LAST NAME SOLUTION Alphabetic # _____

FIRST NAME _____

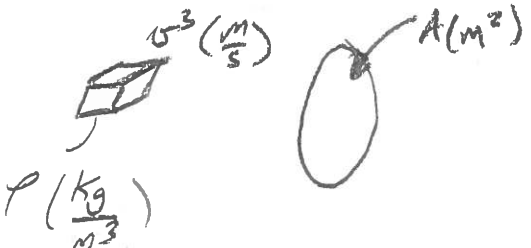
Quiz 7

1. Wind Energy:

a. (2.5 pts) Write the expression for wind's power content under equilibrium conditions?

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

b. (2.5 pts) Draw a diagram visually representing the physical components in the expression for wind's power content?



COULD ALSO HAVE A VISUAL LIKE THIS

c. (2.5 pts) Show that the units on each side of the wind power content expression are consistent.

E : ENERGY $= F \cdot d = Ma \cdot d = kg\,\frac{m}{s^2}\,m = \frac{kg\,m^2}{s^2}$

$P = \frac{\partial E}{\partial t}$; $\frac{kg\,m^2}{s^3}$ $\Longleftrightarrow$ MATCH.

$\rho A v^3 = \left(\frac{kg}{m^3} \cdot m^2 \cdot \left(\frac{m}{s}\right)^3\right) = \frac{kg\,m^2}{s^3}$

d. (2.5 pts) What is the relationship between the wind power content expression and the power that a wind energy conversion system (wind turbine) can convert to electric power system.

$P_t = C_p \frac{1}{2}\rho A v^3$; C_p IS A NON-LINEAR CONVERSION FACTOR THAT DEPENDS UPON WIND SPEED.

NAME SOLUTION

2. An anemometer mounted 10 m above a surface with crops, hedges, and shrubs, shows a wind speed of 5 m/s. Assuming 15°C and 1 atm pressure, determine the following for a wind turbine with hub height 80 m and rotor diameter of 80 m

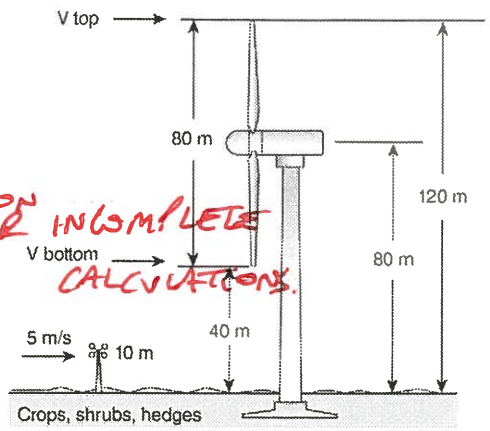


Fig P7.2

Terrain Characteristics	Friction Coefficient α
Smooth hard ground, calm water	0.10
Tall grass on level ground	0.15
High crops, hedges, and shrubs	0.20
Wooded countryside, many trees	0.25
Small town with trees and shrubs	0.30
Large city with tall buildings	0.40

Friction Coefficients for Terrain Types

DOCK NO MORE THAN .5 POINT FOR CALCULATION MISTAKES OR INCOMPLETE CALCULATIONS.

a. (3 pts) How much power will the turbine produce under these conditions?

$P_t = C_P \frac{1}{2} \rho A v^3$

$A = \pi \left(\frac{D}{2}\right)^2 = \pi R^2$

$\rho = 1.225 \ kg/m^3$

$v_0 = 5 \ m/s$

$v = \left(\frac{H}{H_0}\right) v_0 = \left(\frac{80}{10}\right)^{.5}$

$\alpha = .2$

$P_t = C_P \frac{1}{2} \rho (\pi R^2) v^3$

b. (3 pts) Estimate air density at 2500-m at 10°C

IDING/FINDING INTERESTED IN STUDENT UNDERLINED EXPRESSION

$$\rho = \frac{353.1 \, e^{-\frac{(.0342)(2500)}{283}}}{283}$$

$T = 273 + 10° = 283°K$

C

$= .9224 \ \frac{kg}{m^3}$

ANS.

- DOES STUDENT USE CORRECT EXPRESSION
- USE °K
- USE CORRECT ALTITUDE

$$p = p_o e^{\frac{-.0342z}{T}}$$

$$\rho = \frac{353.1 e^{\frac{-.0342z}{T}}}{T}$$

$$pV = nRT$$

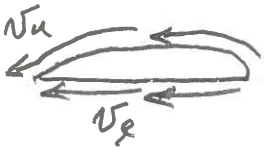
$$\left(\frac{v}{v_o}\right) = \left(\frac{H}{H_o}\right)^{\alpha}$$

$$\left(\frac{v}{v_o}\right) = \frac{\ln\left(H/l\right)}{\ln\left(H_o/l\right)}$$

$$\left(\frac{P}{P_o}\right) = \left(\frac{H}{H_o}\right)^{3\alpha}$$

⇒ DOCK NO MORE THAN .5 POINT FOR CALCULATION MISTAKES OR OMISSIONS.

c. (4 pts) Use Bernoulli's principle to explain lift on a wing. Include a diagram.



AIR MOVING OVER THE WING'S TOP TRAVELS A GREATER DISTANCE. RESULTING IN LOWER PRESSURE ON THE TOP SURFACE ⇒ PRODUCING LIFT.

CAN ALSO INCLUDE ARGUMENTS ALONG THE LINES.

$\frac{1}{2}\rho V_u^2 + \rho g z + P_u = \text{CONSTANT} = \frac{1}{2}\rho V_e^2 + \rho g z + P_L \ ; \ z_u \approx z_e = z$

$\frac{1}{2}\rho V_u^2 + P_u = \frac{1}{2}\rho V_e^2 + P_e$; IF $V_u > V_e$ THEN $P_u < P_e$

Bonus:

(1 pt) Define "value" (in the sense of beliefs) A VALUE IS A BELIEF THAT ORIENTS THINKING & TO IDENTIFY MOST IMPORTANT BELIEFS.

(1 pt) Define "character" (in the sense of beliefs / values)

CHARACTER IS THE CONNECTION BETWEEN ONE'S VALUES AND THEIR ACTIONS. IE. GOOD CHARACTER IS MARKED BY ACTIONS CONSISTENT W/ VALUES.