

Homework 2

Problem 1. [6 points] Compute the density of air under the following conditions:

1. At 1 atm and 30°C?
2. At 15°C at an elevation of 2000 m?
3. At 5°C at an elevation of 2000 m?

Problem 2. [4 points] For a wind site with Rayleigh winds with average, $\bar{v} = 8$ m/s, what is the probability that the wind speeds are between 6.5 and 7.5 m/s?

Problem 3. [12 points] A wind turbine has a constant failure rate: $\lambda = 4.28 \times 10^{-4}$ hr⁻¹. Answer the following questions:

1. What is the probability that the turbine survives one month of continuous operation?
2. What is the mean time to failure of the turbine?
3. Suppose the turbine has been functioning without failure for two months. What is the probability that it will fail during the next month?

Problem 4. [4 points] A wind farm is to be installed in a location with Rayleigh statistics and average wind speed $\bar{v} = 6$ m/s. What is the average power (normalized by area) that the wind turbines would deliver assuming air density $\rho = 1.225$ kg · m⁻³?

Problem 5. [4 points] Suppose we are interested in installing a wind turbine with the following parameters (cut-in speed 0 m/s, rated wind speed 5 m/s, cut-out wind speed 15 m/s, rated power 1 kW) in a location where wind speeds are uniformly distributed between 5 and 20 m/s. What is the annual energy that the wind turbine would generate?