi

A thesis submitted to the
Faculty of Engineering at Cairo University
in partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Electrical Power and Machines Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2018

PRIMARY FREQUENCY CONTROL
FOR WIND TURBINE

By

Abdulhameed Shueai Hassan Alsharafi

A thesis submitted to the
Faculty of Engineering at Cairo University
in partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Electrical Power and Machines Engineering

Under supervision of

Prof. Dr. Hassan Mohamed Rashad Emara

Professor
Electrical Power and Machines Department
Faculty of Engineering
Cairo University

Dr. Ahmad Hussein Tawfeek Besheer

Assistant Professor
Environmental Studies & Research institute
University of Sadat City

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2018

PRIMARY FREQUENCY CONTROL
FOR WIND TURBINE

By

Abdulhameed Shueai Hassan Alsharafi

A thesis submitted to the
Faculty of Engineering at Cairo University
in partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Electrical Power and Machines Engineering

Approved by the
Examining Committee:

Prof. Dr. Hassan Mohamed Rashad Emara Professor in Electrical Power and Machines Department Faculty of Engineering - Cairo University.	Thesis Main Advisor
Dr. Ahmad Hussein Tawfeek Besheer Assistant Professor in University of Sadat City.	Advisor
Prof. Dr. Mohamed Salah Elsobki Professor in Electrical Power and Machines Department Faculty of Engineering - Cairo University.	Internal Examiner
Dr. Eng. Abou-Bakr Abdel-Hameed First Deputy-Minister, Ministry of Elect. & Renewable Energy New & Renewable Energy Authority.	External Examiner

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2018

Engineer:	**Abdulhameed Shueai Hassan Alsharafi.**
Date of Birth:	01/01/1985
Nationality:	Yemeni
E-mail:	alsharafi.ab@pg.cu.edu.eg
Phone:	+201124449678
Address:	Giza - Egypt
Registration date:	01/03/2014
Awarding Date:	/ /2018
Degree:	Master of science
Department:	Electrical Power and Machines Engineering
Supervisors:	**Prof. Dr. Hassan Mohamed Rashad Emara** Professor in Electrical Power and Machines Department Faculty of Engineering - Cairo University.
	Dr. Ahmad Hussein Tawfeek Besheer Assistant Professor in University of Sadat City.
Examiners:	**Prof. Dr. Mohamed Salah Elsobki** (Internal Examiner) Professor in Electrical Power and Machines Department Faculty of Engineering - Cairo University.
	Dr. Eng. Abou-Bakr Abdel-Hameed (External Examiner) First Deputy-Minister, Ministry of Elect. & Renewable Energy New & Renewable Energy Authority.
	Prof. Dr. Hassan Mohamed Rashad Emara (Thesis Main Advisor) Professor in Electrical Power and Machines Department Faculty of Engineering - Cairo University.
	Dr. Ahmad Hussein Tawfeek Besheer (Advisor) Assistant Professor in University of Sadat City.

Title of thesis:
Primary Frequency Control for Wind Turbine.

Key Words:
Frequency regulation, wind turbine, inertial controller, pitch controller.

Summary:
Primary frequency controls for wind turbine are discussed. Variable speed wind turbine connected with hydro turbine is simulated using Simulink/Matlab. Different scenarios are analyzed and compared, where several primary frequency control are used to support the frequency response after system disturbance with two different cases of wind speed, the first is high wind speed and the second is low wind speed. The thesis proposes two new controllers' structure based on combination strategy between different controllers. The best combined controller that leads to reducing the rate of change of frequency and raising the frequency nadir.

Acknowledgment

First, Thank to Allah who supported, helped and strengthened me in all of my life and in completing my study for the Master of Science degree.

I would like deeply to express my thanks and gratitude to my supervisors; Prof. Dr. Hassan Mohamed Rashad Emara and Dr. Ahmed Hussein Tawfeek Besheer for their faithful supervision, enormous efforts, and their great patience during the period of the research.

Finally, I would like thank my family & friends for their great inspiration, kind support, and continuous encouragement.

Dedication

This work is dedicated to my mother, my father's spirit & my family

To my wife & my daughters

To my friends

To my university professors

Table of Contents

List of Tables

List of Figures