EECE325 Fundamentals of Energy Systems Spring 2023 Dr. Charles Kim

Homework 5 - Wind Power (150 points)

A. INSTRUCTION

(a) Due: 8:00pm (Check Class web page for the date)

(b) Scoring Rubric

pts	#1 - #6
25	Correct answer with works displayed
15	Incorrect answer with works displayed
5	Correct answer without works displayed
0	None of the above

(c) Late submission: 10% deduction for each delayed submission date

B. PROBLEMS

1. As a possible wind turbine installation, a site which is of 500 m elevation is being considered. If the temperature of the site is 65 °F and the wind speed is 30 mph. What would be the power density of the wind?

2. The friction coefficient in a site is 0.14. If the wind speed at 10 m height is 10 m/s, what would be the power density of the wind at the heigh of 60 m? Assume the standard air density.

3. At a site, the wind speed at 10 m height is 7 m/s, and the power density at the height of 60 m is 500 [W/m^2]. Assume the standard air density. Calculate (a) the friction coefficient (α), and (b) the roughness length (z) of the site?

4. The average wind speed at the Reagan National Airport is 10 mph at 10 m high with Rayleigh statistics. The friction coefficient is 1/7 and the air density is assumed to be standard. What would be the average power density at 60 m high?

5. A 29.2-m diameter wind turbine having a rated power of 250 kW is installed at a site having Rayleigh wind statistics with an average wind speed of 10 m/s at the hub height. Bu using the approximate formula for CF,
(a) Find the annual energy generated,
(b) From the result, find the overall average efficiency of this turbine in these winds,
(c) Find the productivity in terms of kWh/yr per m^2 of swept area.

6. A wind farm project has forty (40) 1500-kW turbines with 64-m blades. Capital costs are $60 million and the annualized O&M cost is $1.8 million/yr. The project will be financed with a $60 million, 20-year loan at 7% interest. Turbines are exposed to Rayleigh winds averaging 8.5 m/s. What would be the electric energy cost [$/kWh] over the 20-year period?