**Template and Guidelines**

**for FYP Thesis / Project Report**

**of**

**B.E MECHATRONIC ENGINEERING**

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 **Chairman**

 **Department of Mechatronic Engineering**

INSERT THESIS TITLE HERE



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Submitted in the partial fulfillment of the requirements for the degree of

Bachelor of Mechatronic Engineering

Faculty of Engineering

**DEPARTMENT OF MECHATRONIC ENGINEERING**

MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO

November 2020

**DEPARTMENT OF MECHATRONIC ENGINEERING**



**CERTIFICATE**

This is to certify that “**PROJECT/THESIS REPORT ON, TYPE YOUR THESIS TITLE HERE"** is submitted in partial fulfillment of the requirement for the degree of Bachelor of Mechatronic Engineering by the following students:

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Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ACKNOWLEDGEMENT

A brief acknowledgment, in just one page, only to those persons and organizations who have assisted the candidate in his /'her thesis work or provided relevant data / information / laboratory or research facilities and tools etc. should be given on this page.

DEDICATION

The dedication, allows you to dedicate your thesis work to someone or multiple people. This is quite a personal matter, and dedications are often made to family members, spouses, friends, or community groups.

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List of Abbreviations

AoA Angle of Attack

CAD Computer Aided Design

CFD Computational Fluid Dynamics

DU Delft University

DNS Direct Numerical Simulation

FPGA Field Programmable Gate Array

EBMs Embedded Boundary Methods

FEM Finite Element Method

FVM Finite Volume Method

HAWT Horizontal Axis Wind Turbine

IB Immersed Boundary

DSP Digital Signal Processing

NASA National Advisory Space Administration

NSE Navier Stokes Equations

RANS Reynolds Average Navier Stokes

SST Shear Stress Transport

VAWT Vertical Axis Wind Turbine

List of Symbols

**i** Direction cosine for X-axis

**j** Direction cosine for Y-axis Ambient

**k** Direction cosine for Z-axis average

**M** Momentum

**Ø** Any scalar quantity

**µ** Micro

**M** Matrix

**0** Initial conditions

**int** Internal

**ext** external

**f** Fluid

**Ω** Ohm

**s** Solid

**A** Added

**K** Time steps

ABSTRACT

It is sample. Accelerated depletion of the conventional energy resources has been one of the major issues for the past few decades. Pakistan along with many other countries has been a victim of the energy crisis. This severe energy crisis has forced the world to develop alternative methods of power generation. Researchers from all over the world are working to find utilization of renewable and at the same time to improve the efficiency of the existing systems. Over the few past years, Solar and Wind energy technologies have been the fastest growing energy solution for many countries. However, much of the current research focuses on large-scale horizontal axis wind turbines rather than vertical axis wind turbines, which are more suitable for areas with lower wind velocities in contrast to horizontal axis wind turbines. The two most common types of vertical axis wind turbines are: Darrieus wind turbine and Savonius wind turbine. The Savonius wind turbine is an aerodynamically drag-based self-starting turbine and have low cut-in speed. However, due to low coefficient of performance; these are not considered suitable for power generation. In contrast to Savonius wind turbines, Darrieus wind turbines are aerodynamically lift-based turbines, with higher coefficient of performance. The only drawback is its higher cut in speed. From the literature review it was concluded that if leading edge serration applied on airfoil it improved coefficient of performance can be achieved with moderate cut in speed. The objective is to design the effective wing for VAWT, the DU06-W-200 airfoil with leading edge serrations was selected for different.

Chapter-1

# INTRODUCTION

## BACKGROUND

Font is Times New Romans, Size 12, Spacing 1.5. Student will write their own chapter titles, topics, sub topics, sub sub topics. The term renewable energy refers to the power generation sources which are naturally replenished and noncombustible. The main reason and also importance of using renewable energy sources is that to achieve clean energy, these are non-emission sources and environmentally friendly. In renewable energy system there is no any toxic and radioactive waste materials as in nuclear power. The fossil fuels are neither clean nor renewable. Their production, transportation and using in power plants not economical as renewable energy but also causing air pollution, water pollution and most harmful gas CO2 emissions that are continuously polluting climate [1].

## PROBLEM STATEMENT

Since H-Darrieus VAWT is beneficial in different prospective like easy to manufacture simple design good performance in low wind condition, but it also suffer some problems these include low self-starting, fluctuation of torque low efficiency which are the barriers in improving efficiency and performance. Therefore, its efficient design would be highly important to meet the power consumption and demand load requirement. Many VAWT have been developed to fill this gap like Cycloidal, Savonius, Darrieus VAWT [2-3]. The rotor is highly significant part that is responsible to convert wind energy into mechanical energy for power generation. Efficiency of rotor is greatly affected by blade profile. This research will be conducted to fill the gap and design high performance airfoil for excellent performance.

## AIMS AND OBJECTIVES

Study aim to investigate effect of leading edge tubercle amplitude on the aerodynamic performance of the DU06W200 airfoil that is recommended for optimum power performance of H-type Darrieus VAWT. Following objectives were set to achieve aim of the research.

* To develop 3D CAD model of smooth (I.E. baseline) and wavy leading-edge model of the infinite wing for different values of waviness amplitude.
* To perform meshing and other steps of preprocessing and post processing for fluid flow analysis to predict aerodynamic force at different waviness amplitude values.
* To investigate effect of leading-edge waviness amplitude on the aerodynamic performance of DU 06-W-200 airfoil in pre and post stall regime..

##  THESIS LAYOUT

Thesis layout may comprise of chapter wise summary, not more than 3 to 4 lines for each chapter [4].

Basically, the thesis is consisted of five sections;

Section 1: In this section, describe outlines the introduction and overview of the energy, wind turbines and wing analyses. Section 2: In this section, a brief literature review on the current research. Section 3: Methodology used for the data collection, developing required CAD models, selecting solver and obtaining results. Section 4: In this section, discussions and results of the research. Section 5: In this section, discussions about the conclusions and recommendations.

## COVER PAGE AND CERTIFICATE

The cover page and certificate format is as provided on page-ii and page-iii. The students are just supposed to add their thesis titles, names and supervisor details. The formatting of the both pages will be as provided.

## PAGE LAYOUT SETTINGS

The thesis should be prepared on standard A4 size (210 mm x 297 mm) good quality white paper (at least 80 gm). The same paper should also be used for Figures, Tables, Charts etc. and for mounting Photographs if any.

Margins of 1.5 inch must be left at the top and left side, and 1 inch on the right side and bottom of the paper. This template uses, 1-inch margin on top, bottom and right sections of page, while the left section has the margin of 1.5 inch. The page size is selected as A4.

## REFERENCES

All the references quoted in the entire thesis must be placed at the end of the text in order of their first appearance in the text. The publications should be referred in the text by numbers in square brackets, e.g [1]. Or [1-3].

Do not use individual sets of square brackets, e.g. [1], [3], [6]–[10]. The examples of the referrals are given at the end in reference section.

## SUBMISSION / BINDING OF THESIS

Student will print thesis as follows:.

### BEFORE PRESENTATION EXAM

#### Spiral Binding and Plagiarism

The FYP group will submit three spiral binding copies of thesis and the plagiarism report of the thesis to the thesis coordinator of the Department.

The thesis will be accepted for viva-voce examination if the plagiarism report should have similarity index less than or equal to 19 % and no single source has a similarity index greater than or equal to 5 %.

#### Hard Binding

After presentation exam, FYP group will incorporate the given suggestions in thesis.

The FYP group will make (3 + number of members in group) hard binding copies of thesis. Three copies will be submitted in department.

## SUBMISSION OF PROJECT

FYP group will submit the project to supervisor / thesis coordinator of the Department.

### CHAPTER TOPIC

Use “Th H1” to add a numbered topic in any chapter”

### CHAPTER SUBTOPIC

Use “Th H2” style to add a numbered sub-topic. Following is an example

Following is the sample of All heading levels

## WRITE TITLE LEVEL-1

### WRITE TITLE LEVEL-2

#### Write Title Level-3

##### Write Title Level-4

## FIGURES AND FIGURE CAPTIONS

If any figure is referred on a page other than that where it is placed, it should be referred with its number and the page where it is placed, e.g., Figure 4. 1 on p.43. Please refer to tables capitalization and unabbreviated (e.g., “As shown in Figure 2.1”, and not “Fig. 2.1” or “figure 2.1”).

Each figure should be either in jpg or tiff format. Avoid using png format. Each figure should contain the caption. Caption can be inserted automatically from References tab. Following is the example of reference.



Figure .: Wind turbine 2nd figure in chapter 2

## TABLE OF CONTENTS

Table of content is generated automatically after all the heading and text are set into position. Use the References Tab in MS Word for further details.

## TABLE AND LIST OF TABLES

Insert the table caption on top. The format should be “Table 2-1”, which refers to 1st table in chapter-1.

The list of tables can be generated automatically from References Tab in MS Word. Following is the Sample table

 Table ‑: Data Table-1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sr. No. | Theta | Gamma | Beta | Lembda |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |

## SECTION BREAK

Use section break option from the layout tab to separate the different chapters and sections of the Thesis.

## PARAGRAPH BODY

Use the predefined text style “Th Paragraph Body” to style the main text body.

## EQUATIONS

The equation should be written in equation editor. The font size should be 12 in Times New Roman Each use MS word equation editor or Math Type for scripting equation. Each equation should be numbered as Chapter Number and Equation Number in the particular chapter as follow

$y=ax^{2}+bx^{3}+c$ (1.1)

$z=\sin(\left(x\right))+cos⁡(x)$ (1.2)

Chapter-2

# LITERATURE REVIEW

Student will write their own chapter titles, topics, sub topics, sub sub topics. Font is Times New Romans, Size 12, Spacing 1.5. This chapter should consist of the review of the literature performed by the students for writing this thesis. In text citations must be plugged in using MS Word plugin for Endnote/ Mendeley. 15 to 20 references are preferred to be cited at least.

Student will write their own chapter titles, topics, sub topics, sub sub topics.

## MAIN TOPIC

To provide easy access to students for thesis formatting, the text formatting styles are predefined which can be selected from the style section.

### SUB TOPIC-1

Use “Th Chapter Title” Style for add chapter title

 Table ‑: Data Table-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sr. No. | Theta | Gamma | Beta | Lembda |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |

## MAIN TOPIC

### SUB TOPIC-1

#### Sub Sub Topic

##### Sub Sub Sub Topic

Chapter-3

# MATERIAL AND METHODS

Student will write their own chapter titles, topics, sub topics, sub sub topics. Font is Times New Romans, Size 12, Spacing 1.5. This chapter should discuss the design steps of your FYP/Thesis and details of the methodology adopted during the implementation of the project. This includes the simulation design, algorithms and steps of hardware implementation.

Student will write their own chapter titles, topics, sub topics, sub sub topics.

## MAIN TOPIC

To provide easy access to students for thesis formatting, the text formatting styles are predefined which can be selected from the style section.

### SUB TOPIC-1

Use “Th Chapter Title” Style for add chapter title

### SUB TOPIC-2

Use “Th H1” to add a numbered topic in any chapter”

### SUB TOPIC-3

Use “Th H2” style to add a numbered sub-topic. Following is an example

Following is the sample of All heading levels

## MAIN TOPIC

### SUB TOPIC-1

#### Sub Sub Topic

##### Sub Sub Sub Topic

Chapter-4

# PROTOTYPE DEVELOPMENT AND TESTING

Student will write their own chapter titles, topics, sub topics, sub sub topics. Font is Times New Romans, Size 12, Spacing 1.5. This chapter should discuss the design steps of your FYP/Thesis and details of the methodology adopted during the implementation of the project. This includes the simulation design, algorithms and steps of hardware implementation.

Student will write their own chapter titles, topics, sub topics, sub sub topics.

## MAIN TOPIC

To provide easy access to students for thesis formatting, the text formatting styles are predefined which can be selected from the style section.

### SUB TOPIC-1

Use “Th Chapter Title” Style for add chapter title

### SUB TOPIC-2

Use “Th H1” to add a numbered topic in any chapter”

### SUB TOPIC-3

Use “Th H2” style to add a numbered sub-topic. Following is an example

Following is the sample of All heading levels

## MAIN TOPIC

### SUB TOPIC-1

#### Sub Sub Topic

##### Sub Sub Sub Topic

Chapter-5

# RESULTS AND DISCUSSION

Student will write their own chapter titles, topics, sub topics, sub sub topics. Font is Times New Romans, Size 12, Spacing 1.5. This chapter should presents the result of your FYP/Thesis work, which includes graphs, tables of results/ readings etc, and present the detailed discussion and analysis of the obtained results [6].

Student will write their own chapter titles, topics, sub topics, sub sub topics.

## MAIN TOPIC

To provide easy access to students for thesis formatting, the text formatting styles are predefined which can be selected from the style section.

### SUB TOPIC-1

Use “Th H2” style to add a numbered sub-topic. Following is an example

Following is the sample of All heading levels

## MAIN TOPIC

### SUB TOPIC-1

#### Sub Sub Topic

##### Sub Sub Sub Topic

Chapter-6

# SUMMARY, CONCLUSIONS AND FUTURE WORK

Student will write their own chapter titles, topics, sub topics, sub sub topics. Font is Times New Romans, Size 12, Spacing 1.5. This chapter will give the summary of what were the objectives and how much you succeed in achieving them preferably with some facts and figures or percentages of errors/ accuracy or summarized numerical justification of the parameters used in the project [1-5] . nonummy sagittis nonummy posuere sed et habitant vehicula leo odio ultricies fermentum felis dui blandit aptent vitae id et diam vitae molestie, aenean, porttitor mattis, taciti tincidunt sodales massa vulputate fames scelerisque sollicitudin. Nunc viverra Ultrices placerat. Platea taciti. Gravida adipiscing mattis Proin commodo morbi sed consequat. Libero blandit.

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Student will write their own chapter titles, topics, sub topics, sub sub topics.

## FUTURE WORK

Student will write future recommendations.

## MAIN TOPIC

To provide easy access to students for thesis formatting, the text formatting styles are predefined which can be selected from the style section.

### SUB TOPIC-1

Use “Th Chapter Title” Style for add chapter title

### SUB TOPIC-2

Use “Th H1” to add a numbered topic in any chapter”

### SUB TOPIC-3

Use “Th H2” style to add a numbered sub-topic. Following is an example

Following is the sample of All heading levels

## MAIN TOPIC

### SUB TOPIC-1

#### Sub Sub Topic

##### Sub Sub Sub Topic



Figure .: Wind turbine 1st figure in chapter 6

APPENDIX-A: FRONT COVER AND EDGE

Thesis Book Edge Front Cover Page

**2020**

**Title of Thesis**

**Thesis Title Here**

**Author-1 (GL) (F16MTExxx)**

**Author-2 (F16MTExxx)**

**Author-3 (F16MTExxx)**



Bachelor of Engineering (B.E)

Mechatronic Engineering

**MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO**

**2020**

REFERENCES

The examples of the referrals are given below:

**Research journal articles:**

[1] Timmer, W. and Van Rooij, “Summary of the Delft University Wind Turbine Dedicated Airfoils”, Journal of Solar Energy Engineering, Volume. 12, No. 5, pp.487-469, 2003.

**Books:**

[2] Georg Pelz. Mechatronic Systems: Modelling and Simulation with HDLs, 3rd edition, Publisher Wiley, pp. 209-221, 2003.

**Thesis:**

[3] Ahmed M. “Assessment and development of mitigation strategies for membrane durability in fuel cells”, Master, simon fraser university, Canada, 2020.

[4] Adam G. Rogers. “Precision Mechatronics Lab Robot Development”, PhD, Lappeenranta University of Technology, Finland, 2007.

**Conference proceedings:**

[5] Wang Cai, Jianzhuang Wang,Qi Zhou,Yang Yang and Ping Jiang, “Equipment and Machine Learning in Welding Monitoring: A Short Review”, 5th International Conference on Mechatronics and Robotics Engineering CMRE 2019, 16-19 February 2019; Rome, Italy. pp. 9-15.

**Online Publications:**

[6] M. M. Zhang, G. F. Wang,† and J. Z. Xu, “Aerodynamic Control of Low-Reynolds-Number Airfoil with Leading-Edge Protuberances”, Chinese Academy of Sciences, DOI: 10.2514/1.J052319.