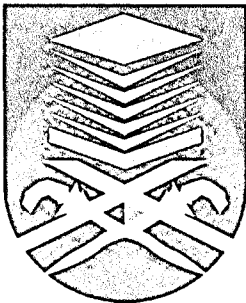


**TWEEK ATMOSPHERICS REFLECTION HEIGHT  
MEASUREMENTS DUE TO GEOMAGNETIC STORM  
OBSERVED IN THE LOW LATITUDE REGION**

Thesis presented in partial for the award of the  
Bachelor of Engineering (Hons) Electronics (Communication)  
UNIVERSITI TEKNOLOGI MARA (UiTM).



**KHAIRUNNISA BINTI ZAINAL ASHAR**  
**FACULTY OF ELECTRICAL ENGINEERING**  
**UNIVERSITI TEKNOLOGI MARA (UITM)**  
**40450 SHAH ALAM,**  
**SELANGOR, MALAYSIA**

## ACKNOWLEDGEMENT

First and foremost, praises to Allah S.W.T., the most Gracious and Merciful for giving me blessing and strength to complete my final year project and thesis. Peace upon our Prophet Muhammad S.A.W. who has given the light to mankind.

I would like to take this opportunity to express my highest appreciation to my project supervisor Dr. Norsuzila Binti Ya'acob for her commitment and effort in helping me completing this research. Her wide knowledge and logical way of thinking have been helping me a lot. Her understanding, encouraging and personal guidance have provided a good basis for the present thesis.

Besides, I would like to thank my co-supervisor Mr. Khairul Khaizi Bin Mohd. Shariff who has giving me guidance, encouragement as well as invaluable knowledge in completing this project. A lot of idea, great instruction and knowledge given to me have been fully used to completing the quality and useful research.

I also wish to convey my thanks to my beloved father, Zainal Ashar Bin Basri and my lovely mother, Nor Hasimah Binti Abd Rani that always gave me space and always encouraged me in completing this project. Their kindness will always get a special place in my heart. Furthermore, this research is grateful to Stanford University VLF research group, and Prof. Umran Inan and Dr. Morris Cohen in particular for providing the online VLF Data on <http://vlf.stanford.edu/vlfdata/>. Special thanks to the World Data Centre (WDC), Kyoto for providing the recorded data of Dst geomagnetic index.

Last but not least, a special appreciation to my friends for being supportive and helpful in process for preparing this project and thesis. I would not make it this far without their support, patience and encouragement along this period.

## ABSTRACT

Tweek atmospherics are ELF/VLF pulse signals with frequency dispersion characteristics that originate from lightning discharge and propagate in the Earth-ionosphere waveguide mode over long distances. In this present paper, investigations are made to examine the response of the D-region ionosphere to major magnetic storm by the tweek observations. This paper is to address issues that might be faced because of geomagnetic storm events due to our communication especially to radio frequency waves and signal strength transmission. The purpose of doing this project is to analyse and identify the tweek atmospheric characteristics in Malaysia, estimate the ionospheric reflection height ( $h$ ), equivalent electron densities ( $N_e$ ) at reflection heights, propagation distance ( $d$ ) using Matlab simulation process and to indicated the correlation on reflection height between active geomagnetic storm on 3<sup>rd</sup>-5<sup>th</sup> August 2010 and quiet day. Major geomagnetic storm on 3<sup>rd</sup> – 5<sup>th</sup> August 2010 is selected due to the changes in the Dst-index executions. The correlation between geomagnetic activity due to active and quiet time based on Kp index and observation of tweek will be investigates. VLF signal is deployed from system called Atmospheric Weather Electromagnetic System for observation Modelling and Education (AWESOME) through its VLF receiver. Located at low latitude station, Selangor (03.5°N 101.31°E) Malaysia, VLF tweek data were recorded for 60 second at every hour only at the night time are presented. Matlab is used to stimulate the data to produced spectrogram to be analysed. The value of ionospheric reflection height varies in the range ~80–90 km. Based on the clarity of dispersion seen in the spectrogram, the analysis for  $h$  was made using few selected tweeks observed during August 2010.

# TABLE OF CONTENTS

<b>DECLARATION</b>	<b>iv</b>
<b>ACKNOWLEDGEMENT</b>	<b>v</b>
<b>ABSTRACT</b>	<b>vi</b>
<b>TABLE OF CONTENTS</b>	<b>vii</b>
<b>LIST OF FIGURES</b>	<b>x</b>
<b>LIST OF TABLES</b>	<b>xii</b>
<b>LIST OF ABBREVIATION</b>	<b>xiii</b>

## CHAPTER

<b>1</b>	<b>INTRODUCTION</b>	
1.1	BACKGROUND OF STUDY	1
1.2	PROBLEM STATEMENT	4
1.3	SIGNIFICANCE OF THE STUDY	5
1.4	RESEARCH OBJECTIVES	5
1.5	SCOPE OF STUDY	6
1.6	THESIS ORGANIZATION	7
<b>2</b>	<b>LITERATURE REVIEW</b>	
2.1	INTRODUCTION	8
2.2	LIGHTNING STROKES	8
	2.2.1 THUNDERSTORM CHARGING MECHANISM	10
	2.2.2 CLOUD-TO-GROUND (CG) LIGHTNING	12
2.3	ELF/VLF WAVEGUIDE	12
2.4	IONOSPHERE	14
	2.4.1 IONOSPHERIC LAYER	17
	2.3.1 <i>D</i> -REGION	17
	2.3.2 <i>E</i> - REGION	18
	2.3.4 <i>F</i> - REGION	18
2.5	TWEEK RADIO ATMOSPHERICS	20
2.6	THE MAGNETOSPHERE	24
	2.6.1 RADIATION BELTS	26

2.7	GEOMAGNETIC STORM	27
2.8	SUMMARY	29
<b>3</b>	<b>METHODOLOGY</b>	
3.1	INTRODUCTION	30
3.2	DATA COLLECTION	31
3.3	AWESOME ELF/VLF RECEIVER SYSTEM	31
	3.3.1 CROSSED LOOP ANTENNAS	32
	3.3.2 PRE-AMPLIFIER	33
	3.3.3 LINE RECEIVER	34
3.4	METHOD	35
	3.4.1 LITERATURE REVIEW	36
	3.4.2 ELF/VLF BROADBAND DATA COLLECTION	37
	3.4.3 ELF/VLF BROADBAND DATA CLASSIFICATION	37
	3.4.4 ELF/VLF BROADBAND DATA SIMULATION	37
	3.4.5 TWEED SPECTROGRAMS ANALYSIS	38
	3.4.6 <i>D</i> -REGION PARAMETERS CALCULATION	38
	3.4.7 RESULT PLOTTING	41
	3.4.8 RESULT ANALYSIS	41
3.5	SUMMARY	42
<b>4</b>	<b>RESULT AND DISCUSSION</b>	
4.1	INTRODUCTION	43
4.2	RESULTS OF TWEED OCCURENCES	43
4.3	NIGHT-TIME <i>D</i> -REGION IONOSPHERE CHARACTERISTICS	44
	4.3.1 GEOMAGNETIC STORMS: 2 <sup>nd</sup> TO 6 <sup>TH</sup> AUGUST 2010	44
	4.3.2 QUIET DAY: 29 <sup>TH</sup> TO 31 <sup>ST</sup> NOVEMBER 2010	53
4.4	DISCUSSION FOR NIGHT-TIME <i>D</i> -REGION IONOSPHERE CHARACTERISTICS	57
	4.4.1 GEOMAGNETIC STORMS: 2 <sup>nd</sup> TO 6 <sup>TH</sup> AUGUST 2010	57
	4.4.2 QUIET DAY: 29 <sup>TH</sup> TO 31 <sup>ST</sup> NOVEMBER 2010	58
4.5	DISCUSSION FOR VARIATION OF DST INDEX	59