2017 Holt Invitational

Wind Power Test

School / Team Name (Please remember to indicate if you are an A or B team from your school if appropriate):

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Team # \_\_\_\_\_\_\_

Student name(s):

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Part I Low Speed Power Score \_\_\_\_\_÷ \_\_\_\_\_x 25 = \_\_\_\_\_\_\_\_

Part I High Speed Power Score \_\_\_\_\_÷ \_\_\_\_\_x 25 = \_\_\_\_\_\_\_\_

Part II (Exam) Score (50 pts) \_\_\_\_\_÷ \_\_\_\_\_x 50 = \_\_\_\_\_\_\_\_

Total Score (100 pts) \_\_\_\_\_\_\_\_\_

Final Ranking: \_\_\_\_\_\_

**(Tiebreaker: #1 – highest high speed voltage; #2 highest low speed voltage)**

**Design Questions (2 points per problem):**

1) Determine the type of wind turbine in each image, and record 2 advantages and 2 disadvantages for each.



Image A type: \_**­­­­­**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Image B type:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Advantages: Advantages:

a) a)

b) b)

Disadvantages: Disadvantages:

a) a)

b) b)

2) How is the solidity of a rotor calculated?

3) What numerical value is Betz’s Limit? \_\_\_\_\_\_\_\_\_\_

Why isn’t it 100%?

4) Explain how the terms “self-directing” or “self-governing” relate to wind turbines, and why they are considered advantageous features. Use appropriate terminology when applicable.

5) Explain how the arrangement of wind turbines on a wind farm is a factor in generating energy. Be specific. Use appropriate terminology when applicable.

**Generator questions (2 points per problem):**

6) A wind turbine with a blade radius of 80 meters is turned by an 11 m/s wind with a density of 1.2 kg/m3. If the turbine generates 12 MW of power, what percent is its efficiency?

7) If you did the previous problem correctly, why is your answer not reasonable?

8) A wind turbine has a 5 ohm resistor connected in series with the CD motor, and the voltage

measured across the resistor is 100 mV. What is the power generated by the CD motor?

9) How does geothermal power generate energy?

10) What is the purpose of a gearbox in a wind tower (or any generator)?

**Storage questions (2 points per problem):**

11) What type of power storage accounts for about 96% of the total storage capacity of the United States?

A) Biofuel B) Flow battery C) Molten salt D) Pumped Hydroelectric

12) Concentrating solar plants capture heat and store it in which of the following:

A) air B) steel C) vacuum D) water

13) CAES works as a generation storage technology, and require an underground reservoir for storage. What does CAES stand for?

14) This electric energy storage system includes a cylinder with a shaft that can spin rapidly within an enclosure.

15) Name 4 types of **mechanical** energy storage.

a)

b)

c)

d)

**Transmission questions (2 points per problem):**

16) A 70 km long electrical power line carries power from Palo Verde to Phoenix. The line supplies

750 MW on a 500 KV line. The line has a resistance of 0.1 ohms per km. Assume all values are

RMS and only pure resistive effects. What is the voltage drop between the ends of the line?

17) What is the difference between AC and DC? Explain how they both relate to electricity in the home.

18) Match the approximate voltage values to the different locations as electrical power travels from a power station generator to your in-home appliances such as a TV or lamp, assuming you live in the U.S.:

voltage when generated: \_\_\_\_\_ A) 120 volts

voltage when leaving power station: \_\_\_\_\_ B) 240 volts

voltage when leaving substation: \_\_\_\_\_ C) thousands of volts

voltage when entering your house: \_\_\_\_ D) tens of thousands of volts

voltage when leaving an outlet:\_\_\_\_ E) hundreds of thousands of volts

19) What is the primary cause of power outages in the U.S.?

A) Grid overload B) Outdated technology C) Severe Weather D) Terrorist attacks

20) What are the Eastern Interconnection and the Western Interconnection?

**History (2 points per problem):**

21) Who was responsible for the first wind turbine used to produce electricity, and where was it built?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

22) Name both of the two functions that the world’s first windmills were generally used for.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

23) Which part of the U.S. has the greatest mean annual wind speed at a height of 80 meters?

A) East Coast   B) Midwest C) West Coast  D) They are all about the same

24) What type of orientation is a panemone windmill and who first designed it?

A) Vertical/Persians B) Horizontal/Chinese C) Vertical/Dutch D) Horizontal/French

25) By 2014, what percent of the world’s power came from commercial-sized wind turbines?

A) 1% B) 4% C) 10% D) 20%