Ali AYDIN 2093326

EE462 Homework I

Q1-) Area of disc is πr^2 where r is radius.

Swept area = $\pi 44^2 = 1936\pi$ m^2

Q2-) To find total power potential, we can use given formula.

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

P = 3.725 MW

Q3-) At 10 m/s wind speed, when we look at the calculated power curve, Cp is 0.5. Then, by using given formula, we can find that electricity produced by wind turbine is 1.86 MW.

Q4-) When we look at the Cp vs TSR graph, we can see Cp is higher when TSR is 6.9. We look at the higher value of Cp since it is related with produced electricity. Then, we apply the TSR formula and we can find tip speed of the blade is 69 m/s and 15 rpm.

Q5-) To calculate rotor speed, we should use gear ratio.

$$\frac{w_{blade}}{w_{rotor}} = \frac{1}{90} = \frac{15}{w_{rotor}}$$

Then, w = 1350 rpm.

Q6-) Electrical power at the rotor is 1.86 * 0.97 = 1.8 MW

T*w = 1.8MW where w = 1350 * 2π / 60 = 141.4 rad/s

Then, T = 12.7 kN

Q7-)

$$f = \frac{n_s * p}{120}$$

f = 112.5 Hz

We cannot connect the grid since we need to give 50 Hz current to the grid. This frequency level can be harmful the system because the devices is produced for 50 Hz.

Q8-) We find electrical power at the question 6 and we need to find power given the grid.

Power given the grid = 1.8 * 0.90 = 1.62 MW

Efficiency = (1.62 / 3.725) * 100 = %43.5

Q9-) Purpose of the gearbox is to increase the rpm (revolutions per minute). The blades rotate very slowly. In order to reach the correct rotational speed and generate power at the frequency needed by the grid, gearbox is needed.