

PROBLEM STATEMENT

The the vertical axis wind turbine shown in Figure is used to produce electric energy from medium wind. The system is designed to produce electric power for domestic application, at free wind speed ranges between 5 to 40m/s. The power out put is calculated from the following equation:

$$P = \frac{1}{2} \rho v^3 2R h c_p$$

Where, ρ = air density, 1.25kg/m³

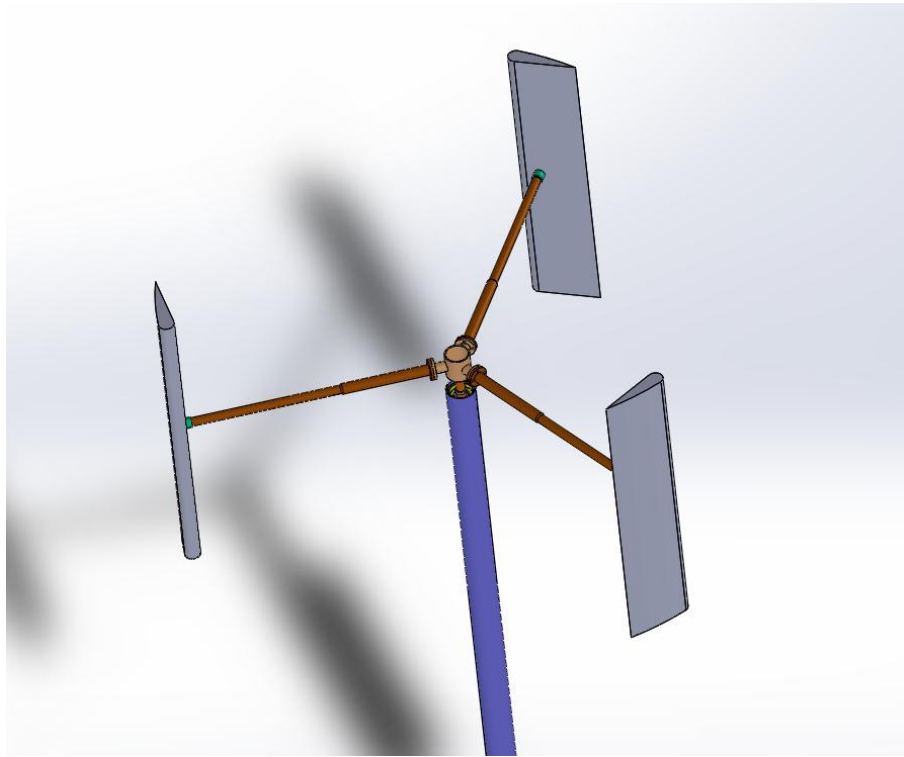
v = wind speed, m/s

R = rotor radius, m

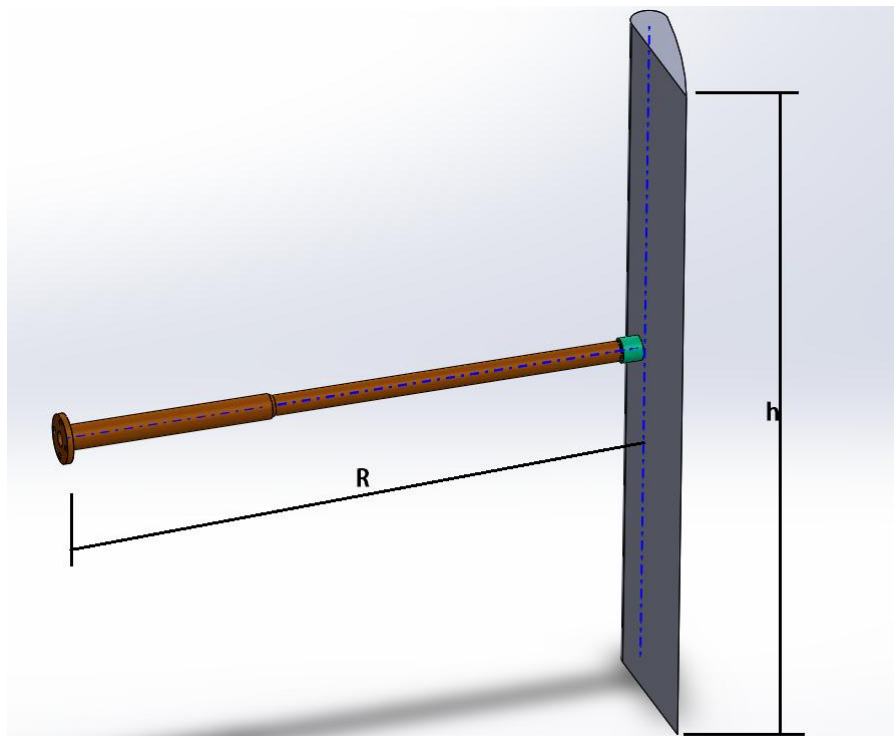
h = height of the rotor, m

c_p = power coefficient of the turbine, ranges between 0.4 and 0.5

The rotor of the turbine is mounted on a vertical shaft as shown in the figure. One end of the rotor arm is mounted on the rotor hub and the air foil is attached to the other end. The rotor hub is attached to the end of the shaft, which is supported on bearings at the bottom and top. The top bearing is an angular contact ball bearing and the bottom bearing is a deep groove ball bearing. The length of the vertical shaft is 5m, the end of which is connected to a generator. The capacity of the generator is 10kW.



Turbine Rotor



Rotor Arm

Problem

1. Design the rotor arm, if the weight of the airfoil is 6.5kg each
2. Design the rotor shaft if
 - a. the wind speed is 10m/s
 - b. the rotor arm length is 2.5m
 - c. the height of the airfoil is 2.25m
3. Find the magnitude and location of maximum stress
4. Locate the bearings and provide suitable support
5. Estimate the fatigue strength of the shaft material
6. Select right size bearings which can support the loads coming on it
7. Assume suitable material for the shaft and rotor arm
8. Prepare a CAD model of the rotor arm and the rotor shaft

Deliverables and Deadline:

Your Report should include:

1. Project Introduction. (5 Marks)
2. Literature Review (10 Marks)
3. Detailed design including: presentation of formula, selection of materials, making right assumptions where ever necessary, etc. (40 Marks)
4. CAD model of the shaft assembly. (10 Marks)
5. Summary of the design (5 Marks)
6. References (3 Marks)
7. Appendices (2 Marks)

1. The date of presentation (5%) will be on 21 November 2017, 9pm