



Team Number: _____

School/Team Name: _____

Student #1: _____

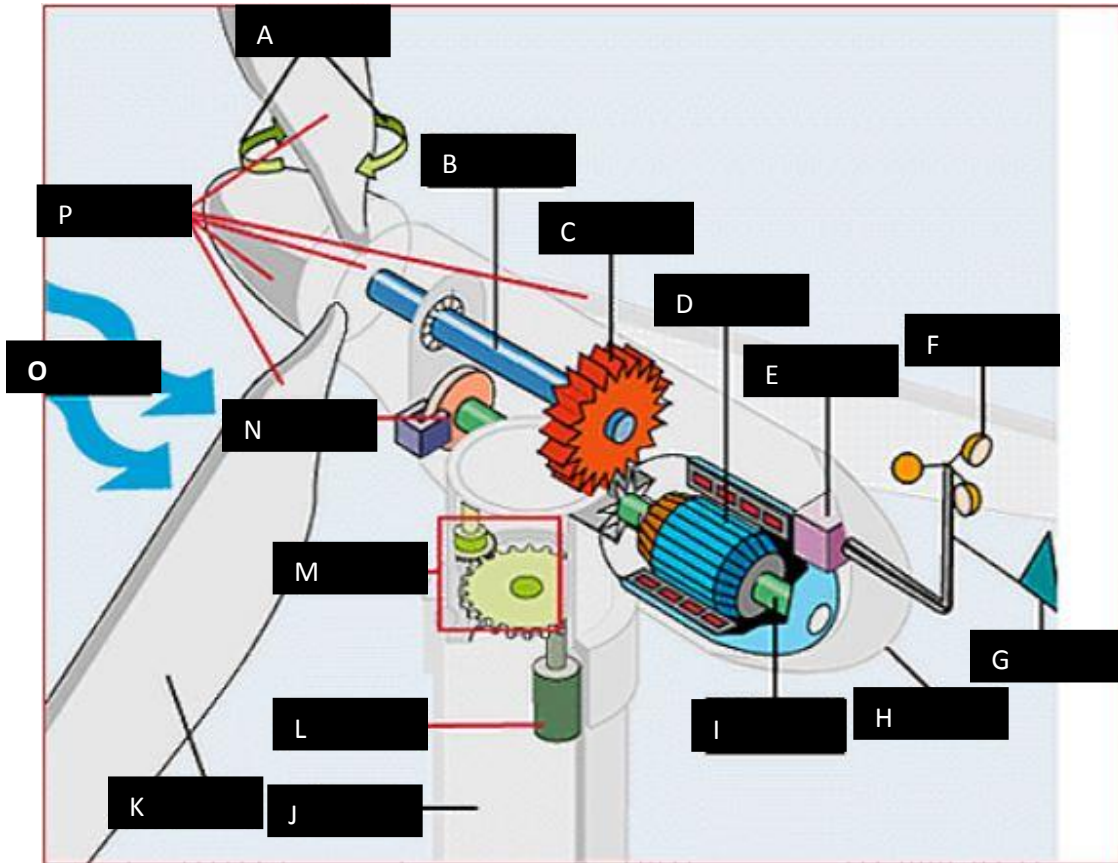
Student #2: _____

Part 1 Exam Score (70 max)	
Part 2 Exam Score (12 max)	
Final Exam Score (82 max)	

Instructions: Students will have 25 minutes to complete this test to the best of their abilities. All answers must be in metric units and proper significant figures unless otherwise noted. Students are allowed a 3-ring binder with informational material, along with a calculator, protractor, ruler, and pens/pencils. Best of luck!

Part 1 (4 points per question unless otherwise noted):

1. Please match the words to their respective positions on the diagram (8pts).



- ____ -High-speed shaft
- ____ -Nacelle
- ____ - Wind Vane
- ____ -Tower
- ____ -Yaw Motor
- ____ -Blades
- ____ -Controller
- ____ -Low-speed shaft
- ____ -Wind direction
- ____ -Rotor
- ____ -Pitch
- ____ -Generator
- ____ -Anemometer
- ____ -Brake
- ____ -Yaw drive
- ____ -Gear box

2. Which value is power *not* proportional to?
- a. Air density
 - b. Rotor Pitch
 - c. Cube of velocity
 - d. Rotor Swept area

3. Write the formula for tip-speed ratio:

4. The maximum theoretical efficiency is known as the _____, which is _____%.

5. Which country generates the most energy from wind power?
- a. United States
 - b. Netherlands
 - c. Germany
 - d. Spain

6. Give two examples of disadvantages, and two examples of advantages of wind power.

Advantages:

1. _____

2. _____

Disadvantages:

1. _____

2. _____

7. The generators in most commercial wind turbines are LVRT devices (low voltage ride through devices). What does this mean?
- a. The turbine's generator has the ability to continue functioning even during a period of lower than normal voltage experienced in the transmission without going offline.
 - b. The turbine generates specifically low-voltage current.
 - c. The turbine generates current using a doubly-fed induction generator.
 - d. The turbine and its generator will immediately go offline when it experiences low voltage in the transmission system until it is manually reset.

8. When was the first all-steel wind turbine introduced to the United States?
- a. 1858
 - b. 1865
 - c. 1878
 - d. 1890

9. Please Match the blank boxes with the correct terms.

		Input	
		AC	DC
Output	AC	A	B
	DC	C	D

- _____ -Inverter
- _____ -Converter
- _____ - Transformer
- _____ -Rectifier

10. ACSR Power Cables use two types of metals. What are they?

- 1. _____
- 2. _____

11. Lenz's law is integral to the function of generators. What does this law say?

12. What is not part of a Permanent Magnet Generator/Motor?

- a. windings
- b. operational amplifiers
- c. insulation
- d. magnets

13. Name four types of energy storages systems/devices.

1. _____

2. _____

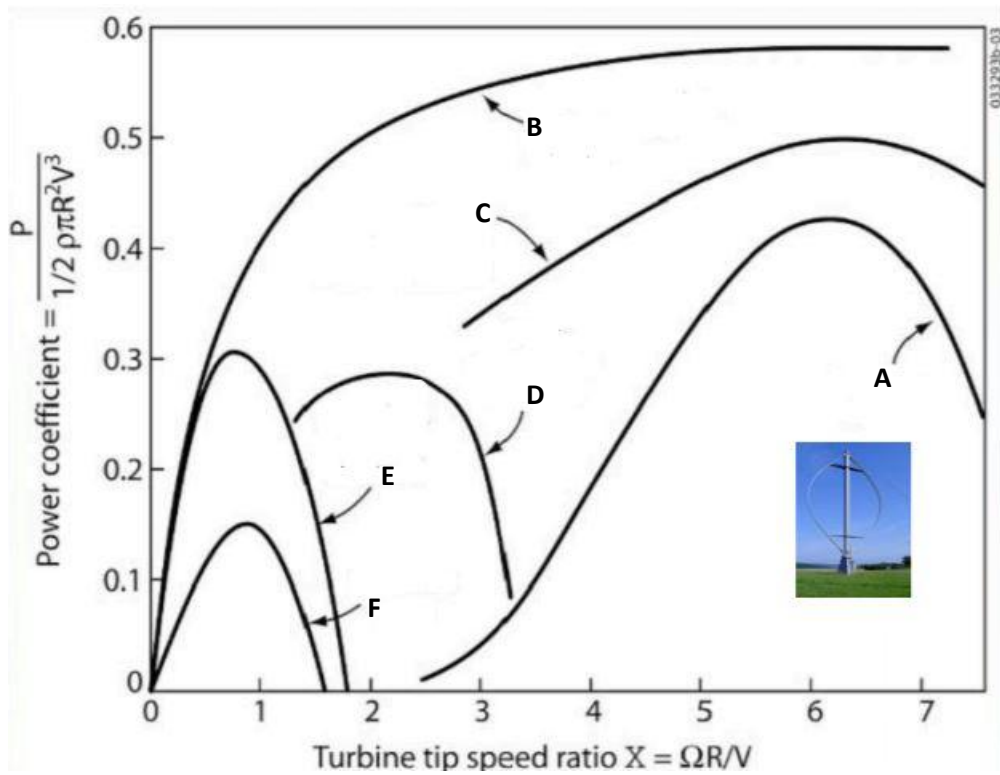
3. _____

4. _____

14. What is the difference between energy density and power density? Give an example of an electromechanical storage device that has high power density but low energy density.

15. Explain the conditions of stalling and luffing, and how they play into apparent wind direction.

16. Match the type of wind harvesting device to the graph below (6pts).



- _____ -Dutch multi-blade turbine
- _____ -Savonius Rotor
- _____ - Darrieus Rotor
- _____ -High speed 2 or 3 bladed turbine
- _____ -American farm windmill
- _____ -Ideal efficiency of propeller-type turbine

Part 2 (6 points each):

17. The elevation of a turbine hub is increased from 30 meters to 60 meters. By what percent will the wind speed increase, and by what percent will the power output increase?

18. Calculate the resistive losses of transmitting 1kW of power over 1 km through a 1 cm ACSR wire ($\sim 1\Omega/\text{km}$) for both 100 volt and 1,000 volt lines.