Engineering Design
6E6Z0010_2324_9

NAME - Aditya Naik

STUDENT ID - 20025377

PART – 1(MAIN BODY DESIGN)

TURBINE LOWER MAST

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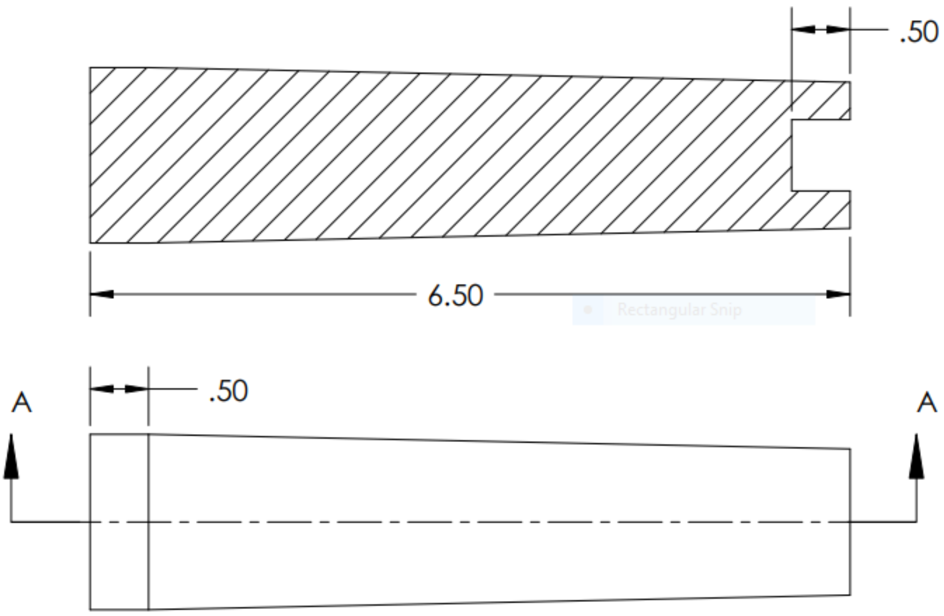

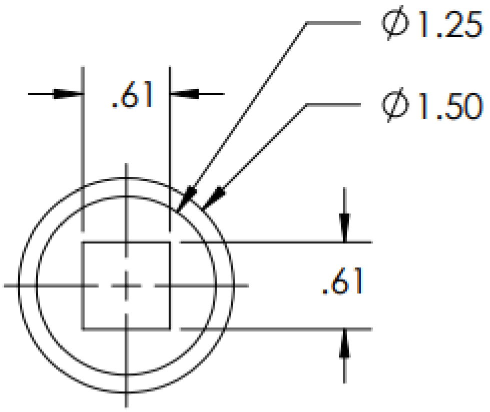

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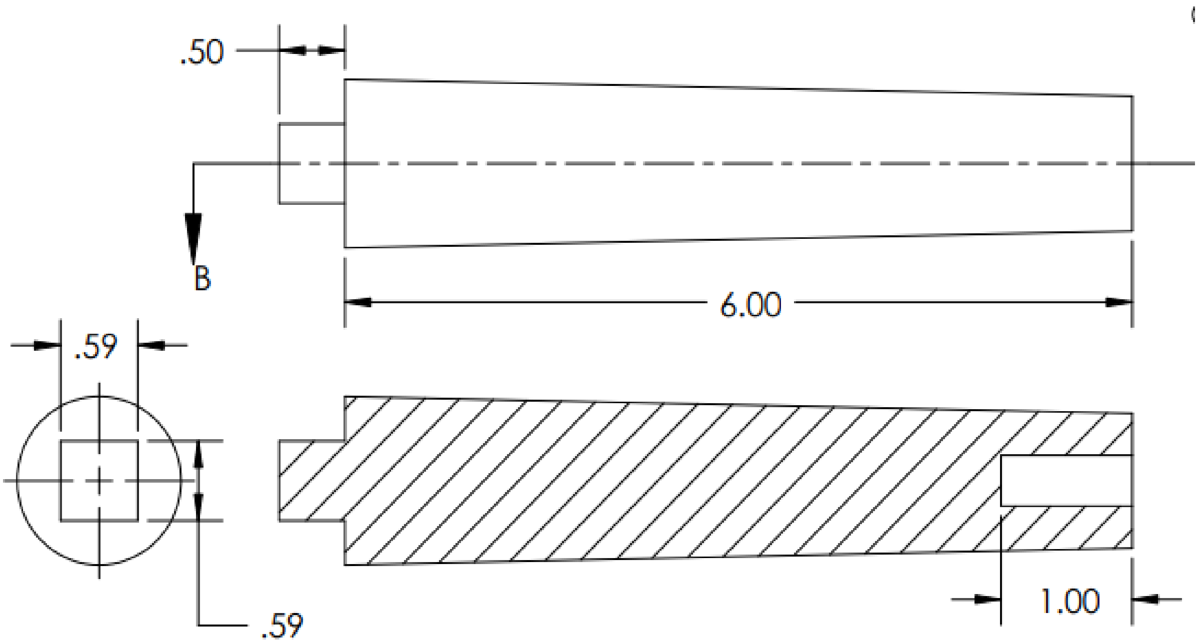

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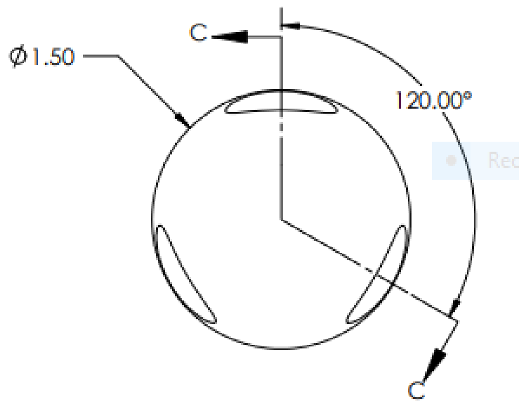
TURBINE HUB

TYPE 1



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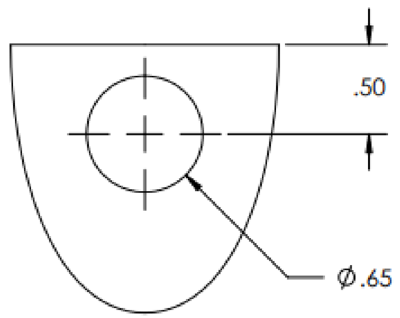

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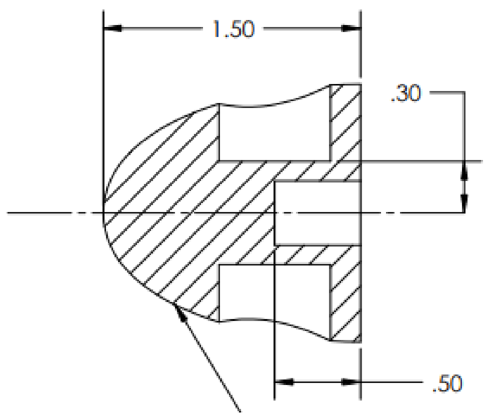

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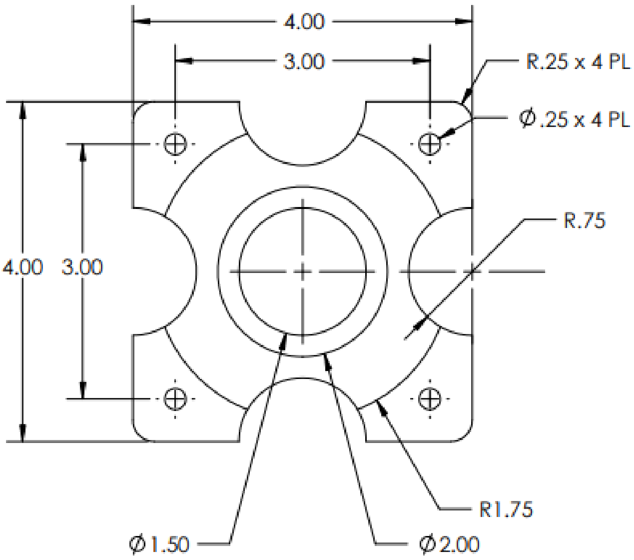
TURBINE BASE

TYPE 1



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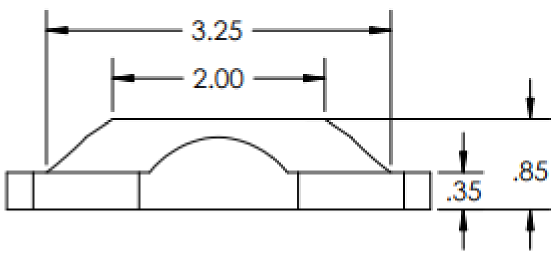
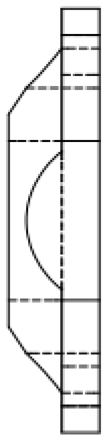
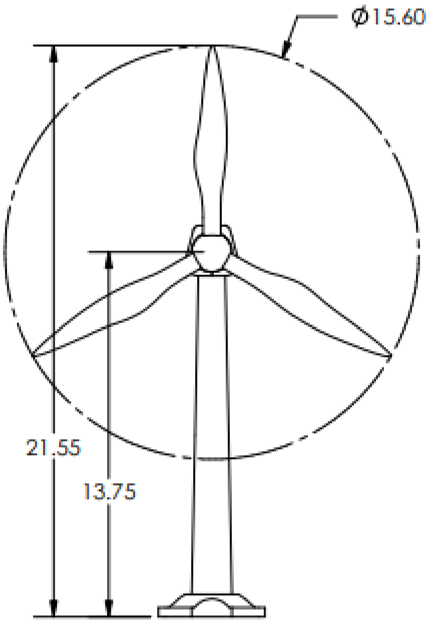




TURBINE ASSEMBLE

TYPE 1



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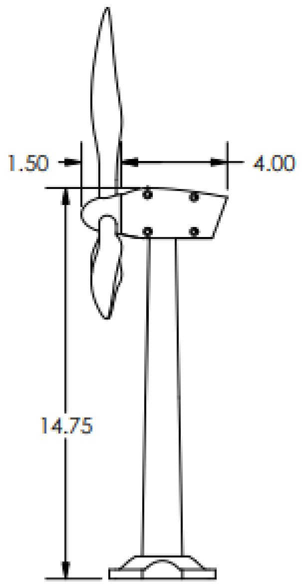
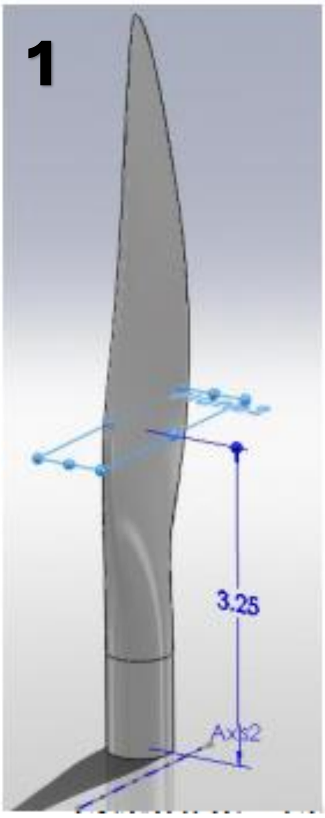
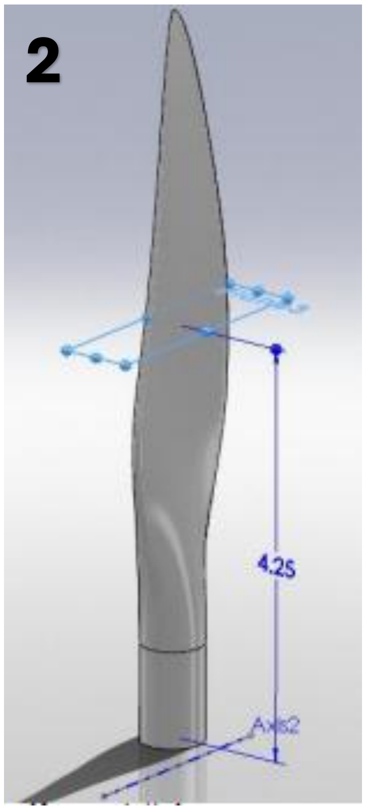
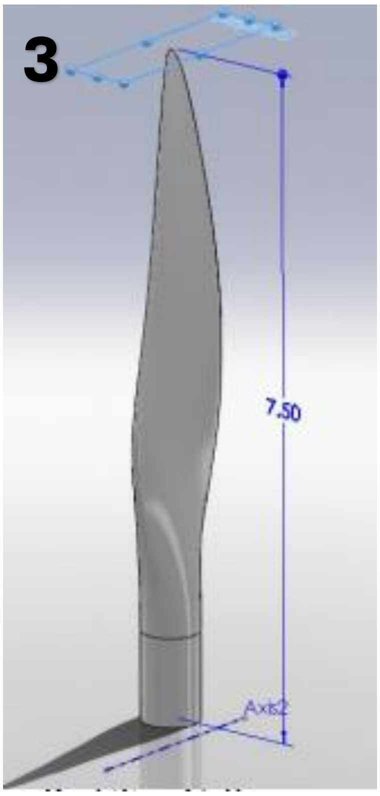
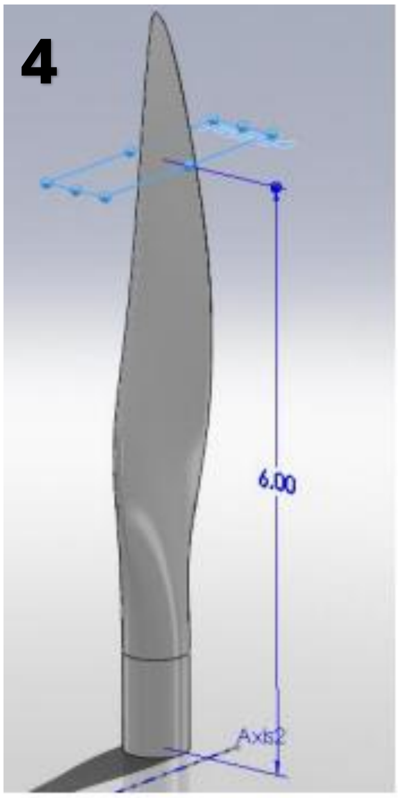


PART – 2 OPTION A (ROTOR DESIGN)









Wind turbine rotors are the components that convert the kinetic energy of the wind into rotational energy that drives the generator. The materials and manufacturing processes of the rotors affect their performance, cost, and reliability. Here are some of the pros and cons of different rotor materials and manufacturing processes:

Composite materials such as glass or carbon fibre reinforced plastics (GFRP or CFRP) are widely used for wind turbine blades because they offer high strength-to-weight ratio, corrosion resistance, and design flexibility. However, they also have some drawbacks, such as high cost, environmental impact, difficulty in recycling, and susceptibility to fatigue and damage.

Wood is a natural and renewable material that has been used for wind turbine blades since the early days of wind energy. Wood has low density, good stiffness, and easy availability. However, wood also has disadvantages, such as variability in quality, moisture sensitivity, low durability, and fire hazard.

Metal materials such as aluminium and steel have been used for wind turbine blades, especially for small and medium-sized turbines. Metal blades have advantages such as high stiffness, durability, and recyclability. However, they also have drawbacks, such as high weight, low fatigue resistance, corrosion, and noise.

The manufacturing processes for wind turbine blades can be classified into two categories:

- **Manual processes** include wet lay-up, prepreg lay-up, and hand-lamination, where the fibre and resin are placed and impregnated by hand. These processes are labour-intensive but offer flexibility and low cost.
- **Mechanized processes** include filament winding, tape winding, pultrusion, injection moulding, and resin transfer moulding, where the fibre and resin are fed and shaped by machines. These processes are more automated but require higher capital investment and specialized equipment.

The pros and cons of different manufacturing processes depend on the size, shape, and complexity of the blades, as well as the material properties and quality requirements. Generally, mechanized processes can produce more uniform and consistent blades with higher production rate and lower labour cost, but they may also introduce more residual stresses and defects in the composite structure. Manual processes can produce more customized and complex blades with lower tooling cost, but they may also result in more variability and waste in the material usage and quality control.

Environmental Life-cycle Assessment (LCA) of wind turbines is a method of evaluating the potential environmental impacts of wind energy production throughout its entire life cycle, from raw material extraction to end of life.

Some of the environmental impact categories that are commonly assessed in LCA of wind turbines are:

- Global warming potential (GWP): the contribution of greenhouse gas emissions to climate change.

- Acidification potential (AP): the contribution of acidifying substances to soil and water acidification.

- Eutrophication potential (EP): the contribution of nutrient-rich substances to water eutrophication.

- Human toxicity potential (HTP): the potential harm to human health from exposure to toxic substances.

- Resource depletion potential (RDP): the depletion of non-renewable natural resources.

The results of LCA of wind turbines depend on various factors, such as the size, type, and location of the wind turbine, the electricity mix, the functional unit, the system boundaries, the data sources, and the assumptions and uncertainties involved in the analysis. Therefore, it is important to conduct LCA in a transparent and consistent manner, following the standards and guidelines of the International Organization for Standardization (ISO) and the International Energy Agency (IEA).

APPENDIX

http://www.perihq.com/documents/WindTurbine-MaterialsandManufacturing_FactSheet.pdf

https://nap.nationalacademies.org/read/1824/chapter/7

https://www.energy.gov/eere/wind/wind-manufacturing-and-supply-chain

https://link.springer.com/article/10.1007/s10098-019-01678-0.

https://sphera.com/blog/evaluating-sustainability-of-wind-energy-fact-based-insights-through-lca/.