Wind Turbine Generator Assignment

Essential Question: How can Energy be transformed into useful forms?

Assignment #1: Blade design

Your Task: Design, test, modify and retest turbine blades to create the highest power output when driven by a 20" fan.

Turbine blades need to be able to do two things well: spin very fast, and apply a strong twisting force to the drive shaft. When turbine blades spin a generator, the generator creates voltage, and the faster the blades spin, the higher the voltage. The ability to twist the drive shaft is called torque, and when you twist the drive shaft of a generator, you create a flow of electricity called amperage. The greater the torque, the higher the amperage.

Your goal is to design turbine blades that capture the most power from the available wind. Power is a combination of speed and torque, so your design will require two steps: Initial design and testing, followed by improvement to the weakest characteristic to improve the overall power capture, as shown by retest data analysis.

Description of your blade: The description should include enough information for someone else to recreate your design. You will need to describe the shape and size of your blades; measurements and a sketch might be useful. You will need to explain how many blades you used, and the angle that they are set at.

Useful Vocabulary

Flat
Concave (cup like, open part facing the wind)
Convex (cup like, rounded part facing the wind)
3D (describe the shape)
rectangular (include length and width)
Angle of attack (the angle that the blades is twisted from facing the wind)
Diameter

Analysis of Design:
Create a plan to adjust the angle of your turbine blades. The blade angle will be an important part of your design decisions, and the angle needs to be accurately measured and kept equal for each blade.

Testing for Speed. Set your turbine test stand in front of a fan. Attach the electric generator to the turbine shaft. Attach a multimeter to the two wires coming out from the generator and set the meter to read voltage (DC V). Turn the fan on high speed and record the voltage. This is the No Load Voltage.

Testing for Torque. Attach a jumper wire from the generator wire to a 10Ω resistor, from the 10Ω resistor to the multimeter, and from the meter to the other wire from the generator. Set the meter to display DCmA (direct current milliamps). Turn the fan on high speed and record the amperage in milliamps. This is the High Load Current.

Compare your results to the results of other groups. Determine what your design is good at and what can be improved on. Remember that voltage indicates speed, and amperage indicates torque. Your goal is to create a design that is reasonably good at both speed and torque, not a design that is great at one and fair at the other.

Consider how the changes that you can make could affect your results. What would using more or fewer blades do for you? What would using smaller or larger blades do for you? What would increasing or decreasing the blade angle do for you?

Modifications to your design: *This should be planned Engineering, not trial and error!* Modify your design to improve your OVERALL performance. Predict how your results will change. Explain your modifications and your reasoning to your teacher BEFORE testing your modified design. What were you trying to improve? What did you change to make that improvement? Why did you think that would work?

Note: Once you settle on a design, you will not be able to change it again. You may want to do more than one round of redesign before you settle on a final design.

Part 1	Original Design	Modification #1	Modification #2
# of blades			
Angle of blades			
No-Load Volts			
Milliamps at 10 Ω			
Force Sensor Reading			

Sketch of original blade design:

Sketch of finalized blade design:

Written Assignment #1:

Your report needs to include a sketch or picture of your original design, a data table of all of your test data, and a sketch or picture of your final design. Your written analysis should explain how your original design performed (better at speed or better at torque AND how you know that), what you were trying to improve with your first modification AND what your first modification was and WHY you thought that would be effective. Your conclusion should explain what your final design is best at, speed or torque, and how you know that.

Part 1 Grade	Rubric Description
A	Accurate and appropriate use of vocabulary, thoughtful critique of design and modifications. Good evaluation of test data and results.
B	Good description of WHAT you did, and good analysis of what the results were, but lacking critical explanation of modifications.
C	Good description of what you did and what the final design is, test data is included but not explained.
C-	Describes the design and modifications.

Your report can be presented in any deliverable format that you choose including hand written paper copy, digital text files and multimedia or video.