TUTORIAL ON HOMEWORK 3

UCC501 – Sustainable Energy

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HYDROPOWER

Probabilities and Return Periods

- Probability of Occurrence (p) is the probability that an event of a specified magnitude will be equaled or exceeded during a one year period.
- Probability of Occurrence within a period of N years (p_N) is the probability that an event of specified magnitude will be equaled or exceeded within a period of N years.
- Return Period (T) is the average length of time in years for an event (e.g. flood or river level) of given magnitude to be equaled or exceeded.

Probabilities and Return Periods

- To calculate the Probability of Occurrence over N number of years:

$$p_N = 1 - (1 - p)^N$$

- A fundamental relationship to remember is:

$$T = \frac{1}{p}$$

- Example: the probability of a 50 year storm occurring in a one year period is 1/50 or 0.02.
- Annual Maximum Series is a series of data consisting of the largest values for each year.

Probabilities and Return Periods

- In a data series, the return period of each value can be found using the Gringorten formula:

$$T = \frac{(n + 0.12)}{(i - 0.44)}$$

  - T is the return period
  - i is the position of the value when all values are in a descending order
  - n is the number of all values being considered

WIND POWER

Wind Power Calculations

- To find the power generated (in Watts) by a wind turbine:

$$P = \frac{1}{2}\rho A v^3 C_p$$

  - ρ is the air density (kg/m3)
  - A is the swept area (m2)
  - v is wind speed (m/s)
  - Cp is the power coefficient (unitless)

Wind Power Calculations

- In order to obtain the power coefficient Cp, first find the blade tip speed (in m/s):

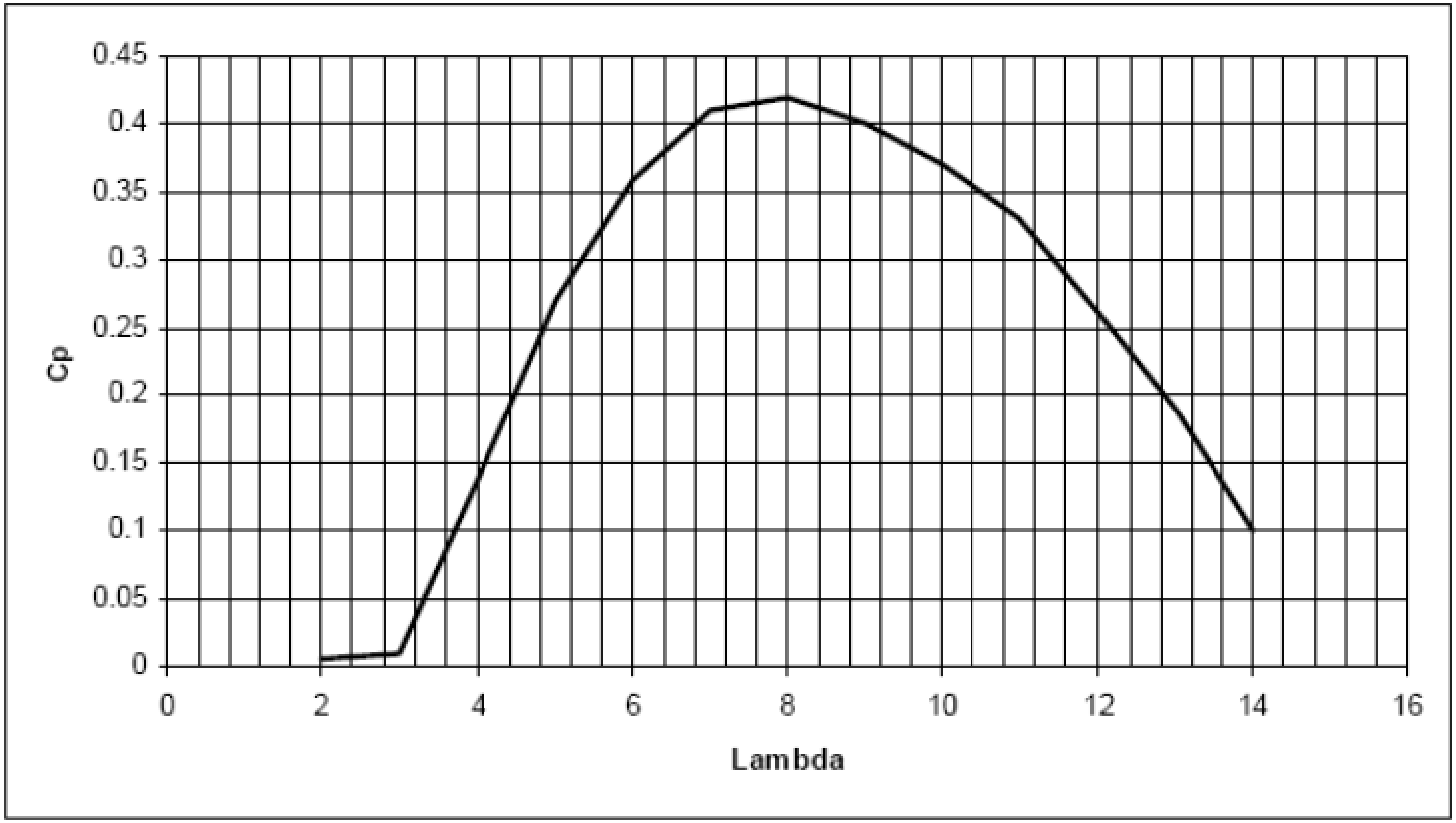
$$u = \frac{rotational\ speed\ (rpm) * \ \pi * D}{60}$$

  - D is the diameter of the turbine (assume it to be double the blade length)

- Then find the tip speed ratio λ:

$$\lambda = \frac{u}{v}$$

Wind Power Calculations



NUCLEAR POWER

Alpha Decay

- The nuclear equation for an alpha decay reaction is as follows:

$$ {}^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}X' + {}^{4}_{2}\alpha $$

- A is the mass number, which is the sum of protons and neutrons in the nucleus
- Z is the atomic number, which is equal to the number of protons in the nucleus, and from it we can determine the type of atom

Beta Decay

- The nuclear equation for a beta decay reaction is as follows:

$$ {}^{A}_{Z}X \;\rightarrow\; {}^{0}_{-1}e + {}^{A}_{Z+1}X' $$

Radioactive Decay

- The rate of radioactive decay is typically expressed in terms of either the radioactive half-life, or the radioactive decay constant. They are related as follows:

$$k = \frac{\ln(2)}{t_{\frac{1}{2}}} = \frac{0.693}{t_{\frac{1}{2}}}$$

  - k is the radioactive decay constant
  - $t_{1/2}$ is the radioactive half-life

Radioactive Decay

- The relationship between the final quantity of the consumed reactant and its starting quantity can be expressed as follows:

$$N_t = N_o e^{-k.t}$$

- N_0 is the initial concentration
- N_t is the final concentration
- t is the number of years between N_0 and N_t
- k is radioactive decay constant

QUESTIONS?