Masdar Institute of Science and Technology

UCC501 – Sustainable Energy

Fall 2014

Homework #3

Release Date: 20th of October 2014 Due Date: **10th of November 2014**

Topics:

- Hydropower
- Wind Power
- Solar Power
- Nuclear Power

Type: **Individual**

The problems below are fairly trivial mathematically. The main effort involves structuring your answer. Work out each of the problems giving a reference from where you obtained the data or informed assumption – try to use as first priority our recommended sources and assumptions and **ONLY** if you need additional information refer to other material.

Answers should be submitted in PDF format. All information needed including the steps you have taken and your assumptions should be included in that document. Build an Excel spreadsheet to answer the questions. Include **ALL FILES** in your submission.

Question 1: Hydropower

In order to design safe emergency spillway in dams, the concepts of "**return period**" and "**probability of occurrence**" of floods play an important role.

1. If a 50-year flood event occurred, is it possible for it to occur again in the next year? (Explain your answer)
2. What is the possibility (probability) that a 100-year flood event will occur within 20 years?
3. The maximum monthly values of daily rainfall for a station are given for the period of 1980-2000. Using this data, obtain the following:
    a. The **Annual Maximum Series**
    b. The **return periods** of the Annual Maximum Series (use the Gringorten formula)
    c. The **probability of occurrence** for each value in the Annual Maximum Series
    d. What is the **rainfall magnitude** for which there is a 50% probability of exceedance?

Question 2: Wind Power

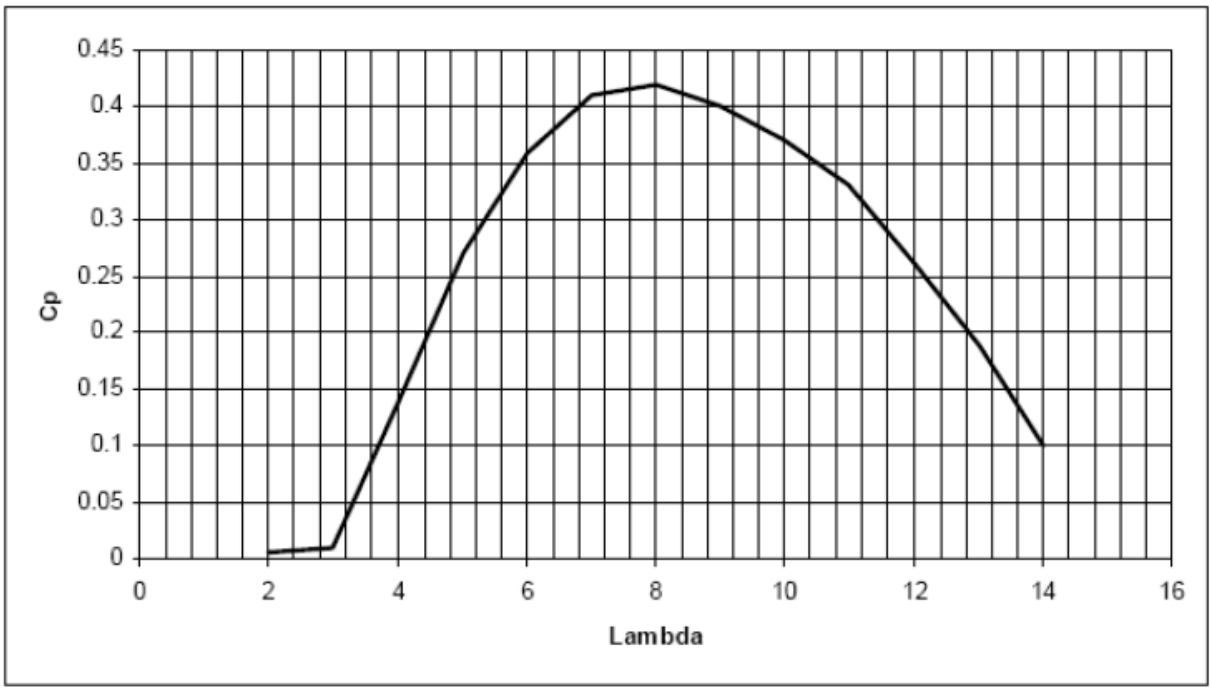
1. List 3 pros and 3 cons for the use of wind energy. Write a brief statement (200 words max) on whether you think utilizing wind energy is viable or not.
2. A wind turbine has a blade length of 60 m and rotational speed of 12 rpm (rotations per minute). The following information is given related to its location and height:

- The wind speed is 15 m/s
- The air pressure is 1 atm
- The air temperature is 25°C

Calculate the following:

a. The **power** generated by the wind turbine (in MW)
b. The wind **power density** (in MW/m^2)
c. The **total energy** (in MJ) generated by the wind turbine in 5 years, assuming that the power generated in this time period stayed constant at the value calculated in part a

Hint: You will need to obtain the power coefficient C_p using the following graph:



Question 3: Solar Power

1. Give a brief description of the difference between PV and CSP technologies for solar power (150 words max).
2. A household has an annual electricity usage of 11,000 kWh. The average number of solar hours per day for the area in which the household is located is 4.5. Calculate **the number of solar panels** needed to provide 60% of the household's electricity needs, using the following assumptions:
    a. An efficiency constant of 0.7
    b. To generate 1 kW of power, 5 solar panels are needed

Hint: find the array size (in kW) to answer the question

Question 4: Nuclear Power

1. Describe briefly (max 100 words) the difference between nuclear fusion and fission.
2. Alpha and beta decay are two different kinds (among others) of radioactive decay.
    a. Write the nuclear equation for an atom of $^{245}_{96}Cm$ undergoing an alpha decay
    b. For the following beta decay reaction, fill in the missing isotope:

$$? \rightarrow {}^{0}_{-1}e + {}^{139}_{52}Te$$

    c. Stronium-90 has a beta decay half-life of 28.8 years. If a sample started out containing 20 ppm of strontium-90, **how long would it take** (in years) for the concentration to drop to 5 ppm?